THE VALUE OF ANTHROPOGENIC SEDIMENT TO ARCHAEOLOGICAL STUDY

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ABSTRACT

Anthropogenic sediments, particularly those found in constructional contexts, have been used rarely for the purpose of deducing ancient cultural activities, especially at tel sites. Traditionally, for these types of archaeological enquiries, the emphasis has been on studying architectural features such as walls and floors, sealed deposits, or *in situ* artefact assemblages. In contrast, this thesis examines the potential systemic information that can be derived from anthropogenic sediments. As these sedimentary deposits are formed or allowed to accumulate as a consequence of human activities, it is suggested that they contain similar culturally significant information as other artefacts and features, and thus deserve to be studied as such.

In an effort to create an interpretive foundation for the analysis of anthropogenic sediments, a standardised terminology is proposed and a catalogue of materials and formation processes is created. As well, the systemic significance of various elements contained within the deposits, such as pottery shards, bones, the chemical composition of the earthen material, and the physical properties of the earthen material is examined.

To test the applicability of the interpretive foundation, a case study was conducted on a small sample of anthropogenic sediments from the site of Tel Dor, Israel. These sedimentary deposits were derived from a variety of functional and systemic contexts dating from the Persian to Roman periods. It was found that the careful examination of this sedimentary component of the archaeological site provided useful 'added value' to the analysis and interpretation of a number of systemic processes and contexts that related to the occupation of the ancient city of Dor. Information was obtained about construction materials and methods, ancient human activities that had occurred in the excavated area, and dates of construction and abandonment.

This thesis shows that anthropogenic sedimentary deposits are valuable features of archaeological sites. It demonstrates that the theoretical and archaeological frameworks that have been developed through this research can enhance significantly the archaeologists comprehension of the systemic reality revealed through the excavation of archaeological sites.

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This thesis could not have been completed without the assistance and encouragement of a large number of people. I will begin by extending a heartfelt thank you to all of the volunteers and students that participated in the excavation of area D1 at Tel Dor during the seasons I was collecting data for this thesis; I simply could not have done it without you! I cannot express my appreciation for your patience, understanding and careful excavation when I was asking you to be particularly diligent with material that everyone else on the site was heedlessly tossing into the dump. Although the list is far too long to name all of these important people, I would like to thank Jackie, Kristin, Jody, Jaret and Peter from the 1996 field season, and the 1997 square supervisors – Anna, Brandi, David, Karla and Zenon. I would like particularly to thank Peter Popkin for his additional help with the collection of bone data and for his work as area recorder during the 1997 season. Other people from Tel Dor who I must thank for their assistance, ideas, and contributions to this work include: Gila Benadiva Zionit, John Berg, Bracha Guz-Zilberstein, Dr. Ilan Sharon and Dr. Ephraim Stern.

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To my mother.

CHAPTER ONE

Site formation studies must not be seen as an optional extra, or an esoteric dream, but rather the heart of archaeological endeavour.

Quine 1995:96

1. Introduction

This thesis examines the role that anthropogenic sediments from tel sites can play in the enhancement of archaeological interpretation. It is proposed that sedimentary deposits, which have been created by the activities of past peoples, can be studied as features like other *artefactes fixes* such as walls, tabuns and paved streets. In this way, the archaeological importance of these features is not limited solely to that of the context in which artefacts, such as pottery shards, beads, figurines, etc. are recovered. Instead, it is suggested that anthropogenic sediments in and of themselves can provide information about the activities of past peoples, just like the artefacts they contain. This perception of sedimentary deposits is derived from a theoretical approach that emphasises the importance of formation processes in any archaeological inquiry: to interpret properly the artefacts found within deposits, it is first necessary to understand the nature of the deposit itself.[1] By looking at the formation processes of artefacts, it was not difficult to extend this theory to the examination of the sedimentary deposits themselves. As tel sites are the result of

[1]The theoretical framework for this study is known as Behavioural Archaeology, as proposed by Michael Schiffer (1976 and 1987). This approach argues that past activities by people are responsible for the creation of archaeological deposits. Thus by thorough study of these accumulations, the behaviour that placed the various artefacts in that specific context can be discerned. Since their original deposition, however, both the artefacts in the deposits, and the deposits themselves have undergone a series of transformations (both cultural and natural) that have caused their alteration. As a result it is imperative to clarify the formation processes (transformations) and the context of the remains in order to interpret properly the behaviours involved in their creation. A detailed discussion of this theoretical framework and how it was enhanced, is found in Section 2.1.

enormous quantities of anthropogenic sediments contained within a skeleton of walls and floors, the proper study of these deposits is thought to be an as yet untapped resource of important data about the manner in which ancient peoples existed in their commercial or domestic space.

1.1 Origin of Study.

One of the main reasons that I began studying archaeology was a curiosity about how ancient peoples in the Near East went about their daily lives – what they would have seen, how they would have interacted with both their natural and urban environments. Out of this interest I had chosen initially a thesis topic that would have allowed me to examine the urban environment of an archaeological site. I had intended to develop a spatial plan of an ancient Near Eastern city for a specific time period; to analyse the spatial patterning of buildings and activity areas during a specific phase of occupation at the multi-phase/multi-component tel site of Tel Dor in Israel. As I pursued this project, however, I became increasingly frustrated in my efforts to achieve a clear picture of a distinct phase of occupation in this archaeological context. I had encountered one of the "great problems of archaeology ... the problem of how much of one level was simultaneously under occupation at any one time" (Kemp 1977:125). I discovered that the types of data that were collected were not sufficiently precise to facilitate such a study. At issue was the problematic identification of phases to the architectural features, like walls and foundations. The phasing, or dating, of the walls had been based exclusively upon architectural stratigraphy. While usually a reliable method for phasing architectural remains, the complexity of walls and foundations made this task incredibly difficult.

Unlike earth stratigraphy, which sees archaeological sites as having accumulated gradually by sequenced layering of sedimentary deposits (both natural and anthropogenic), architectural stratigraphy views sites as having been built intentionally. This latter approach emphasises the construction/destruction cycle of site formation, where large amounts of debris accumulate in relatively short periods of time, from a few minutes to a few weeks. These mass accumulations are then followed by long periods of stasis that are marked by relatively little build-up of sediments until the next construction/destruction event. As a result the important temporal relationships for architectural stratigraphy are those between walls and between walls and floors, rather than between layers of earthen deposits.[2] In fact in some cases, the detailed study of the stratigraphic elements of these 'built' sites stop at walls and floors and no attention is paid to the

[2]For a more complete discussion of both earth and architectural stratigraphy see Chapman, III 1986; Dever 1973; and Sharon 1995a.

sedimentary or 'non-architectural' deposits (Sharon 1995a:73).

In the case of Tel Dor, architectural relationships frequently were obscured by the lack of clearly defined floors and the continuity of the town plan from the Persian through Roman periods (550 B.C.E. - 132 C.E.). Often, certain walls remained in use for hundreds of years. This resulted in their association with numerous sequences of partition walls and series of floor fragments that could not be phased clearly. Occasionally, this situation would lead to the creation of up to four or five sub-phases for a given period in a single area of the site. As a consequence, it was rarely possible to evaluate reliably the contemporaneity of any two architectural features, let alone entire structures. This presented a wall of a different nature in my attempt to study the spatial patterning of buildings and activity areas.

At this point I began to search for other means of identifying the phasing and contemporaniety of features so that I could have a new source of data from which a spatial plan of the city could be developed. I determined that a solution to this difficulty could be achieved through an analysis of sub-structure construction; that is, the earthen materials in which the structure's foundations are embedded. Like walls, wall foundations and floors, this earthen fill is the direct result of construction events that occur in a very short time span. Due to the vast amount of construction that took place on tels, these deposits, commonly known as constructional fills, form the majority of the anthropogenic remains in ancient mound sites. And while the 'valued' elements of architectural stratigraphy may be too complexly organised (in the case of walls and wall foundations) or rarely present (in the case of floors), this type of fill is the one constructional component that is almost always present and can be related to building events. I began to believe that by treating constructional fills as *artefact fixes*, that is to say features, like walls or foundation walls, these deposits could be additional elements used to infer the deliberate human activity reflected in their deposition. It was at this point that I decided to centre my research on an analysis of constructional fills, with the aim of determining the potential of these deposits to assist in the establishment of chronologies for architectural features.

It quickly became apparent, however, that there was yet another more pressing reason for examining constructional fill, or for that matter, any anthropogenic tel sediment. To date there has been no systematic research conducted on this type of material. The basic understanding of the tel sediments, and especially constructional fills, was primarily intuitive and pragmatic. These materials were interpreted on the basis of such sediments having been dug through in the field rather than having been studied quantitatively and methodically in the laboratory. This practice was due to the general perception that we 'already knew' what constructional sedimentary deposits were, and that they were not of great stratigraphical importance.[3] Constructional fills were thought to be the result of heavily mixed collapsed building material that had been transported to the area of study for construction purposes, such as levelling of the site and the filling in of pits and other unconformities, prior to the erection of a new building.[4] The main archaeological function of these anthropogenically derived sediments was to provide a context for the *artefacts mobiliers* like pottery shards, bones and tools, which are so prevalent in these deposits. Unlike *in situ* deposits or burial assemblages, constructional fills contained a large amount of redeposited materials that did not relate directly to specifically identified activities or activity areas. As a result, the 'stratified accumulations' of constructional fills were considered to be of little archaeological or chronological value when it came to the interpretation of the site.[5] Nothing more than anecdotal evidence, however, had ever been provided to support this supposition (see encounter cited in footnote 3).

Given that constructional fills form the bulk of most tel sites in the Near East, and that such material is a major component of the sub-structure of buildings, the lack of analysis is distressing. In further study of constructional anthropogenic sediments I became increasingly aware that **all** types of anthropogenic sedimentary deposits had received very little academic attention, particularly the nature of their formation processes and their potential as independent units of archaeological evidence. How could archaeologists begin to understand and interpret the archaeological material (artefacts and ecofacts) they were removing from these sediments if they had never actually studied the deposits themselves? And indeed, how could archaeologists know what the archaeological and chronological values of anthropogenic sediments were *a priori* to any analysis? To address these issues I decided to study empirically a group of anthropogenic sediments from Tel Dor, under the premise that these sediments are entities in and of themselves, and that the deposit (viewed as an artefact) should have chronological, stratigraphical and behavioural significance. This possibility simply has never been tested.

I am not the first to take the position that a broader definition of artefact is warranted in

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[3]I can recall a memorable conversation with a Near Eastern field archaeologist and stratigrapher, about this very subject. Upon discovering that my thesis topic was focusing on a study of constructional fills, his very words were: "Why are you doing that? We already know what it is. There are far more important things to study." What followed was an extended conversation about why this should be an important area of study.

[4]See Gitin 1990:15; Kenyon 1974:56; Lloyd 1963:17; Rosen 1986:16; Saragusti and Sharon 1995:235; Ussishkin 1977:38 and 1978:21,31,34; and Van Beek 1988:139.

[5]In a discussion of architectural stratigraphy William Dever noted that in this method of analysis, "It is assumed that ... nothing of importance is to be learned from fills and other such debris-layers, nor from the material in them." (Dever 1973:7*)

elucidating cultural processes. Indeed, William Dever has said much the same thing about tels, as has Timothy Quine, about archaeological micro-sediments. Dever advocates strongly that tels should be considered as artefacts, since they are "central phenomena of the overall cultural process" (Dever 1996:38). Quine advances the idea that it is necessary to move beyond the 'artefact-based' approach to archaeological analysis, stressing that sedimentary deposits hold a great deal of important information for archaeologists, particularly in the area of site formation processes (Quine 1995:77). However, I have yet to encounter anyone who has attempted specifically to treat 'deposits' as artefacts, and to establish their archaeological value. This thesis is a first step in this direction.

1.2 Tels

The type of site, to which this analysis of anthropogenic sediments is directed, is known as a tel. This kind of site is an archaeological phenomenon that is limited geographically to western Asia. They are found only in the geographic region bounded by the Indus River in the east, southern Israel in the southwest and eastern Anatolia in the northwest (Wright 1974:123). Not only are tels limited geographically, but their initial development was limited also to a specific time frame. The Early Bronze through Iron Ages (ca. 3100 - 600 B.C.E.) were the most important periods for tel development in the Levant (Rosen 1986:18). While these sites continued to be inhabited and to grow in the later periods, some having had continuous occupation through to the present day, no new tels were formed following the Iron Age. Due to their intensive and confined formation processes, tels have presented unique and complex problems for archaeologists over the past number of years that are specific to these archaeological phenomena.[6]

The term tel is an ancient word, occurring in both Hebrew and Arabic, which is derived from the Akkadian *tillu*, meaning "ruin heap" (Van Beek 1988:131). In present contexts the word tel retains that same general meaning, being broadly defined as an artificial mound (as opposed to a naturally occurring geographical feature) that contains the buried remains of an ancient city or settlement. The creation of these artificial mounds was the result of superimposed remains of human settlements being frequently destroyed and rebuilt at the same location (see Figure 1.1). Over time, as the site repeatedly passed through this construction/destruction cycle, the resulting sequential layers were representative of the sequential phases of occupation. Thus the site grew to form an artificial mound (see Figure 1.2).

[6]A fuller discussion of this, and tel formation process in general, is to be found in Section 3.2.

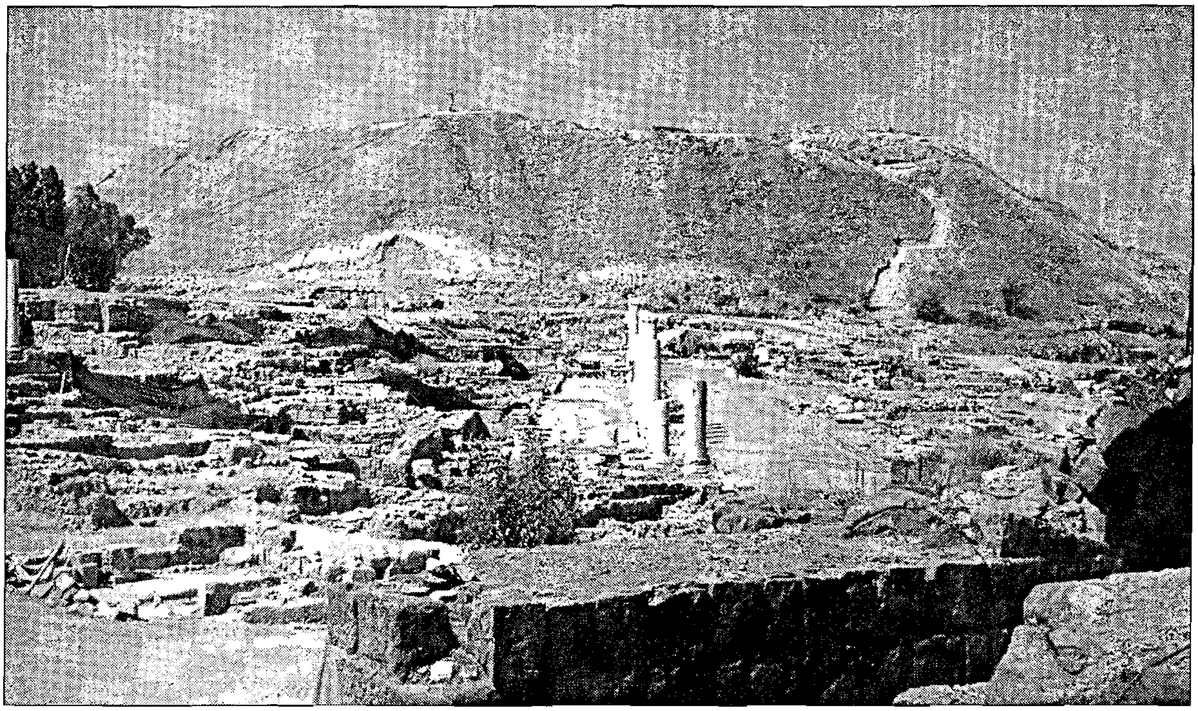

Figure 1.1 The large tel at Beth Shean, Israel. The ruins in the foreground belong to the lower city built during the Roman Period. The tel stands over 30 metres in height, and was created primarily in the Bronze and Iron Ages.

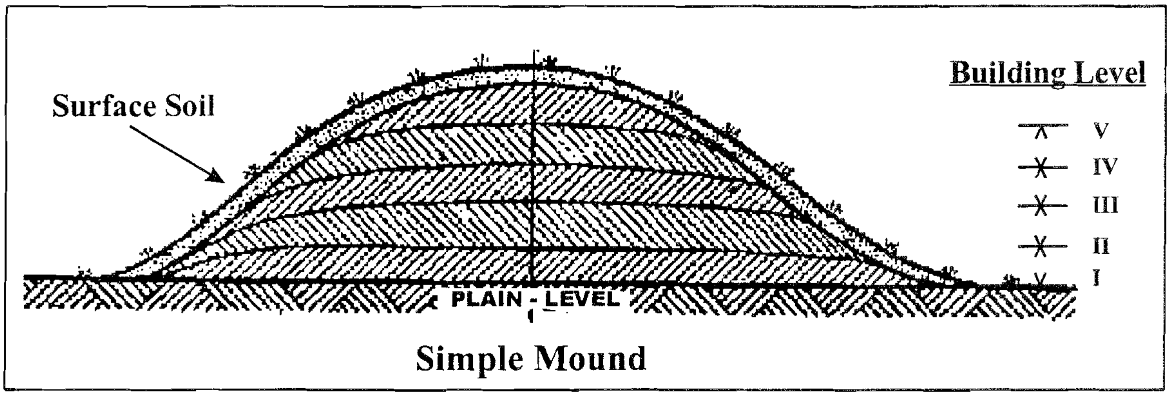

Figure 1.2 Schematic of a simple tel with the 'layer-cake' form. Adapted from Lloyd 1963.

The layers of tels usually are likened to a layer cake, where each creamy layer represents an occupational phase that is uniformly separated from the next occupational phase by a site-wide destruction or abandonment event.[7] This view of tel site formation has played a large role in the

[7]In my review of the literature, this 'layer-cake' analogy is almost always presented in any book or article that seeks to define a tel. This is true of the whole range of literature, from introductory texts (such as Turnbaugh *et. al.* 1999:438) to Ph.D. dissertations (see Sharon 1995a:260) and everything in between (see Lloyd 1963:18; Rosen 1986:9; and Van Beek 1988:133).

development of the architectural stratigraphic method of analysis and interpretation already mentioned in Section 1.1. Archaeologists today, including those who belong to the architecturalist school of thought, recognise that most tel stratigraphy is much more complex and convoluted than this. The implicit assumption of the layer cake model is that the entire site was repeatedly constructed simultaneously and then destroyed simultaneously. Most sites, however, did not experience such a tumultuous history. Many, including Tel Dor, had extended periods of uninterrupted occupation where the vast amount of mound accumulation was the result of individual construction/destruction events of single structures or small areas of the city or settlement. These localised intra-site processes resulted in a variety of deposits and architectural features in often ambiguous stratigraphic associations. The many activities involved in these small-scale construction/destruction events include: the collapse of buildings, the accumulation of refuse in vacant lots, the renovation of extant structures, and the demolition of small sections of the city for urban renewal. To accommodate all these processes, and many others, new building material would be brought onto the site, and the debris and refuse already present would accumulate and eventually be moved around the site, usually as constructional fills. For archaeologists today, this has resulted in a type of site that has been described as "an unholy mess" (Lance 1978:74), see Figure 1.3.

1.3 Research Program.

Anthropogenic sediments are important archaeological features in tel sites, which contain very little evidence of natural sedimentary deposits. Because of my previous excavation experience at Tel Dor, I was acutely aware of the quantity of these sediments in the mounds of ancient cities, and I became increasingly curious about the potential of anthropogenic sediments to reveal aspects of ancient people's lives. It was from this place of intellectual inquiry that the research program for this thesis arose.

As mentioned in Section 1.1, this study puts forward the position that anthropogenic deposits are just as useful as *artefacts mobiles* in elucidating cultural processes. Further, this study proposes that an examination of these deposits can provide valuable information about archaeological sites that may be otherwise overlooked or ignored. As anthropogenic deposits were created by the activities of past people, much like the objects found within them, it is hypothesised that the proper study of these deposits can yield valuable information about behaviour and activities of previous cultures and periods.

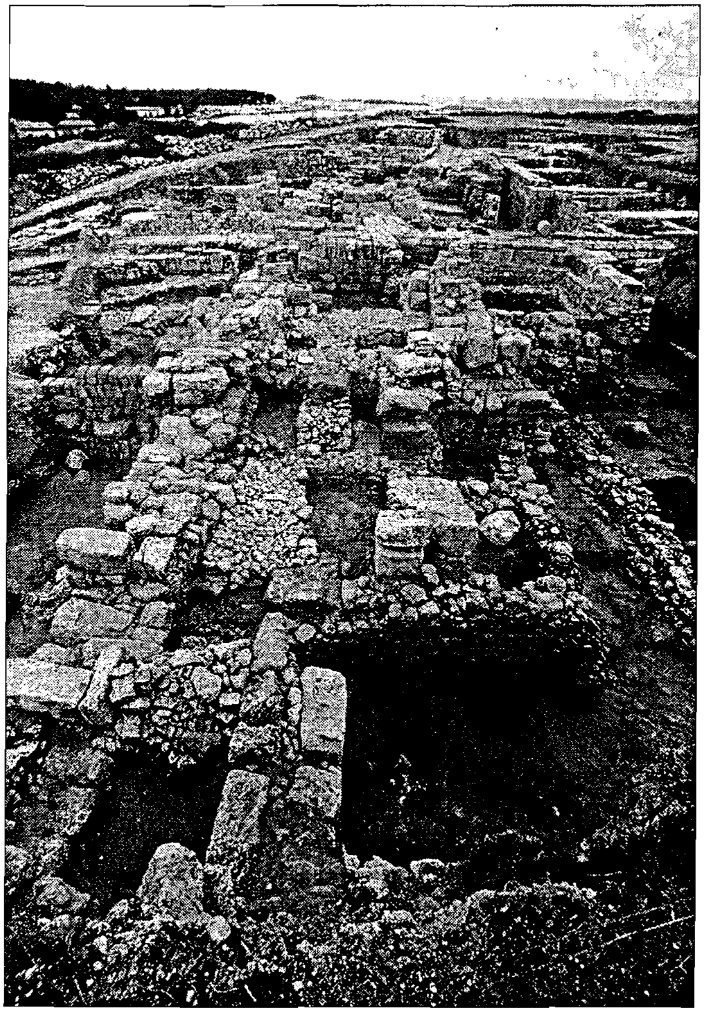

Figure 1.3 General photo of a small area of a tel that has undergone excavation. The photo was taken of area B at Tel Dor, Israel. Note the variety of wall and foundation wall construction styles across the exposed area. In many cases definable structures or occupational layers are not evident.

To begin the process of understanding the nature of anthropogenic sediments it was first necessary to examine the theoretical foundation upon which this study could be based. Schiffer's "Behavioural Archaeology" framework (as mentioned in section 1.1) was chosen because of his emphasis on the importance of understanding formation processes as windows to past human activities. To make this theoretical approach relevant to the study of **deposits**, rather than to artefacts alone, and to address the major criticisms that have been levelled against behavioural archaeology, some modifications and enhancements had to be proposed.

To further enhance the theoretical basis of this study, the enigma of the archaeological terminology and classification systems that surrounds this material had to be clarified. While I always had been aware of some variability in the way sedimentary deposits from tels had been described, I was surprised nonetheless at the difficulty I encountered in writing about this material because of the ambiguous descriptions it had received in the literature. Often the classification system of sedimentary archaeological deposits varied widely from site to site and from archaeologist to archaeologist. It was not uncommon for a number of archaeologists to use the same term, but for it to mean entirely different things. A good example of this is the word 'fill', which has been used to mean anything from an unspecified sedimentary deposit (Gitin 1990:20 and Herzog *et al.* 1978:109) or a destruction layer (Sharon 1995a:71), to acting as a shorthand for constructional fill (Tufnell 1958:45), robber trench fill (Ussishkin 1978:31), and pit fill (Ussishkin 1978:41), among others. While the use of the word 'fill' as shorthand is understandable, unless its true nature is specified, it can lead to ambiguity in site reports and articles. As a descriptive term, 'fill' (and many other terms, like 'sediment', 'soil', 'strata', etc.) has become essentially meaningless. To address this area of confusion, I found it necessary to develop a new classification scheme for anthropogenic sediment. Both this proposed classification scheme and the modification of Schiffer's theoretical framework can be found in Chapter Two.

Once the theoretical approach to this study was developed, the nature of the formation processes for different types of anthropogenic sediments had to be clarified with emphasis on those deposits that can be found at tels. To achieve an 'atlas' of cultural sedimentary deposits, it was necessary first to identify and examine the types of materials that ultimately become incorporated into these deposits. The majority of these elements were building materials for new structures that had degraded over time. The second step was to identify the processes of degradation to which building elements had been subjected, and to identify the manner in which they became incorporated into the sedimentary matrices of the tel. In order to gain a comprehensive understanding of the processes that occurred during the normal and ongoing redevelopment of these sites, a 'Construction Cycle' was developed. The final step in this development of a system of criteria for interpreting the formation processes of anthropogenic sediments was to identify the systemic contexts that could be inferred from the archaeological contexts of these sediments as uncovered during excavation. In other words, it was necessary to provide a method of relating the deposits that had been identified in the field to systemic (or behavioural) processes that caused their deposition. Chapter Three outlines the processes that participated in the creation of anthropogenic sedimentary deposits, and articulates how the various types of deposits can be systemically interpreted.

As my study postulates that the specific elements which form sedimentary deposits, such as pottery shards, bones, and chemical components, contain systemic information in and of themselves, it was necessary to investigate the known qualities associated with these primary elements typically found at a tel site. Chapter Four addresses this issue by presenting the systemic data that anthropogenic sediments can yield, and creates a context within which to determine the nature of activities that occurred in the area of the deposit's formation.

In order to evaluate the usefulness of the theoretical framework, the archaeological framework and the significance of deposit elements, a case study was undertaken. The study of a select number of different anthropogenic sediments from the 1997 season of excavation at Tel Dor was conducted. These sediments were thoroughly analysed, with most aspects of their composition being recorded (including: total count and weight of pottery shards by size and form, total count and weight of bone fragments, particle size analysis, and phosphorous analysis). From this limited sample of sediments, the resulting data were examined to ascertain as much systemic information as was possible from these "not terribly important" sedimentary deposits. The results from this case study can be found in Chapter Five.

Through this research program it is shown that anthropogenic sediments are important archaeological features that do provide important systemic information that is not always identifiable through the traditional methods of archaeological data recording and analysis. Rather than completely replacing the architectural and sedimentary schools of archaeological interpretation, or some combination of the two, the systematic study of sedimentary deposits provide a 'value added' tool in the archaeologist's repertoire that complements existing methods of analysis. I believe that by the thorough study of these materials, there is new hope for clarifying our understanding of how ancient peoples functioned in their daily lives.

CHAPTER TWO

2. Theoretical Framework

In presenting the theoretical framework of this thesis, two important issues need to be addressed. The first of these examines the archaeological theory behind the study and interpretation of anthropogenic sediments. The second topic centers upon the classification and terminology utilized in discussing and describing anthropogenic sediments, both in the literature and this study. This issue is considered to be an important aspect of the perception, both theoretical and physical, of this material. As such the language used to describe anthropogenic sediments has a profound influence on our comprehension of these deposits and the way in which we frame our study of this material.

2.1 Behavioural Archaeology.

The theoretical approach adopted for this thesis falls under the broad category of "behavioural archaeology" as put forth by Michael B. Schiffer in his book *Behavioral Archaeology* (1976) and more specifically "the transformation perspectives of behavioral archaeology" discussed in his *Formation Processes of the Archaeological Record* (1987). This theory along with some modifications made to enhance its applicability to the study of anthropogenic sediment is discussed below.

2.1.1 The Theory.

The concept of behavioural archaeology begins with the maxim that past activities result in the deposit of cultural materials. Thus, when these deposits are found in archaeological contexts, they can be used to infer the behaviours that caused their deposition. This theory goes on to declare, however, that there is **not** a **direct** relationship between the archaeological deposit, what Schiffer calls the archaeological context, and the interpretation of the past behaviour, known as the systemic context (Schiffer 1976:11-12 and 1987:3-6). Instead, behavioural archaeology suggests that since the time the artefacts in archaeological deposits were used initially by people in their systemic contexts, they have undergone a number of transformations caused by cultural and natural processes. These non-primary cultural (c-transforms) and natural (n-transforms) or environmental operations on deposits of material culture have resulted in the smudging of the connection between the original systemic context of the artefacts and their archaeological context. In order to remove the distortion created by the various transformation processes so as to achieve an accurate understanding of past behaviour, these same processes themselves must be studied. This is the transformation perspective of behavioural archaeology (Schiffer 1987:8-11,21-22).

Schiffer proposes that c- and n-transforms are quite regular in their causes and consequences. As a result of this regularity, he believes that the transforms can be described by "experimental laws" (Schiffer 1987:22). These transformation laws are intended to describe the general regularities of formation processes and can be elucidated through extensive analysis of the archaeological record and ethnographic research. Specifically, the study of c-transforms attempts to understand and establish artefact patterns related to the transformation processes associated with discard, reuse and recycling (in Schiffer's terminology this would include the creation and distribution of earthen works like constructional anthropogenic sediments), as well as cultural post-depositional disturbances such as ploughing and looting. The study of n-transforms examines artefact patterns associated with the non-anthropic aspects of transformation processes such as bioturbation, decay, erosion, and flooding.[1] It is through an understanding of the manner in which these processes are reflected in the archaeological record that it is possible to sort out the artefact patterns that are the result of c- and n-transforms, as opposed to the patterns created by the systemic context. Therefore, in order to properly "read" the archaeological record, archaeologists must apply the laws of c-transforms and n-transforms "to eliminate the distortions introduced by formation processes" (Schiffer 1976:42). It is only at this point that Schiffer believes the systemic context, or the behavioural aspects of a deposit, can be revealed. Thus, it is through the intense and appropriate study of the material in a deposit (pottery, bone, tools, etc.) that the nature of the transforms can be uncovered and cleared away so as to expose the past behaviour related to the artefactual remains in the deposit.

If transformation processes are not recognized and accounted for prior to analysis of

[1] For further information about c-transforms and n-transforms see chapters 3-9 in Schiffer 1987:25-262.

archaeological data, the resulting artefact patterns may have little to do with the behavioural phenomenon being investigated, and much to do with post-depositional transformations that have re-patterned the remains. The necessity for the study of formation processes of archaeological deposits has led Schiffer to state that "unless the genesis of deposits is understood, one cannot infer the behaviours of interest from artefact patterns in those deposits" (Schiffer 1983:675).

At the risk of being repetitive, plainly stated, the theory of behavioural archaeology proposes that while behaviour initially may have produced an artefact pattern, a variety of post-depositional activities, both cultural and natural, have altered that pattern. It is this altered pattern that is preserved for archaeologists. There can be **layers** of behavioural phenomena involved in the creation of the archaeological record. These post-depositional activities or transitions must be unraveled through careful study to reveal the behaviour patterns of the artefacts in the original deposit.

In principle, the need to clarify formation processes before engaging in archaeological interpretation of the artefacts or deposits has gained wide acceptance within the field of Near Eastern Archaeology. Many archaeologists extol the virtues of this approach and have used it as the theoretical framework for their research.[2] Unfortunately this level of enthusiasm has yet to reach the site report.[3]

There have been some criticisms of Schiffer's theoretical approach, based mainly upon the inability of archaeologists to remove all the distorting influences of post-depositional activities from the archaeological record.[4] The most resonant criticism relates to the large number of transformation processes, particularly c-transforms, to which some artefacts have been subjected, which has resulted in deposits of extreme complexity and variation. This is particularly true of Near Eastern tel sites, where the possibility of extracting the original systemic context of all the artefacts in a deposit is seen to be unattainable. As Ilan Sharon points out: "... the patterning of the most common artefact on the *tell* -- loose sherds in constructional fills, offers few clues, if any to behavioral patterns" (Sharon 1995a:125).

This main criticism of Schiffer theory implies that its implementation in many

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[2] See Barham 1995; Bullard 1970; Davidson 1973; Dever 1996; Goldberg 1992; Hassan 1987; Matthews 1992; Matthews *et.al.* 1997; Rosen 1986; and Rowley-Conwy 1994.

[3] There is no mention of the importance of interpreting formation processes in the site reports for well documented sites like: Tel Dor (Stern:1995a), Gezer (Gitin:1990), Tell Keisan (Briend and Humbert:1980) or Tel Mevorakh (Stern:1978).

[4] For further discussion of this topic see Binford 1983:235; Sharon 1995a:119-128; and Watson 1986:450.

archaeological situations is impractical. I would have to agree with this criticism if the theory remains the way it has been originally put forth. I do not think, however, that this should result in the abandonment of this approach. Instead I propose that this shortcoming of 'Behavioural Archaeology' can be corrected by slightly modifying the theory in two main ways. The first modification is made to Schiffer's understanding of the systemic context being limited to the 'original' function or behaviour associated with an artefact. According to Schiffer, once an artefact is no longer being used as it was first intended, it is no longer in its systemic context, but has entered the realm of c-transforms. While in some cases this may very well be an accurate evaluation of the situation, in others, artefacts that are in a re-cycling or re-use context can take on an entirely new systemic context for themselves as unique entities. This is particularly true if they are no longer a part of the initial functional object in which they originated (for example a ceramic shard is no longer part of its original vessel). As a result, an incomplete artefact such as a shard that is selected for and used for a specific purpose has a systemic context that is worthy of archaeological investigation, and is 'original' for that artefact. These types of past behavioural activities are not just transformations that need to be cleared away to elucidate the function of the first incarnation of archaeological remains; they are indicators of other, equally important, behavioural activities. In other words, almost every c-transform can create a new systemic context.

Additionally, Schiffer's theory as it has been presented lacks recognition that the deposit itself can also be the result of a primary behavioural activity, and thus have an original systemic context. This omission is due to Schiffer's emphasis upon objects found within deposits, and not on the deposits themselves. This is reflected in his classification scheme for archaeological material, which will be discussed in Section 2.2.1.

Despite my concerns, I accept the underlying principle of Schiffer's theoretical framework, that the archaeological record reflects a distorted image of past behaviours and activities and that these distortions can be reduced through a thorough study and interpretation of the genesis of the context in which the deposits and other artefacts are found. Nonetheless, I also acknowledge aspects of the criticisms leveled against this theory, particularly that not all behaviours are reflected in the archaeological record and that artefacts utilized in derivative functional ways and deposits can have their own systemic context. To incorporate a more realistic and viable theoretical approach I have chosen to modify Schiffer's system, while retaining the importance of understanding formation processes to bridge the gap in the archaeological record between the archaeological context and the systemic context.

2.1.2 Modification of the Theory.

The first modification of Schiffer's theory of behavioural archaeology that I applied to this system is the recognition that archaeological deposits have a systemic context of their own. As already mentioned in Section 1.1 and 1.3, this thesis treats archaeological deposits as *artefacts fixe*. This position is an extension of Schiffer's theory incorporating anthropogenic sedimentary accumulations into his framework, as I have already proposed. These sediments are the result of past behavioural activities, which are related directly to their specific formation processes. In other words, the deposits have a systemic context that is different from the systemic context of the objects contained within their matrices.[5]

The second modification that I introduce into this theoretical framework is the recognition that there are multiple systemic contexts for the remains found in the archaeological record, and that each is 'original' to that cultural behaviour or function, which caused its creation. While it is true, as the first criticism of Schiffer's theory indicates, that the **initial** systemic context of **all** the artefacts in a complex deposit can not always be elucidated[6], it is premature to suggest that no 'original' behavioural information on the remains can be acquired. As indicated above, at issue is the question of what is the 'original' behavioural context of the artefacts found in anthropogenic sediments. In other words, it becomes a question of perception, as a single artefact can report on a number of behavioural activities depending upon the archaeological context in which it is found and the systemic contexts in which it was used. Indeed, the re-use of broken artefacts gives these objects a new initial systemic context that is different from the initial systemic context of, for example, the vessel from which a shard originated. The behaviours associated specifically with re-used shards reflect their use as functional entities, rather than as a piece of a larger functional entity (in this case, a complete vessel). An example of this situation would be the use of a pottery shard as a foundation for affixing plaster to a wall, or as a replacement roofing tile, following its discard as a piece of a storage jar. In contrast to Schiffer's emphasis on elucidating the systemic context of the 'initial' nature of the original artefact, I propose that the systemic context of each of

[5] Quine 1995 and Stein 1987 both advocate a similar modification to the study of the formation of archaeological deposits.

[6] An example of the type of information that could not be elucidated would be the context in which an imported vessel was utilised in a particular household, when but a single shard of it was found in a constructional fill for a sewer installation.

the various phases of an artefact's 'life' can be equally informative in archaeological interpretation. This same concept holds true for deposits as well. Like artefacts that can have a series of 'lives' as they are used, broken, and re-used, deposits can be created and re-created repeatedly from the same source material. Each deposit can be laid down only once; every time it is altered through trampling, mixing, the addition of a new component, transportation, etc., a new deposit is created even though the same initial material may be present. Every new deposit is the result of a single depositional event, whether it be over a long or short period of time. As Julie Stein points out in her article 'Deposits for Archaeologists', should the contents of a deposit be moved and re-deposited "a second time a new layer is created, a layer that possesses a new depositional history, a new source, transport agent, and environment of deposition" (Stein 1987:351). In sum, the contents or sedimentary particles in a deposit, including pottery shards, bones and other artefacts, may each have a unique history, and it is through their collective study that it is possible to determine to source of the material utilized for an anthropogenic deposit.

With these modifications to Schiffer's behavioural archaeological theory, I have broadened the scope of the term 'systemic context'. This enhanced definition reflects the possibility that the past behavioural activities of interest to archaeologists are not always the very first functional uses that an artefact represents. Indeed, depending upon the context of the deposit and the focus of archaeological inquiry, different systemic context can be made available for study. The flow chart labelled Figure 2.1 provides an hypothetical scenario of various c-transforms that result in the creation of multiple systemic contexts. In this scenario three types of artefacts are traced over time from their original created context, to their presence in a new feature, an archaeological deposit. An original vessel, in this case a tea pot, was first made and used as a tea pot. Over time that role was changed to that of a flowerpot (perhaps it dribbled tea once too often, and was relegated to a decorative role). These two different roles for this pot are different systemic contexts, both informative about past behavioural activities. This pot could then have been broken, and one of the larger body shards used as a small scoop to dig holes, and through wear later became a small game piece. Eventually the shard was discarded into a rubbish midden. Again each time the artefact served a different functional purpose, it is representative of a different systemic context. This same pattern of use and re-use can result in different systemic contexts for mudbricks and for bones. These individual artefacts, once collectively in a midden heap, become part of the make-up of that single deposit, which has specific behavioural and cultural meaning. The midden deposit could undergo a c-transform that resulted in its transportation to a new site in the role of constructional fill.

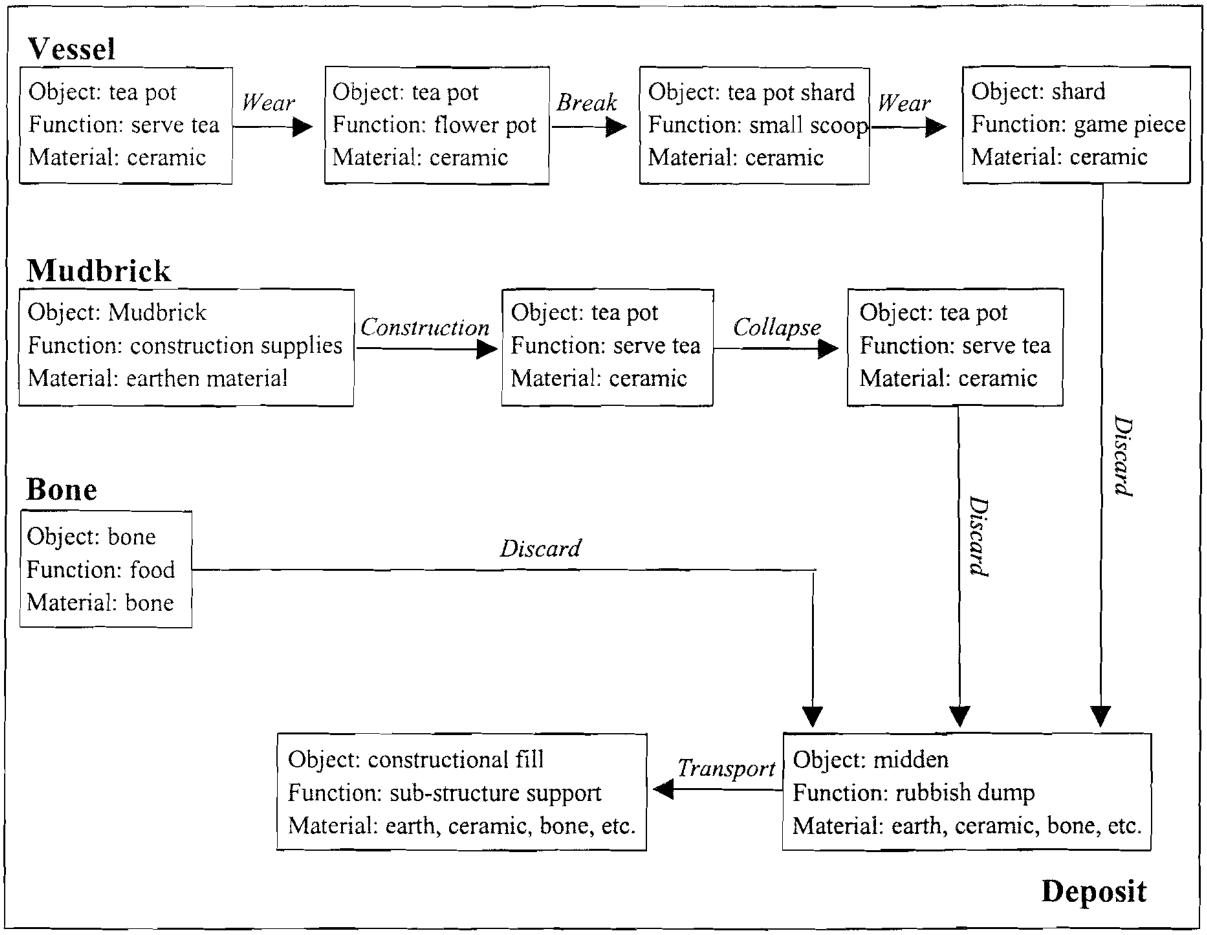

Figure 2.1 Flow chart of different types of systemic contexts. Each box represents a different systemic context for that particular object, each arrow represents a c-transform.

Although this is an artificially simplistic model of the relationship between different systemic contexts, the pattern of activity and the meaning associated with each activity holds true. At any point the systemic contexts that result from the c-transforms (or formation processes) can be interrupted. These arrested situations are what ultimately become preserved in the archaeological context. The task for the archaeologist interested in understanding behavioural process is to identify the systemic context represented by the archaeological record. Once this has been achieved it is then necessary to unravel the various levels of formation processes that have occurred to the material of interest until the systemic context of the research objectives is reached. For example, if a rubbish midden is uncovered and the research objective is to determine the kinds of animals that were consumed by these past people, the formation processes involved between these two systemic contexts is quite direct. If however, the research question is related to the first function of a particular vessel represented by a shard in the midden, then the various formation processes and systemic contexts represented in that path can be quite complex, and potentially impossible to resolve. It is useful to note that the systemic context of a deposit (such as a midden or a constructional fill) can contain artefactual elements that are no longer in an original systemic context themselves, but have been subjected to c-transforms so as to be brought together to form the deposit.[7]

As stated in section 1.3, the goal of this research program is to elucidate the cultural processes that are associated with the deposition of anthropogenic sediments. The precepts of behavioural archaeology provide the appropriate context for this study. The emphasis placed by this theory upon the nature of formation processes as they pertain to relationships between the systemic and archaeological contexts of the archaeological record is a particularly useful concept for this research. Schiffer's theory, as modified above, serves as the theoretical framework for this study.

2.2 Classification of Anthropogenic Sediments.

The next step in formulating an applicable theoretical framework for this study is the clarification of both concepts and terminology employed with respect to anthropogenic sediments. Like the discussion in section 1.2.2 regarding the confusion of terminology utilized when dealing with constructional fills, there is a similar level of ambiguity in the archaeological literature regarding the more general classification of sedimentary deposits as a whole. In his book *Archaeology as Human Ecology: method and theory for a contextual approach*, Karl Butzer remarked that: "There is no systematic body of data or even a list of procedures for dealing with cultural sedimentation in towns or cities." (Butzer 1982:87). While this statement was made over seventeen years ago, little has changed. In the past, as well as more recently, a number of systems of classification for anthropogenic deposits have been put forth, but unfortunately they have been

[7] Thus Sharon's comment quoted in Section 2.2.1, that the patterning of loose shards in constructional fills is not indicative of behavioural patterns (Sharon 1995a:125), is not entirely accurate. These artefacts may be too far removed from their very first systemic context so as to interpret properly that level of behavioural activity, but they are not so distant from a re-use systemic context that may display patterning in the constructional fills. Sharon does not acknowledge the potential behavioural information inherent in the deposit itself.

neither inclusive nor specific enough.[8]

It is important to remember that there is an intense interaction between the lexicon of a language and the perception and behavioural choices of the speaker. The words we use to describe the things around us, or that we observe, have a significant impact on our understanding of them (Dr. Mary Marino, University of Saskatchewan, personal communication). Thus when formulating a classification system for archaeological sedimentary deposits, it is of great importance to be precise and inclusive in the terms used. For if we are ambiguous in any way about what we mean, then it will only lead to confusion and for the potential of inaccurate information to be spread.

2.2.1 Review of Existing Classification Schemes.

One of the first people in Near Eastern archaeology to recognize the importance of the sedimentary matrix, and to develop a system of classifying it was Reuben G. Bullard. In his article "Geological Studies in Field Archaeology" in *The Biblical Archaeologist*, Bullard recognized that the stratified remains (the sediments) of tel sites were a "vital and highly important facet to the understanding of the history of a city" (Bullard 1970:113). In his study of the sediments and soils from Gezer, a large tel site in the Southern Levant, Bullard took an ecological approach, proposing that sediments were useful indicators of the interface between the city's inhabitants and their environment. He suggested that by studying archaeological sediments it would be possible to learn about three main areas of interest: a) how people exploited their surrounding resources (e.g. where they acquired their clays for pottery, etc.); b) how natural processes reflected human activity (e.g. abandonment); and c) how site altering processes could be identified in the archaeological record (e.g. flooding and earthquakes). To this end he developed a classificatory framework that provided a "genetically meaningful designation" (Bullard 1970:115) of the sediments, which addressed issues related to the primary composition of the sediment, the manner of its deposition, and the agency responsible for the occurrence of the sediment in its particular context. In this classificatory framework, Bullard identified six sedimentary groups: occupational sediments associated with various installations and structures; anthropogenic destruction sediments; natural destruction sediments; abandonment sediments; the effects of erosion; and sediments associated

[8] Some of these classification schemes will be reviewed in Section 2.2.1, but for further examples of the variety of systems employed by archaeologists both in the literature and in the field see Chapman, III 1986; Gitin 1990; Reisner *et.al.* 1924; Stein 1987; and Zorn *et.al.* n.d.

with exotic artefacts (Bullard 1970:115-116).

Bullard's scheme was purposely organized to relate directly to the interface between the natural environment and the human use of it. As a consequence those sedimentary deposits that were not close or specific to that interface, seemed to have been excluded from his framework. As a classification system for all types of sedimentary deposits, Bullard's system is useful, but it is not complete or comprehensive. Much like other archaeologists who have suggested that some deposits, like constructional anthropogenic sediments, are useless for archaeological interpretation because of their highly mixed nature[9], Bullard appears to take a similar attitude in regard to the interpretation of sediments. He recognizes how certain sediments can inform the natural/human interface while ignoring how sediments could be meaningful to all aspects of site interpretation

Another archaeologist who identified the importance of archaeological sediments to site interpretation was Karl Butzer (1982:77-100). Rather than developing a classification scheme of anthropogenic sediments and deposits in his work, he focused mainly on description. Butzer proposed that sediments could be described on the basis of three different aspects: 1) their contents, 2) their mode of original deposition at a site, and 3) the transformational processes that resulted in their archaeological context.

The contents of archaeological sediments were first divided among three physical components: physiogenic (water-laid silt, slope movements, eolian dust, etc.), biogenic (animal dung, soil formation, etc.) and anthropogenic (mud bricks, artefacts, erosion due to human intervention, etc.). Butzer then went on to identify the different types of genesis for the materials within sedimentary deposits, dividing them among: primary materials (things introduced to the site by people in their original forms, such as stones, fuel, pottery, etc.), secondary materials (including those remains that were altered products derived from on-site processing or biochemical decomposition, such as shards of pottery, structural debris, burials and food by-products), and tertiary materials (which were deposits of primary and secondary materials that were not in the context in which they were initially discarded or abandoned, including structural fills and water-laid beds).

Following this description of sedimentary deposit contents, Butzer described a series of five methods in which the majority of anthropogenic sediments would be first deposited at an archaeological site. These different methods of deposition were: organocultural refuse (such as middens), collapse rubble (from building material), water-laid sediments, biogenic and

[9] See section 2.1.

geochemical alterations, and eolian sediments. These types of deposits were not considered to be the only deposits found in archaeological sites, but they were proposed as reflecting the manner in which the majority of deposits were originally created.

In conclusion to his descriptive process, Butzer proposed that the sediment would be subject to various transformational processes before they could enter the archaeological context, much like Schiffer proposed in his 'Behaviour Archaeology' theoretical framework. Unlike Schiffer, however, Butzer categorized the resultant culturally transformed deposits into three identifiable types: primary cultural deposition (discards within use area), secondary cultural deposition (the re-utilization of primary deposited material), and cultural disturbance (the rearrangement of archaeological material from a non-functional site, such as ploughing, excavation, and 'pot hunting').

Throughout this descriptive process, Butzer emphasized the role that demographic changes could play in altering the appearance and content of the various deposits. He often provided examples of selected sedimentary deposits from various functional areas and demographic situations in order to indicate how these different systemic contexts could be identified in the archaeological record.

Although Butzer's approach provided broad descriptions of sediments (particularly of their contents) within the archaeological context, his scope was limited. His focus on broad environmental and contextual goals yielded a set of systemic guidelines to interpret the demographic interfaces, rather than a comprehensive classification of sediments in and of themselves. Similar to Bullard, Butzer acknowledged an important use of archaeological sediments, but fell short in providing a comprehensive classification scheme.

Two other archaeologists who examined archaeological sediments were Michael B. Schiffer (1983, 1985 and 1987) and Ilan Sharon (1995a). The methods with which sedimentary deposits were dealt by both Schiffer and Sharon focused, however, not on the nature of the deposit itself, but rather on the positioning and interpretational significance of the individual artefacts within the deposit. In this light, Schiffer's approach focused solely on <u>refuse</u> deposits as the main anthropogenic feature of archaeological sites. His goal in classifying the various 'refuse' deposits was to determine the manner in which the artefacts contained within them arrived at their position. In this way, as was explained in the discussion of 'Behavioural Archaeology', the formation processes of the deposits could be peeled away so as to be better able to interpret the significance of the artefacts. For this purpose Schiffer developed a classification system of archaeological refuse that has gained wide popularity, being utilized in many publications.[10]

Like Butzer, Schiffer's classification system recognized primary and secondary elements of deposits. Schiffer regarded primary refuse as artefacts that had been discarded at their locations of use, that is to say *in situ* remains, and secondary refuse as artefacts that had been discarded anywhere else. Within the category of secondary refuse, however, he placed a number of sub-categories that identified the processes involved in the creation of the refuse deposit. These sub-categories included: provisional refuse (temporary household middens), loss, child's play refuse, and reuse refuse (refuse deposits whose artefacts or the deposits themselves were reclaimed for reuse). In this last category Schiffer included what he called constructional fills. In this classification scheme, the primary and secondary division is ultimately related to the level of information/understanding that could be extrapolated from the artefacts within the deposits about the surrounding features.

Ilan Sharon in his Ph.D. thesis, *Models for Stratigraphic Analysis of Tell Sites* (1995a), while discussing sedimentary deposits emphasized the role that artefacts play in the assignment of stratigraphic phases to archaeological features on tel sites. He created a classification scheme very similar to Schiffer's, where the interest in the nature of the deposit was related to the nature of the artefacts within it. Sharon identified three main types of artefact deposits. The first type was '*in situ*', which were artefacts that were found "as left by the person(s) last using them, i.e.: intact (or broken but in articulation) in a probable use-context" (Sharon 1995a:60). This category would coincide with Schiffer's 'primary refuse'. The second type of artefact deposit identified by Sharon was labeled 'primary deposition', which were situations where most of the various broken pieces of an artefact were located in the same deposit but were not in articulation. His final class was called 'secondary deposition', which was artefact deposits that had undergone transportation and mixing after their initial discard. Within this last class, Sharon, with his interest in stratigraphic phasing, indicated three subclasses that related to the chronological significance that could be applied to the artefacts in these deposits. These sub-classes were: indigenous (objects that had been shifted laterally, and were in the same phase from which they originated), residual (objects that ended up in later deposits) and intrusive (objects that intruded into earlier contexts). Sharon's last two classes (i.e.: primary and secondary deposition) would be equivalent to what Schiffer labeled secondary refuse. In his discussion of

[10] See Dever 1996; Matthews 1992; Needham and Spence 1997; Rapp and Hill 1998; Stein 1987; and Sullivan, III 1989.

secondary deposition, Sharon noted that it was essentially impossible to distinguish between the different sub-classes. Because of this 'impossibility', he felt that these deposits (which he also identified with construction deposits) were not useful archaeologically, and in fact the analysis of the elements "within the deposit (e.g. discerning between primary and secondary deposition deposits) [was] praiseworthy if it [could] be accomplished, but [was] not held to be mandatory." (Sharon 1995a:117)

Each of Bullard, Butzer, Schiffer and Sharon have each provided interesting contributions to the creation of a classification scheme for archaeological sediments. It should be noted however, that no single individual has attempted to understand the deposits to their fullest extent. Both Bullard and Butzer associated behaviour or systemic contexts with deposits as individual entities. With this approach, Bullard examined and classified the deposits on the basis of their make-up in order to further understand how people exploited their environment and Butzer examined and described the deposits on the basis of the different ways they were formed, relating it to the level and intensity of occupation of the site. Schiffer and Sharon recognized that the depositional context was important to interpreting the relevance of the artefacts within the deposit to a broader behavioural or functional understanding of the surrounding features and site.

For the purposes of this thesis, however, none of these approaches or classificatory schemes fully embodied the entire nature of anthropogenic sediments. To this end, a new system was necessary in order to be able to discuss the dual nature of sedimentary deposits, as both a matrix for individual artefacts and as an individual feature itself. In the creation of this new system, Bullard and Butzer's recognition that sedimentary deposits could be used to understand behavioural processes, Schiffer's emphasis on the importance of understanding depositional context before interpreting behaviour and function of the surrounding features, and Sharon's identification of the usefulness of depositional context in developing stratigraphic assignments, were all important contributions.

2.2.2 Terminology Developed for this Study.

At the current time, there is no agreed upon term for what, in the field, we call 'fill' and in site records we call 'stratigraphic accumulation'.[11] Within published works the terminology is both prolific and confused. Some of the expressions frequently used to describe essentially the same

[11] See Tel Dor staff manual, Zorn *et..al.* n.d.

material are: 'refuse', 'occupation debris', 'occupational deposits', 'anthropogenic debris', 'anthropogenic deposits', 'anthropogenic soils', 'anthropogenic sediments', 'archaeosediments', 'archaeological sediments', 'archaeological deposits', and 'fill'. While these various terms can be and are used to specify the same type of material, there are instances when they do not. Depending on who is using them, some of these terms can refer to only a portion of the sedimentary matrix, usually omitting the larger artefacts, such as pottery shards and bone from the discussion, in favour of the micro-components such as mineral particles, pollen and micro-artefacts.[12] As well, the different terms often reflect different perceptions of the material being discussed, specifically the systemic name (referring to the deposits in their behavioural context) versus the archaeological name (describing the deposits in their excavational context). To this end I argue that it is necessary to develop a standardized terminology in order to facilitate discussion and comparison of archaeological material between sites, as well as to assist, in a meaningful way, the interpretation of archaeological sites.

From the archaeological literature discussed in Section 2.2.1 and the recognition of the necessity for precise and inclusive terminology, I have identified five criteria that a comprehensive nomenclature of archaeological sediments should meet in order for the system to be both useful and informative. These criteria are: 1) it must be precise and accurate in its use of terminology, each term should have only one possible referent; 2) it must be comprehensive, so as to include all archaeological sediments while indicating their relative degree of relatedness in a hierarchical system; 3) it must inform on both the systemic and archaeological contexts of the deposit and its contents; 4) it must allow for initial flexibility in identification of the material, being useful both in the field and in the literature; and 5) it must provide a mechanism for the recognition of the sediments during the process of excavation.

To this end, I have created a hierarchical nomenclature that moves from a broad identification of archaeological sediment to increasingly more detailed description and identification of it and its components. This classificatory system consists of three parts, resulting in a trinomial structure for sedimentary identification.

Level 1 – Deposit Type

Archaeological sediments can be divided into two types: 'natural sediments' and 'anthropogenic sediments'. Natural sediments are those deposits that accumulate on sites through no activity of humans or their domesticated animals; that is to say natural sediments occur through

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[12] See Macphail and Courty 1985; Goldberg 1992; and Matthews 1995.

'natural processes'. These sediments could include eolian deposits, flood deposits, and geo-chemically altered sediments. Natural sediments will not contain anthropogenic artefacts.

Anthropogenic sediments are sediments that have been deposited as a result of cultural processes. The term sediments was chosen over soils as it more aptly describes implicitly the process of the development of the archaeological deposit. Although to many archaeologists the terms soils and sediments are perceived as being synonymous, they indicate entirely different formation processes (Barham 1995:149). As defined by Michael Waters, sediments are "the solid inorganic and organic particles accumulated or precipitated by natural or human processes" (Waters 1992:15), in contrast to soils which are "the weathering profiles developed by the in-place physical and chemical alteration of preexisting sediments" (Waters 1992:40). Given these definitions, soils are emphatically not anthropogenic in nature, and thus the term 'soil' should not be used to describe archaeological deposits. As for the content of anthropogenic sediments, I agree with Stein who notes, "... all particles (including artefacts) found in archaeological deposits can be viewed as sediments" (Stein 1987:339). There is no size limit. In geological terms, the larger artefact in the anthropogenic sediments, such as intact ceramic vessels, pottery shards, mudbricks, bones, glass, and coins, are simply large clastic particles. In this sense, the choice of terminology 'anthropogenic sediments' is an inclusive term used to describe all aspects of a culturally laid archaeological deposit in its systemic context. Ancient fortified, multi-occupational sites consist of a number of features including: walls, foundations, tabuns and a variety of anthropogenic sediments.

Level 2 – Deposit Formation

Both anthropogenic and natural sediments can be categorized in terms of the number of transforms that the components of the deposit have undergone. Natural sediments will only undergo n-transform; otherwise they will become anthropogenic if they are manipulated through cultural processes. With regard to anthropogenic sediments, Level 2 describes the transformational state of the objects (i.e.: artefacts, bone, etc.) within the sediment. This level of definition relates to the interpretational significance that can be placed on these objects for elucidating the functional and behavioural aspects of the archaeological features around them (at this level, my position is similar to the way Schiffer and Sharon identify deposits). This level also describes the history of the deposit itself, and can be useful in extrapolating previous systemic contexts of the deposit. Three different deposit formations have been identified:

I. **Primary**. Primary deposits contain artefacts that are found in their original place of use (in their original systemic context). These artefacts can include: *in situ* artefacts (i.e. complete amphorae in a storage room); micro-artefacts embedded in the floors of their location of use; stored grain (in storage pits); animal dung; raw building material (large deposits of unused plaster adjacent to a wall); and 'clean' sediments (those containing no anthropogenic materials) that are specifically selected for structural properties in construction (rampart fills). These sediments display no elements of mixing and are quite homogenous. They are usually situated on distinct surfaces or floors.

II. **Secondary**. The contents of secondary deposits have undergone one transformation process. The objects within these deposits are not in their functional location, but rather in a refuse context. These deposits can include: household middens/refuse dumps; favisae; collapsed building material; and destruction debris. These sediments display some mixing, and if allowed to accumulate over time an obvious chronological stratigraphy will be displayed by the deposits and artefacts.

III. **Tertiary**. Tertiary deposits are those whose contents are no longer in an initial refuse context, but have undergone further transformation processes via transportation or mixing with other sediments. These deposits can be reworked repeatedly to form new tertiary sediments. Examples of these sediments can include: re-worked collapse and destruction debris, used for filling in foundation trenches, standing foundations, robber trenches, and leveling uneven surfaces for floor construction; city dumps; and sewer sediments. These sediments display a large degree of mixing of the artefacts within them, being quite heterogeneous. These deposits could display general reverse stratigraphy if they were taken from a stratified secondary anthropogenic sediment that was systematically used to fill in a large deep area.

Level 3 – Deposit Mode

This final level of the nomenclature of archaeological sediments is descriptive of the functional role of the deposit itself, and is not reflective of the artefacts within it. This level describes the final systemic context of the sediment, that is to say the activities that resulted in the deposition of this sediment as found in the archaeological context. These can include activities as denoted by such terms as: disposal, constructional, domestic, and manufacturing.

When this level of terminology is combined with the categories in level 2, it is possible to be very specific about the nature of the deposit under discussion. For example, the term "disposal tertiary anthropogenic sediment" refers specifically to deposits of refuse material that have undergone a series of transitional phases. Natural sediments would, of course, not have a functional or systemic role as the title of this level suggests. Instead, level three, when describing natural sediments, would describe the nature of the manner of deposition, such as: eolian, water-laid, and geochemically altered. In this way, when combined with the categories in level 2, it is possible to be specific about the nature of the natural deposit (e.g. 'eolian primary natural sediments' in an archaeological context would indicate natural sediments of eolian origin that had been deposited on the site, and not have undergone any processes of cultural or natural alteration).

The descriptive terms used in level three can become increasingly precise in their identification of the systemic context of the deposit. A constructional tertiary anthropogenic sediment could become more specific, by identifying it as a 'foundation trench constructional tertiary anthropogenic sediment', as its systemic context was further clarified.

Many descriptive terms occurring in level three can be related to more than one transformation category from level two. There are certain systemic contexts, however, that can be associated only with a single transformation category, or minimally, can exclude a particular formation category. For example, if an anthropogenic sediment is identified as being a refuse disposal, it is not possible for that deposit to be primary in nature, simply because the objects within the deposit are no longer in their functional location. For those descriptive terms in this level that can be related to more than one deposit formation (i.e. primary, secondary and tertiary), the distinctions between them are important as they reflect their different formation process and if misinterpreted by the archaeologist can result in lost information.

While this nomenclature can appear to be cumbersome and complex, it is no more so that that used in the biological sciences for the classification of living organisms. Depending on the amount of known information about different archaeological deposits, they can be categorized at different levels. As more data are collected about the deposits, it is a simple matter to become more precise in their identification. The flow chart in Figure 2.2 shows the relationship between the various levels of this nomenclature.

It can be seen from Figure 2.2 that each depositional formation can have numerous depositional purposes (or systemic contexts). As an example, 'Constructional Primary Anthropogenic Sediments' would be 'clean' deposits that were thinly layered in the construction of an ancient rampart to help prevent erosion. These deposits would have been specifically selected so as to retard soil slippage and to aid in drainage of these important parts of a city's fortification system.[13] A 'Geochemical Secondary Natural Sediment', on the other hand, would be natural sediments that had been deposited on an archaeological site, that would have undergone geochemical weathering processes to transform it into what is properly defined as 'soils'. A 'Disposal Tertiary Anthropogenic Sediment' could be a refuse dump or midden that had received numerous deposits from a variety of sources.

This trinomial classification system provides a thorough and specific method of identifying archaeological deposits. It is hoped that this system will in turn allow for more thorough and accurate interpretations of the archaeological record.

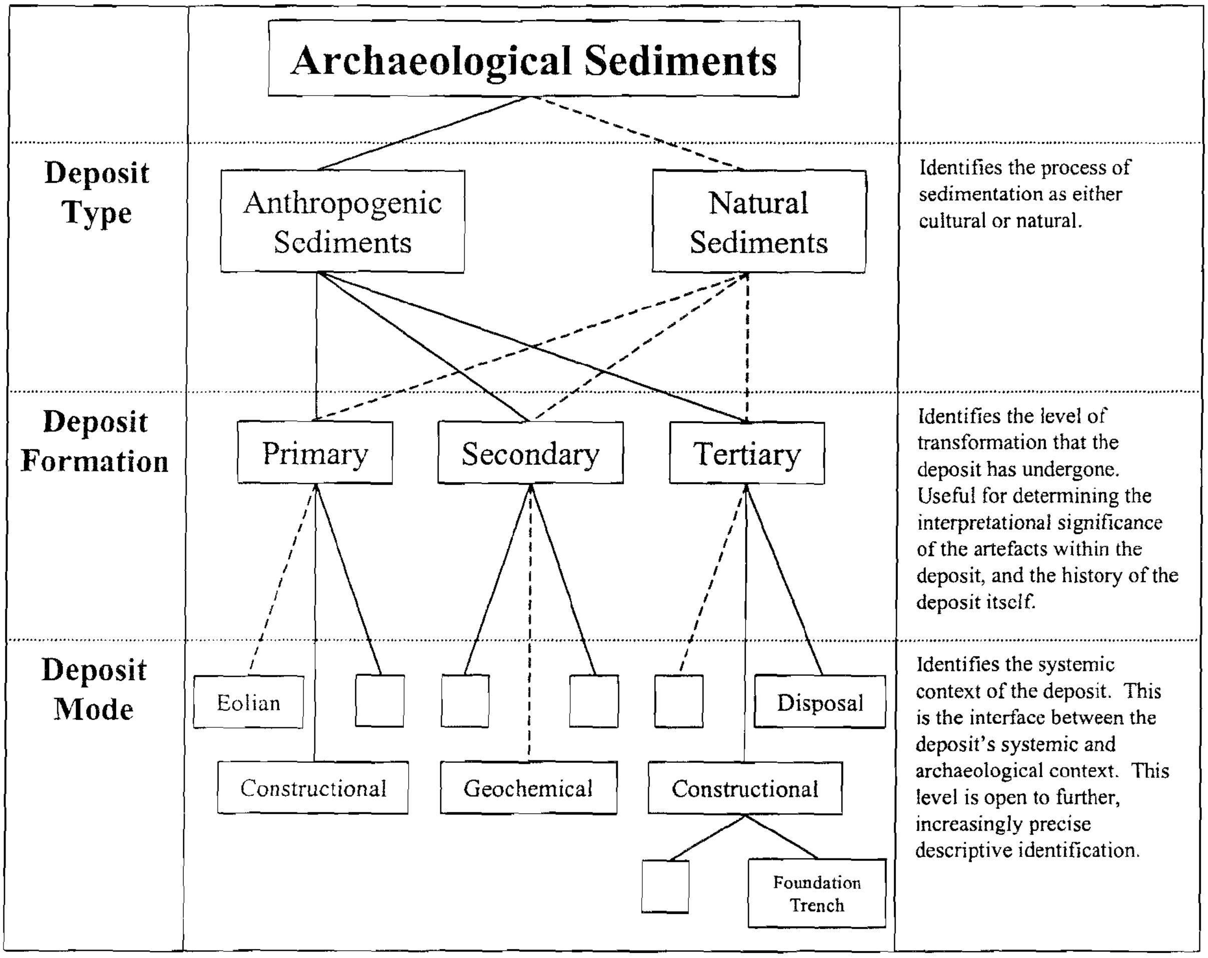

Figure 2.2 Flow chart of the trinomial nomenclature for archaeological sediments. The solid lines represent the flow of anthropogenic sediments and the dashed lines, natural sediments. The empty boxes represent other, unnamed depositional purposes.

[13] See Rosen 1986:14-15.

CHAPTER THREE

3. Archaeological Framework.

> *Intelligent excavation begins with the recognition of how cultural deposits were laid down in the first place; what activities of man and nature they reflect; and how they were transformed over time into the archaeological record that comes down to us.*
>
> Dever 1996:41

3.1 Introduction.

This study centres upon the manner in which archaeological sites (specifically tel sites) developed. As the theoretical approach adopted here necessitates that the formation processes that result in archaeological deposits be unravelled before the systemic or ancient behavioural context of the deposits can be understood, it is important for this study to understand the general principles of site development. It is necessary to review both the systemic and archaeological contexts of the formative elements of archaeological sites to create a basis for comparison and interpretation of the archaeological record. In this way the formation processes of studied deposits may be elucidated, allowing for the systemic contexts associated with their deposition to be exposed. This chapter will look at the primary elements of tel site formation, followed by an examination of the systemic contexts associated with different phases of the construction cycle. Additionally, a brief archaeological atlas of the archaeological contexts of some of the pertinent systemic contexts will be provided.

3.2 Formation Processes of Tel Sites.

Tel sites are composed primarily of the remains from ancient architectural features and their constituent components. These sites were created by the continuous process of construction and destruction followed by renewed construction. As already discussed in section 1.2.1, this cycle can occur on a massive scale involving the entire site at one time, or on a smaller scale involving individual isolated locations within the fortified city or town. Irrespective of the scale, this process of rebuilding and renewal was, and still is, part of the daily life of the city on a continual basis. It was through this building process that the tel would increase in height, for the structural and functional components of ancient architecture (mudbricks, stone, etc.) usually would not be removed beyond the enclosing walls of the city after having fallen into disuse. Although recycling and re-use of constructional material did occur in antiquity, new material was always being brought to the city during its existence. In the processes of tel site formation, natural deposits were not important contributors of sediment. Since ancient cities were sites of almost constant activity, there was very little chance for the accumulation and preservation of entirely natural sedimentary deposits. Indeed, the role of natural processes in the development of tel sites has been accepted as being almost inconsequential (Gé, *et al.* 1993:151; Davidson 1973:146). Thus to begin to understand the anthropogenic processes that resulted in the creation of the modern archaeological phenomenon of tels, it is necessary to start with an examination of the fundamental processes that resulted in the fabric of a tel.

3.2.1 Primary Elements.

The primary elements of a tel site are those features and objects whose constituent parts form the bulk of the material that ultimately becomes deposited in archaeological contexts. These elements are associated with the construction processes, as this is the biggest supplier of sediments to site formation (Davidson 1973:149). The following five primary elements will be discussed below: walls, roofs, floors, artefacts and earthen fills.

3.2.1.1Walls.

From the Neolithic Period onward, permanent structures were being constructed in the Near East. Initially the walls for these early structures were made of stone or wood with the frame being filled in with mud, in a wattle and daub fashion (Adam 1994:58-59 and Aurenche 1981:123-124). This latter method of construction was quickly transformed and improved with the introduction of mudbrick as a primary building material. The various types of materials that were used in construction depended upon a number of factors including local availability, technological innovation and economic constraints.

Mudbrick walls (Figure 3.1) were the predominant type of wall built for most structures from the Neolithic until the Roman Period in the Southern Levant (Reich 1992:5 and Adam 1994:58). As a result, mudbricks were the main source of earthen sedimentary material that accumulated on archaeological sites in the Near East during this time, resulting in the formation of tels. The quantity of earthen material (sand, silt and clay) that mudbricks brought to a site was quite substantial. It has been attested that the collapse of a mudbrick building would result in the deposition of brick material and sediments that could fill the structure to one-third its original height (Lloyd 1963:17). The primary reasons that sun-dried mudbricks were used so extensively throughout the Near East were due to a variety of factors, not least of which was the cheap cost of manufacture and ease of use in construction. The cost of manufacture was kept low because it was not a specialised craft like masonry, which required special tools and skills. Thus individuals could engage in the manufacture of mudbricks themselves, without hiring external labour. As well, the relative abundance of component materials (earth) made their acquisition quite easy compared with the processes involved in the quarrying of stone. Sun-dried mudbricks were also found to be structurally sound, and to provide good insulation against the climatic variability of the Near East (Roaf 1996:30-31).

In much of the literature, mudbricks are usually identified as 'clay' bricks. However, this is something of a misnomer. While clay was (and is) an important component of mudbricks, making it denser and increasing the brick's resistance to water erosion, if it were the only component the resulting bricks would have been unable to maintain their form. In addition to the use of clay in the manufacture of mudbricks, particles of silt and sand, pebbles, broken pottery shards, straw and other clastic bits were mixed with the clay as temper to prevent the bricks from cracking as they dried.[1] These tempering agents formed a 'skeleton' for the clay particles to cling to, which allowed the bricks to shrink as one unit and to reduce the overall shrinkage of the bricks as they dried (Rosen 1986:75). Otherwise during the drying process pure clay bricks would have developed more than one centre of contraction and developed major cracks (Boudreau 1974:15). The actual proportions of sand, silt and clay in ancient mudbricks varied widely and were greatly dependent upon the source material. Tests have shown, however, that the optimal amount of sand to produce the strongest bricks was 20%, and that the quantity of clay should range between 9-28% (Rosen 1986:75-76). Higher amounts of clay (included to reduce the effects of erosion) could be offset by the quantity and type of temper employed. In most ancient bricks from the

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[1] For a more extensive discussion of mudbrick manufacture and constituent components, see Delougaz 1933, Reich 1992, Boudreau 1974, Oates 1990, and Moorey 1994.

Levant, silt was the predominant grain size of the earthen particles (Rosen 1986:78,87). It was discovered during antiquity that the addition of carbonates (from burnt occupational debris) to the mudbrick mixture could result in stronger bricks (Oates 1990:389). As a result, the manufacture of bricks was sometimes a form of re-use of destruction debris. However they could not be made purely of ashy occupation material for the unstable sand, silt and clay proportions would offset any additional hardness (Delougaz 1933:5).

Sun-dried mudbricks were not perfect building blocks. Due to their composition, these bricks were eroded by running water such as rainwater and runoff water. This meant that mudbricks, unless carefully maintained by the application of plasters (as discussed below), would have a very short lifespan. The average life of sun-dried mudbricks was 30 years (Lloyd 1963:17). Since mudbricks deteriorated so quickly, the resultant quantity of sedimentary accumulation on archaeological sites in the Near East was equally as fast.

In the later periods (beginning in the Hellenistic), some mudbricks were baked in kilns at high temperatures, for long periods of time, to produce very strong and water-proof bricks. These kiln-fired bricks (essentially, anthropogenic metamorphic rocks), unlike the sun-dried mudbricks, required highly specialised skills for their production, and as a result were not used frequently (Reich 1992:7). The main function of kiln-fired bricks was to protect vulnerable surfaces from water seepage, particularly in water installations such as basins, drainage channels, and Roman baths (Moorey 1994:306). The exception to this function was the creation of roofing tiles during the Roman Period and onward. While the tiles were not bricks, their manner of manufacture was much the same.

Stone also was frequently used in the construction of walls (Figure 3.2) in the Near East, especially in the Southern Levant. This was due to the fact that unlike in Mesopotamia, stone was commonly available in accessible outcrops throughout the region. As a result stone is often a significant component of proto-historic and historic archaeological sites in this region. For the most part, stone was used in the construction of foundation walls for most structures beginning in the Neolithic. The properties of stone, such as its impermeability to water and its relative compressive strength, proved to provide good support for the superstructure of buildings made of the less costly mudbricks. In the later periods (and consistently from the Roman Period onward), stone became a more common material of choice for the construction of superstructure walls as well (Ragette 1974:27), although mudbrick has remained in use up until the modern day. However, as mudbrick was no longer the primary building material for walls, there was no longer a continuous large-scale input of sedimentary material to sites. This switch was partially responsible for the cessation of continued tel growth from the Hellenistic and Roman Periods onward.[2]

Figure 3.1 Photograph of a mudbrick city wall and arch from the Bronze Age at Tel Dan. Not the arrow that points to the stone foundation that supports the mudbrick wall.

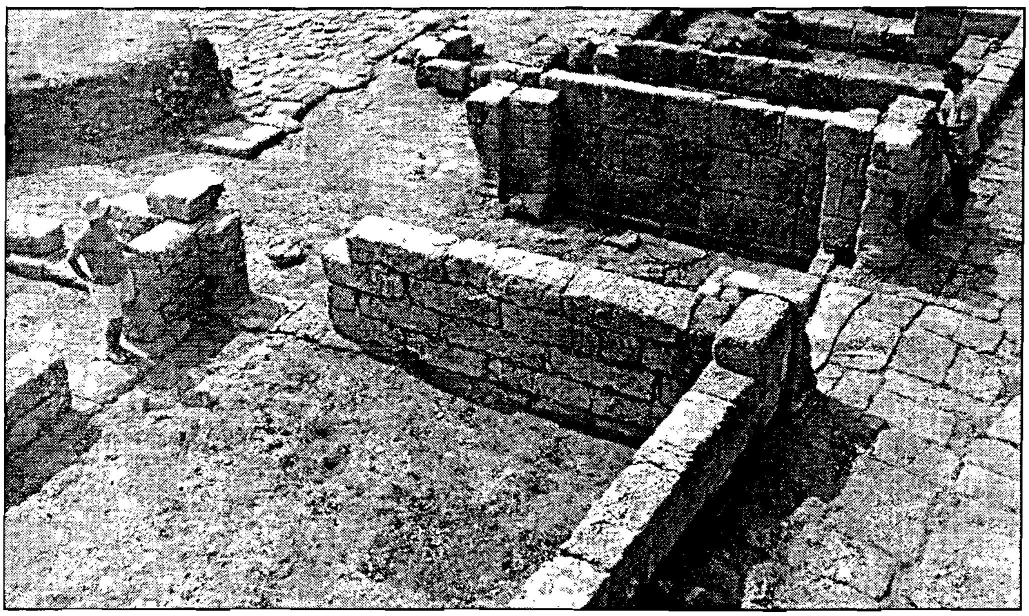

Figure 3.2 Photograph of stone walls from structures lining a Roman street at Tel Dor. Photograph courtesy of C.M.Foley.

[2] The change in building materials, coupled with a stabilisation of the political situation, which did not require the maintenance of large fortification systems, was the key development that saw the end of the creation of the archaeological phenomena known as tels.

The specific types of stone used for general construction purposes depended largely upon local availability. Limestone outcrops are commonly found throughout central and southern Israel, and thus became the main type of building stone used in these areas. In the north however, basalt is the most common stone outcrop, and as a result in the areas in and around the Golan it became the primary building stone. There were of course, small regional variations in the type of stone used. Along the coastal plain a type of sandstone known as kurkar was often the main building stone. This stone originated as Pleistocene sand dunes, which had been cemented together by calcareous solutions. Although kurkar was susceptible to crumbling, in large blocks it was very hard and hardened even further when wet (Orni and Efrat 1971:41). Kurkar was the stone of choice for construction at Tel Dor.

In the construction of foundations and walls, three main classes of stone were used: fieldstones, rough-hewn stones and ashlars (Reich 1992:3-4). Fieldstones were surface rocks and rubble that had not been quarried, but rather had been collected from fields and natural rock falls. No effort was given to the shaping of these stones; rather specific shapes and sizes were selected during the collection process. These stones were then laid in courses to create the foundation walls, with gaps between the stones being filled with smaller stones and/or a mortar (to be discussed below). Rough-hewn stones were partially worked fieldstones. The shaping, done with a mallet rather than a chisel, facilitated the laying of the wall's courses. Ashlars were large square-hewn stones that had been specifically quarried and transported to the site. These stones were used in large public buildings and in the construction of 'wealthier' structures, as they provided the most sturdy and aesthetically pleasing walls. The cost associated with the acquisition of ashlars was quite large due to the intensive labour involved in their quarrying, transportation and shaping.

In the process of quarrying ashlars, blocks much larger than necessary for building purposes were created to act as a protective surfaces during transportation to the building site (Camp and Dinsmoor 1984:9). At the location of construction, the final 'dressing' of the stones occurred. This dressing, or final shaping, of both rough-hewn stones and ashlars resulted in much stone debris (Camp and Dinsmoor 1984:12) that became incorporated into various earthen matrices of ancient archaeological sites.

Foundations were key elements in the process of wall construction, for they formed the link between the walls and the ground that supported them. Although foundations have been poorly studied (Mark 1993:16), they were and are integral to the success of the walls, in that they prevented the sinking (partial or entire) of the structure.[3] The main purpose of the foundation was to transfer the load of the building (including the walls, ceilings, people and furniture) into the ground, in a manner that allowed the structure to remain firmly in its place (Netzer 1992:17). As a result the builder had to take notice of the type of material on which the building was to rest. Ideally, the best foundations were those that were laid on bedrock, as it had the highest bearing pressure and was not susceptible to unwanted subsurface shifts. In sites that had bedrock outcrops close to the surface, like Tyre in South Lebanon, tels would rarely form as it was to the benefit of ancient peoples to clear destruction debris away and continually rebuild directly upon the bedrock.[4] Most sites, however, were not underlain by bedrock and the sediment types played an important role in defining the nature of the foundation that would be built for different structures, specifically its width and depth. In the case of ancient cities that formed tels, the majority of the foundations were sunk into sediments that contained the remains of constructional material, similar to a coarse sand or gravel. This type of sediment has been identified via modern technology as having been very sound (Legget 1973:226), having a bearing pressure of between 30 and 40 metric tons/m^2 (Mark 1993:18-20).[5] In sediments where the weight of the building exceeded the bearing capacity of the sediments, the foundations were made wider than the walls they supported (see the schematic, Figure 3.6), and also were built to a greater depth so as to spread the load more broadly (Netzer 1992:18).

In the Southern Levant, almost all foundations were continuous; they followed the entire length of the walls rather than being intermittent pilings (Netzer 1992:17). Two different types of continuous foundations were built in antiquity. The earliest examples, and the most common types of foundations, were those set in foundation trenches. In these cases, trenches were dug along the path of the walls to be built. These foundation trenches would be dug until a suitable sediment or depth was reached. In many cases on tel sites it has been found that foundation trenches have been dug to the depth of remains from a previously buried wall or wall foundation (Netzer 1992:19). The second type of foundation built in antiquity was the standing foundation.

[3] The best known example of a structure with a poorly laid foundation is the Leaning Tower of Pisa, which has undergone differential settlement due to a foundation that did not account for the weak clay stratum 9.5 m below the surface. There are many other examples of similar uneven settlement of buildings due to unsound foundations; see Legget 1973.

[4] For archaeologists this can result in sites that are very difficult to stratify, as there is no vertical stratigraphy.

[5] By modern standards this is quite low, but for the purposes of regular, non-monumental structures of antiquity, this bearing pressure more than suffices.

Similarly to construction methods today, whole areas were cleared, and the walls of the foundation were built from the ground up (Reisner *et. al.* 1924:73). As sites are cleared for construction, large holes sometimes can be created, into which the foundation walls are erected. In these ways, the nature of the sediments surrounding the structure could be controlled. It would not have been uncommon for the foundation of large structures to have been a combination of both foundation types.

Foundations were surrounded by earth, and thus subject to humidity on a regular basis, and to high levels of humidity during rainy periods. For this reason, most foundations were made out of stone rather than mudbrick in order to help preserve the longevity of the structural integrity. In buildings with a superstructure of mudbrick, the stone foundation would usually rise 5 - 10 cm above ground level to help reduce the wear from splashes (Netzer 1992:23). In buildings with stone superstructures, the method of foundation and wall construction were often identical. For archaeologists, this can pose a problem if no floor level is found in association with the walls. To this end the main clue that foundation walls are being uncovered is the lack of a doorway into the room. One of the first known foundations built in the Near East dates to the Pre-Pottery Neolithic B at Nahal Oren in the Carmel Mountains (Aurenche 1981:104). This early foundation, like almost all later ones, was of stone construction.

Mortar was a necessary addition to mudbrick, stone and foundation wall construction, as it helped to hold the stones or bricks in place while filling in any gaps in the structure. The presence of mortar in a wall made the wall into a single unit by distributing the compressive forces within the wall equally between all of the building elements: each stone or brick participated completely in the transference of compressive stresses to the foundation sediments (Netzer 1992:20). The efficiency of the mortar was directly related to the longevity of the walls. For most structures in the Near East, mortar was made of the same general composition as mudbricks (clay, sand, silt and other tempering agents), and had the consistency of wet bricks when it was applied (Delougaz 1933:14). It has been shown however, that the mortar used in mudbrick walls was not identical to the mudbricks it connected.[6] This may have been due to the fact that mortars and mudbricks were not made at the same time, and thus had different proportions of sand, silt and clay. Notwithstanding this reasoning, it has been suggested that this difference between the bricks and the mortar resulted in a more strongly constructed structure (Rosen 1986:91). The strength of

[6] For some data of various mudbricks and mortars from the Southern Levant, see Rosen 1986, chapter 5.

mortars was also increased, as with mudbrick, by the addition of ashy carbonates from occupational materials. To increase the strength of mortars even further and to reduce permeability of water, lime was added to the mixture. While mud mortars bound the bricks and stone mechanically to one another, lime mortars hardened slowly and bound the bricks and stone by creating a chemical compound (Moorey 1994:331). Although the method of lime production (which will be discussed below) was well known from the early part of the Iron Age, lime mortars were not commonly used in the Levant until the late Hellenistic and Roman Periods.

Plaster was an important constructional element in antiquity as it protected mudbrick walls and mud mortars of stone walls from the climatic elements, specifically rain. Three different types of plaster were used in the past; these were mud, gypsum and lime. Mud plasters were the most widely employed throughout all of the periods in antiquity and were the simplest to create. Similar to mudbricks and mud mortars, mud plaster was made up of local sediments. However, it was almost totally predominated by fine clays that had been mixed with finely chopped straw (Moorey 1994:329). This type of plaster has been called 'wattle-and-daub'. In order to enhance further the protective nature of plaster, the fine clays were sometimes mixed with gypsum to create a gypsum plaster. When pure gypsum has been heated to 100-200°C, it creates the hemihydrate 'plaster-of-paris'. Although this material was relatively easy to produce in antiquity, its qualities as a protective coating were only slightly better than pure mud plasters (Moorey 1994:330). In contrast, lime plasters provided excellent protection from rain water and water seepage, since during its drying process, the lime particles crystallised, which made them impermeable to water. Lime was manufactured in a two step process. First, quarried limestone was heated to 800-1000°C and burned for up to one week to create calcium oxide, also known as 'quick lime'. In the second step, the quick lime was hydrated to form calcium hydroxide, also known as 'lime' (Adam 1994:65-70). The chemical equations of the calcination of limestone and the hydration of calcium oxide can be expressed as:

$$\underset{\text{calcium carbonate}}{CaCO_3} \xrightarrow{\text{calcination}} CO_2 + \underset{\text{calcium oxide}}{CaO} \quad \textit{or} \quad \text{quick lime}$$

$$CaO + H_2O \xrightarrow{\text{hydration}} \underset{\text{calcium hydroxide}}{Ca(OH)_2} \quad \textit{or} \quad \text{lime}$$

When the lime was applied as a plaster to surfaces, it was very durable, allowing mudbrick walls to last for centuries (Camp and Dinsmoor 1984:8). As already mentioned, however, the use of lime in the Levant did not become common practice until the late Hellenistic and Roman Periods. Plasters were most commonly used to line water installations, such as cisterns, drains and water channels, rather than as wall plasters (Reich 1992:9). During excavation of sites where different types of plasters have been employed, the only manner to differentiate between lime and gypsum plasters is to test with hydrochloric acid; lime plaster will react, while gypsum will not (Adam 1994:70).

Plasters not only served to protect mudbrick walls, but they were also a necessary preliminary step in the application on any kind of design or decoration to the interior of the structure (Moorey 1994:329). Often the external surfaces of these walls were coated with a type of plaster that was resistant to water damage, while the inner surface was covered with a slightly less costly plaster, which was to be painted.

In summary, the construction of walls, from those for domestic purposes to those for fortification purposes, was the primary source of material which resulted in the formation of tel sites in the Near East. Indeed, it has been proposed that the rate of tel formation would be directly related to the number of walls that had been built during the life of the city (Davidson 1976:260). These walls, their remnants and especially their foundations, have served to maintain the shape and size of tels, as they form its skeletal framework. In this way they hold the various anthropogenic sediments in their systemic contexts, protecting them from the natural processes of erosion (Reisner, *et al.* 1924:89). It is for this reason that tels have been able to withstand the passage of time so well. Until the remnants of the walls themselves have been eroded away, the contents of their rooms remain virtually untouched by erosive processes.

3.2.1.2 Roofs.

The main function of roofs has always been to protect the occupants and contents of buildings from the elements, primarily rain and sun. In antiquity roofs served additional functions, acting as storage or drying areas for fruit and other supplies, as well as providing places for people to sleep at night (Netzer 1992:24). Since roofs had multiple functions, their successful construction was often the most problematic aspect of the building process. Roofs had to be resistant to water penetration, while being sturdy enough to support the weight of themselves as well as everything that was placed upon them. These tensile stresses, which caused the stretching and sagging of roofs were very unlike the compressive stresses to which walls and foundations were subject. Since the building materials commonly used in walls (stone and mudbrick) could not resist tensile stress effectively, they were not used extensively as roofing material (Netzer 1992:23-25) except in exceptional circumstances. Wood, with its fibrous composition, was the only readily available material that fulfilled the requirements. Roofs were also important for maintaining the structural integrity of the building, for they were able reinforce the walls and foundations. In most cases, the collapse of a roof or the stories in a multi-level structure can result in the ultimate collapse of the entire structure.[7]

The most typical roofing style in the Near East from the Neolithic until quite recently has been a flat roof, built in layers, laid upon wooden beams. These beams, spanning the width of the covered rooms, were laid parallel to one another at fixed intervals of between 35 and 80 cm. Small branches, canes, or palm fronds were then laid on top of the beams, at a right angle to them, which were covered over by a layer of mortar, marl or clay to help make the roof as waterproof as possible[8] (see Figure 3.3). As the timbers of the roofs would have a tendency to stretch and compress as various weights were placed upon them, the high grade plasters or mortars, which included lime, could not be used. Lime-based mortars and plasters were very susceptible to slight vibrations, and had a tendency to crack and break apart, reducing their effectiveness. In order to ensure proper weather protection, the clay mortars laid on roofs were tightly packed and consolidated, sometimes using a stone roller. The packing of the roofs had to be annually maintained prior to the winter rains in order to keep their effectiveness (Netzer 1992:24). The actual thickness of the wooden beams used in roof construction was directly related to the width of the room they had to span and the weight of material they had to support. It has been suggested that the weight of a wood and earthen roof described above would be approximately 500 kg/m^2 (Aurenche 1981:154). Rooms that were too wide, often had pillars in the middle to provide support for a cross-beam. In the Southern Levant during antiquity, the wooden beams of flat roofs usually used the natural round profile of the trunk rather than being worked (Netzer 1992:25 and Aurenche 1981:154). During the processes of construction, there was very little difference

[7] In his article, "Massive Structures: processes in construction and deterioration" Ehud Netzer provides the following example: "A wall built with fieldstones and limeless mortar, and whose width is 0.5 - 0.6 m, would remain stable up to a height of 3-4 m. Beyond this height it would be in danger of collapsing. However, the same wall could be safely built as high as 6-8 m if reinforced in the middle. A two-storey house thus built will remain firm as long as its interlevel ceiling supports the walls. Should, however, the ceiling be destroyed … the walls would suddenly become … unsupported walls 6-8 m high, and the building would be likely to collapse." (Netzer 1992:21)

[8] For further discussion of the construction methods of flat roofs in antiquity, see Aurenche 1981:153-155; Ragette 1974:22-25; and Netzer 1992: 23-25.

between the methods employed for the exterior roof and the interior floors for multi-storied structures. The weight bearing prerequisites remained the same. However, the interior levels did not have the same needs for water resistance.

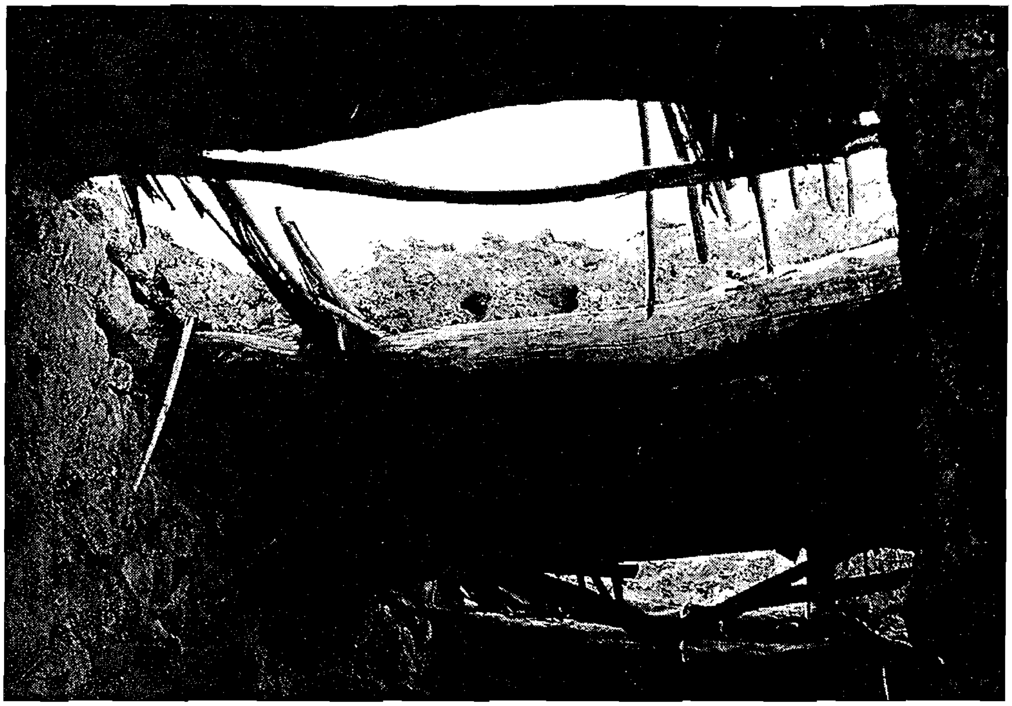

Figure 3.3 Photograph of a traditional roof. Note the round wooden beams overlain at a right angle by small sticks and reeds, covered by a layer of clay mud.

The specific type of wood used in the past was usually related to local resources. In the southern Levant wood from the juniper was among the most commonly used for building both public and private structures (Reich 1992:8). In antiquity, the Sharon Plain was forested with oak and terebinth trees (Mazar 1990:3; Liphschitz and Waisel 1987:253) and in those areas these types of wood were commonly employed. Other woods, however, were also used, including the cedar from Lebanon, and the cypress. Cedar was considered to be the best wood for construction because of its strength (Camp and Dinsmoor 1984:23), resistance to insects and its fragrant aroma (Mark 1993:184-186; Moorey 1994:348).[9] Despite the fact that wood was found commonly in the northern parts of the Southern Levant, particularly along the Sharon and Coastal Plains, demand for appropriately sized beams was high. As it was a necessary component of construction, wood became one of the more expensive building elements.

Although wood played a significant role in the development of ancient buildings, it is

[9] Because of its qualities, cedar wood from Lebanon was transported all over the Mediterranean and to Mesopotamia (Moorey 1994; Camp and Dinsmoor 1984; and Mark 1993).

not a material that has been found frequently in archaeological sites from the Near East. This absence is due to its poor preservation. In antiquity the two most pressing dangers to the preservation of wood were rotting from exposure to dampness, and fire. It is the rotting and similar degradation of wood that removes it from the archaeological record. In contrast, fire actually helped preserve wood for the archaeological record. In a standing structure however, both decay and fire would result in the collapse of the building (Moorey 1994:347-356; Netzer 1992:25 and Reich 1992:7).

Roofs in antiquity, although flat, tended to have a slight inclination in order to prevent the build-up of water puddles (Carter and Pagliero 1966:66). The inclination was such that it directed the run-off into a water storage installation, such as a cistern, in order to facilitate the preservation of water for systemic purposes.

In later periods (from the Roman Period onward) a gabled roof was introduced in the Southern Levant. This new low pitched roof was developed as the result of the technological innovation that saw the introduction of roofing tiles (Mark 1993:194; Netzer 1992:25). The terracotta tiles provided excellent protection from the rain, as they were the equivalent to kiln-fired mudbricks. In the construction of gabled roofs, wood continued to serve as its base; for the "tiles were set on a layer of clay and straw which rested on a wooden deck" (Camp and Dinsmoor 1984:23).

3.2.1.3 Floors.

For the most part, floors were not purposely constructed elements of a building, using external materials. Instead, floors were simply earthen surfaces that had been trampled down. Within structures, these areas were often covered with straw mats and carpets (Reich 1992:16). Like wood, however, these materials were rarely preserved in the archaeological record. The only evidence of their existence is through imprints they have left on earthen floors, and occasionally their charred remains. The surface level of earthen floors could, over time, become higher and higher with the accretion of debris. The amount of accumulation on the surfaces would vary depending upon the activities that occurred there.[10]

Some floors were intentionally created by the laying down of plaster surfaces; plastered surfaces of mud, gypsum and lime have all been attested in the literature at sites from the

[10] The study of micro-artefacts that have accumulated on the surfaces of activity areas is a growing field of archaeological inquiry. For some examples of this work see Matthews 1992; Macphail *et. al.* 1990; Goldberg 1992.

Southern Levant.[11] If plastering of the floor and walls were occurring at the same time, it would not be uncommon for the floor plaster to slope up to the wall plaster, thus indicating their contemporaniety (Ragette 1974:22).[12] Usually surfaces selected for plastering required an impermeability to water, such as the case of drainage channels and cisterns (Reich 1992:16). Some high activity areas that caused wearing on the made floors, resulted in repeated re-plasterings (see Figure 3.4). At Tel Dor, another type of prepared surface (other than plaster) has been noted. These floors were made with the crushed remains of the common building stone, kurkar. The high level of calcium carbonate in kurkar created surfaces that had a plaster-like appearance.

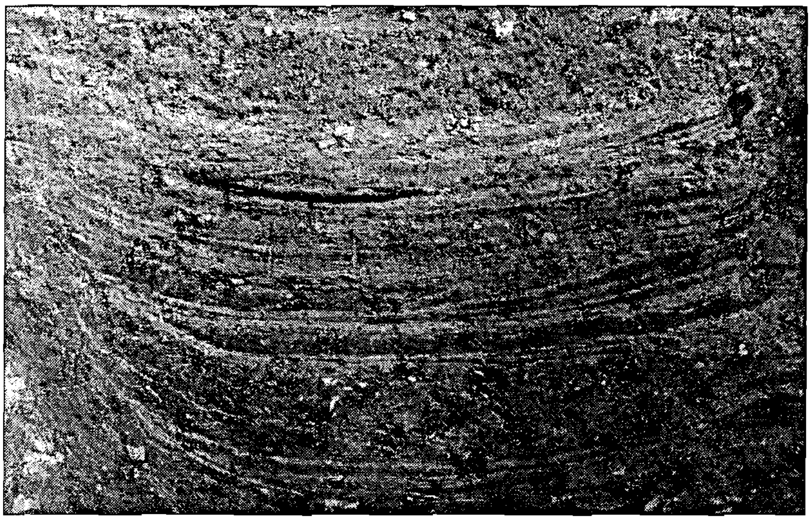

Figure 3.4 Photograph of the multiple layers of a re-plastered surface. These layers of floor surfaces from Tel Dor extended for over 1 m in depth, and spanned the entire Iron Age.

3.2.1.4 Artefacts and ecofacts.

Artefacts and ecofacts make up a culturally significant aspect of archaeological sites, if not a quantitatively significant one. For the most part, artefacts and ecofacts found on tel sites are the result of the various processes of garbage disposal. They are present on sites because they have been lost or purposely discarded. The various methods of refuse disposal were numerous, and depended upon the systemic activities that occurred in the area (a discussion of refuse disposal can be found in section 3.2.2.1). Whether the artefacts were randomly thrown

[11] See Stern 1995; Tufnell 1958; Ussishkin 1978; Gitin 1990; Ussishkin 1977; and Kenyon 1981.

[12] As noted by Ragette, this "rounding out" of the corners where walls met floors commonly occurred even with floors of compacted earth; the plaster of the walls was laid down in such a way as to merge with the mud of the floors.

away or systematically disposed of in middens, they become incorporated into the fabric of the site in a refuse context.

There are many attested incidences of artefacts (principally pottery shards) becoming purposely incorporated into the architectural structure of the buildings on sites.[13] The main reason for this architectural re-use of broken vessel fragments was that pottery had properties that were not readily duplicated by natural products; they were durable, impermeable and fire resistant (Sullivan 1989:111). In the construction of drainage channels and pools shards were embedded into the plaster to help stabilise the material and to add an impermeable layer to the structure (see Figure 3.5). Pottery shards were also used to repair damaged roofs and plastered

Figure 3.5 Photograph of pottery shards employed as a constructional feature. These shards were laid to form a surface in association with a drainage channel. These features date to the Early Hellenistic Period at Tel Dor.

[13] Much of the quantitative data on this subject has been researched in Central and South America see Sullivan 1989; Hayden and Cannon 1983; Deal 1985; and Schiffer *et. al.* 1987. In the Southern Levant, I have seen a number of examples of re-used artefacts in architectural contexts (see Figure 3.6); however, there are relatively few published systematic studies of the phenomenon. A few published examples of artefacts in re-use as architectural elements can be found in Herzog *et. al.* 1978, and Ussishkin 1978:41.

walls, as well as having been incorporated into the structure during construction (Sullivan 1989:103, 110-111).

3.2.1.5 Earthen Fills.

Primary earthen material was also imported onto tel sites during the construction of particularly important structures. This material was imported to provide specific support qualities that were required during construction. Sand, for example, was (and is) a very good material for promoting drainage, and thus in sediments that had unusually high levels of clay, sands were imported to fill the bottom of foundation trenches in order to keep water from collecting around the base of these structurally important elements (Netzer 1992:19). In this way, depending on the needs of the builder, new raw materials could become incorporated into the site. In most cases, however, materials that were already present on site (see section 3.2.2 below) met the general needs of constructional 'fills'.

3.2.1.6 Summary of Primary Elements.

The type of structure built with the use of the structural elements noted above would have resulted in something very similar to the schematicised cross-section shown in Figure 3.6. It was

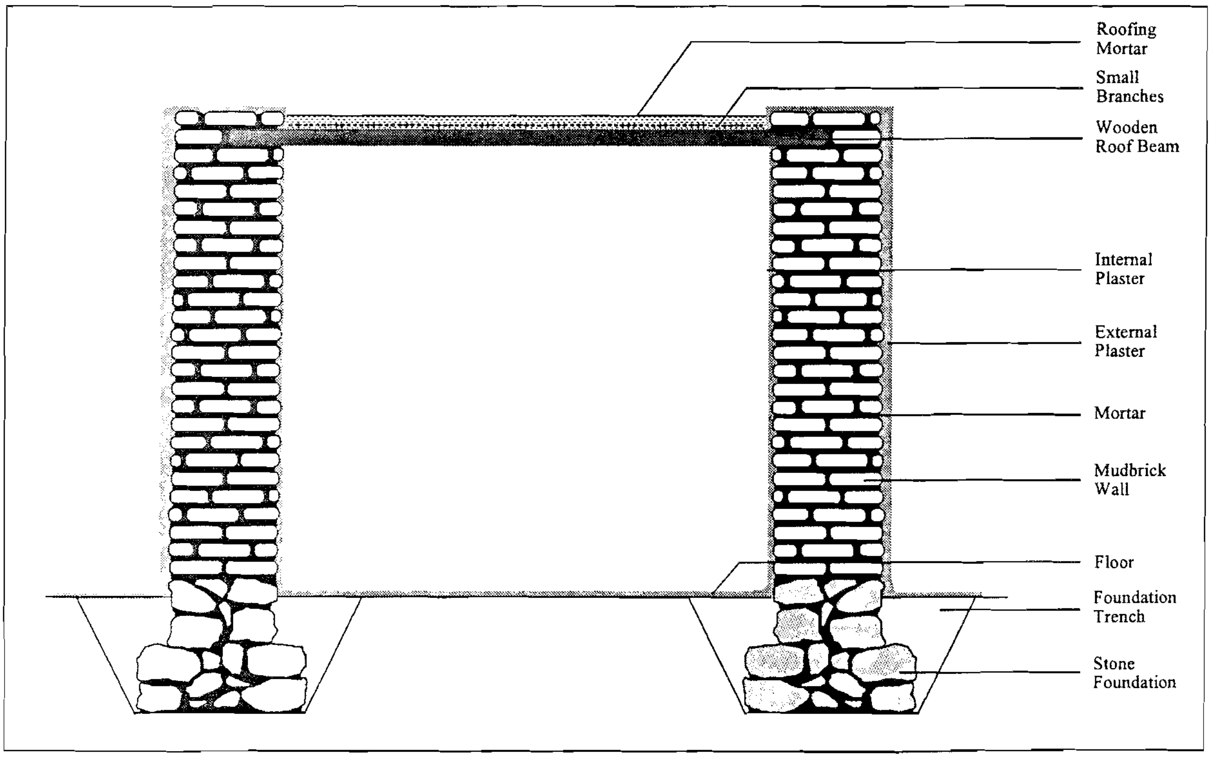

Figure 3.6 Simple schematic of an ancient structure.

primarily for the creation of such structures and other installations (drains, tabuns, etc.) that new materials were introduced to tel sites. Once the materials had been introduced, eventually they became integrated into the matrix of the site as archaeological deposits. This process of integration is the focus of the following section.

3.2.2 The Systemic Process of Site Development.

Now that the various materials and constructional elements that form tels have been introduced, the next step in the formation processes framework of archaeological interpretation requires a grasp of the systemic contexts that led to their deposition within the site. To this end it is necessary to re-examine the manner in which archaeologists understand the formation of tel sites, and employ that understanding in their interpretation of these sites.

3.2.2.1 Approaches to Site Formation.

The main systemic processes that conventionally have been identified as resulting in the incorporation of raw materials into sites usually have been related to destruction events and activities, often perceived within a context of repeated construction/destruction sequences of site formation. This traditional site cycle had four frames. The first of these was the actual construction of buildings and installations, immediately followed by an occupational phase in which dirt accumulated on floors, pits were dug, etc. After a period of occupation the final two frames occurred; the site was destroyed and then finally abandoned. The site would then begin anew with a repeated construction frame.[14] In this formation framework the destruction phase is perceived as the primary manner in which raw elements become incorporated into the site. For archaeologists, these destruction deposits can be of great importance because they create sealing depositional layers between different occupational phases of the ancient city. These sealed layers frequently serve as chronological markers between successive occupations, and preserve *in situ* remains. Both factors assist greatly the interpretation of the archaeological site. This traditional approach to site interpretation is strongly tied to the identification of these sealing elements (such as: the destruction layers, and floors and surfaces constructed during the

[14] This process of tel development, can be considered analogous to the idea of "Punctuated Equilibrium", as it is applied in Evolutionary Theory – long periods of stasis (in the case of tels, little growth during peaceful occupation of the site), followed by rapid spurts of change (in the case of tels, sudden destruction/abandonment followed by the reconstruction of the site. In other words, rapid growth of the site). For further discussions on this traditional cycle of construction and destruction, see Gitin 1990:11 and Sharon 1995a:57-59.

occupational frame of the construction/destruction sequence) because of the near *in situ* deposits of artefacts that can lie beneath them.

In contrast to sealing destruction deposits, unsealed deposits and features found on sites are less likely to be considered for intensive investigation. These include deposits created during the processes of construction. In the construction/destruction cycle of site formation, construction deposits are not considered to represent the functional and spatial activities of the features and structures under study because the artefacts they contain predate occupation and are in a highly mixed context. As noted in Section 1.2.1 however, the actual stratigraphy of tels indicate that their growth and development was the result of a much more complex process than that identified in the standard 'layer-cake' construction/destruction sequence. While massive destruction events did occur in antiquity, sealing occupational phases beneath them and causing tels to increase in height, for the most part in the development of tels these occurrences were the exception rather than the rule.[15] Truncated cycles, involving localised construction and destruction events within what was identified as the occupational frame of the site-wide cycle, have long been recognised (Sharon 1995a:59).[16] These mini-cycles were the result of repair and renovation that occurred on the site during localised occupational phases, prior to the frame of site-wide destruction or abandonment. Nonetheless, since the deposits created by these processes were primarily constructional in nature, the prevailing interpretation of ancient sites viewed them as added complications, leading many archaeologists to be wary of these deposits as potential systemic informants.[17]

Despite the emphasis placed upon destruction debris and associated deposits, the reality of archaeological sites is that there is a general paucity of these materials, especially on tels. A more realistic interpretation of site development would recognise that for the majority of the

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[15] For examples of sites that have had such episodes, see Herr (1997) regarding Tell el-'Umeiri, and Ussishkin (1977) regarding Lachish.

[16] Unfortunately, many archaeologists still retain the traditional understanding of tel site formation and rely upon it in developing their approach to excavation and deciding upon the elements to be analysed. It is interesting to examine excavation manuals (such as Zorn *et. al.* n.d.; and Blakely and Toombs 1980) to see the emphasis placed on different types of deposits as related to chronology, artefact acquisition, etc. As well, the examination of different site reports illuminates extreme differences in the amount that is written about destruction layers and deposits, and those non-destruction deposits even though their actual quantity on a site is inversely proportional (see Ussishkin 1978 and 1977; Stern 1995; and Gitin 1990).

[17] Deposits from these truncated cycles tend to be considered as intrusive elements that disrupt and complicate the stratigraphy of sealing elements such as destruction layers and floors. See Zorn *et. al.* n.d.; Sharon 1995a; and Chapman, III 1986.

active life of an ancient city, its growth was a result of the intrinsic processes of urban renewal and development during periods of peace and tranquillity. Thus, local construction and destruction mini-cycles associated with urban renewal within towns and other ancient sites are the cause of most archaeological deposits. As individual buildings fell into disrepair, needing to be rebuilt, or entire blocks were demolished for ambitious new building projects, the city would grow slowly and unevenly on a cell-by-cell basis (Morris 1972:7). It was through these gradual processes that site growth normally occurred, and was thus the processes that led to the formation of most of the archaeological deposits found on tel sites.[18] In this manner, any degraded material is usually reworked and re-incorporated back into the construction of subsequent structures.

By approaching the interpretation of archaeological deposits on tel sites from the perspective that day to day construction events were the main cultural transforms associated with their creation, the sedimentary matrix of the site takes on a new significance. Specific systemic behaviours (those related to the cycle of intra-site redevelopment) are now acknowledged as being represented in the archaeological record by the construction deposits. A sphere of meaning is now given to the deposits that were previously viewed simply as a complication to site interpretation.

3.2.2.2 Intrinsic Processes of Site Development.

Like city development today, the construction and decay within ancient cities was typically a gradual phenomenon over the life of the site. On an almost daily basis new buildings and facilities were being constructed, old ones renovated, and those no longer in use ignored and/or destroyed. As vibrant centres of social activity, sites were alive with many innovative approaches implemented to obtain supplies (eg: scavenging), deal with decay or obsolescence (eg: levelling and rebuilding), and dispense with unwanted materials (eg: throwing into a dump).[19] With site development in constant motion, there was rarely a clear cut-off point where the artefacts and structures from one time period ended and another began on a site-wide scale. Indeed, as development was gradual, artefacts, architectural structures, and most importantly sedimentary deposits were exposed to many uses and reuses.

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[18] To continue the evolutionary analogy adopted in footnote13, this process of site development would be akin to "Gradualism".

[19] There is some evidence in ancient literature about this constant renewal of cities, see Sperber 1998.

To understand the processes involved in this type of site formation is to recognise that most of the deposits of a site were intentionally laid down during the process of construction. They were created purposely for very specific and intentional reasons. Archaeological deposits from built sites were primarily the result of systemic intentional and planned activities, as opposed to haphazard and unintentional deposition through uncontrolled destruction and abandonment.

To take advantage of this alternative paradigm of tel site formation, a closer look must be taken at the processes of intra-site development and the mechanisms that result in this gradual formation of tels. To this end, a cycle is presented below that accounts for the processes associated with introduction of material onto a site during construction and occupation, and then the manner in which their materials degrade and eventually become buried into an archaeological context. This cycle that elucidates this intra-site renewal has been labelled a **Construction Cycle** (a schematic can be found at Figure 3.7) as opposed to the traditional Construction/Destruction cycle. The choice of name was made to emphasise the intentional nature of depositional accumulation as the result of pro-active and planned activities, rather than the deposits being the result of unplanned and haphazard events. During the life of an ancient city, this cycle was an ongoing, open system with different parts of the city falling into different phases of the cycle at any given time.

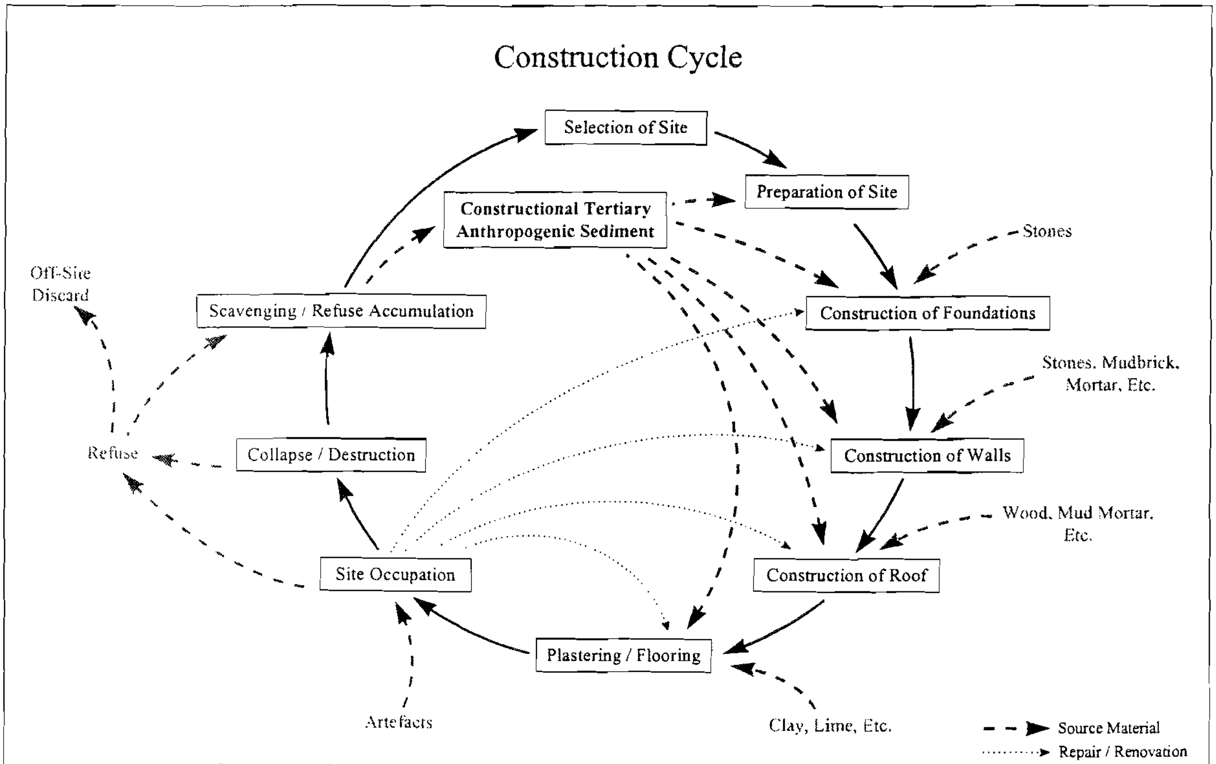

Figure 3.7 Schematic of construction cycle as outlined in the discussion.

The construction of a building began with the selection of a site and its preparation. The process of site preparation involved the raising, clearing (possibly the demolition of pre-existing structures) and levelling of the ground (Roux 1992:20; Kenyon 1974:62; Morris 1972:7; Reisner *et. al.* 1924:87; Reich 1992:8; Coe 1990:878; and Roaf 1996:30-31). Excess materials from this process were removed and dumped elsewhere within the city (Gitin 1990:15 and Reisner *et al* 1924:80) and if holes needed to be filled in or the level of the site raised, earthen material was brought in from nearby sources. Following the preparation of the building site, trenches would be dug for the construction of foundation walls and building material would be brought to the site for the construction of the walls, roof and floors (Sperber 1998:104-106; Netzer 1992:17; and Reisner *et al* 1924:80). It was these four steps in the construction cycle, from foundation building to plastering, that caused the accumulation of the majority of raw materials (such as: stones, mudbrick, mud mortars, clay, wood, lime, etc.).

Once the structure had been erected, it would undergo a period of occupation. During this phase of the cycle, artefacts would have been brought to the site for various systemic purposes and the structure itself could have undergone a series of renewal processes ranging from simple repairs to large scale renovations in order for it to continue to be a useful and inhabitable building.[20] When this was the case, any of the stages from site preparation to floor re-surfacing could be repeated a number of times, forming new systemic deposits associated with the occupation and renewal of the structure. It was during the occupation of the site that the majority of the refuse associated with the systemic activities that occurred in that building would be created. The sources for refuse included: organic remains (eg: discarded foodstuffs such as plant and animal remains, and faeces from both humans and animals), ash, broken ceramic vessels and other artefacts, lost artefacts, and finally residual building materials (eg: stone fragments from the process of created dressed or rough-hewn building stones (Moholy-Nagy 1997:300)). The manner in which this refuse was disposed in antiquity was generally very haphazard and unorganised. This material was usually allowed to accumulate within the walls of the city, as its removal was generally difficult and uneconomical (Tufnell 1958:47).

Since refuse is rarely maintained in the archaeological record in the exact way in which

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[20] Literary evidence for the process of rebuilding and renovation can be found in the ancient law codes. The Sumerian Law Handbook of Forms (ca.1700 BCE), *iii* 18-47; the Laws of Eshnunna (ca.1770 BCE), Law ¶58; and the Laws of Hammurabi (ca. 1750 BCE), gap ¶e; all discuss various scenarios associated with the maintenance and reconstruction of individual walls and entire structures. (As quoted in Roth 1997).

it was discarded, the evidence relating to the manner of discard in antiquity is limited (Green and Lockyear 1994:102). Daniel Sperber, however, in his book, *The City in Roman Palestine* (1998), provides a number of amusing anecdotes taken from various Rabbinic sources about how refuse was disposed of at this time:

> *One time [Rabbi Eliezer, late first century CE] was passing through the market and saw a woman sweeping (refuse out of her) house, and she threw it [out] and it fell on his head.*[21]

and

> *... to save themselves further trouble* [some people] *would empty the contents of their chamber pots from their heights into the streets. So much the worse for the passer-by who happened to intercept the unwelcome gift.*[22]

Other sources describe similar practices of refuse discard, where it was simply thrown out onto the street (Roux 1992:19, 220; Kemp 1977:134). As well, Sperber notes the frequency with which storage and transport vessels would have been broken during the daily traffic through the streets (1998:105) and thus adding to the amount of rubbish that accumulated in the public parts of the city. Additionally, there were laws and regulations about the maintenance of general upkeep and cleanliness of streets, which usually fell to the persons who owned property along the street or to particularly wealthy individuals within the city (Sperber 1998:110-111; Alcock, *et. al.* 1994:149). Often the accumulated refuse would be pushed aside and left to accumulate in vacant or unoccupied areas nearby.

Unfortunately, very few studies have been conducted in traditional settings in the Near East that could provide concrete examples about the way in which both public and private refuse was disposed of in the past. In Central and South America, however, many ethnographic studies have been conducted in traditional settings that have shown that household and community refuse tended to accumulate in abandoned and/or deteriorating structures (Deal 1985:263, 267). In these processes of refuse accumulation, it was found that the most economical path of rubbish disposal was almost always taken, that is to say that garbage dumping was done close to the area of garbage creation (Hayden and Cannon 1983:133). Studies of modern Nubian houses that maintain traditional customs have suggested a similar

[21] From Sperber 1998:9.

pattern of refuse disposal and accumulation as that found in the ethnographic studies from Central and South America. The Nubian homes were found to consist of several rooms or buildings that were occupied on a rotational basis, with only a few being used at any single given time. The remaining rooms and buildings served as animal pens, storage rooms, or were simply left in a derelict state, serving as household middens where layers of rubbish accumulated (Rowley-Conwy 1994: 30). While it is not possible to make direct correlations between the manners of rubbish disposal in the Ancient Near East and those of the indigenous Americas of the past two hundred years, the American studies do provide guidance. The close parallels between the types of building materials and household implements and technologies employed by the different societies, along with the limited information archaeologists do have as to the nature of refuse disposal and accumulation from ancient and traditional Near Eastern contexts, support a correlation of garbage disposal methods.

There is literary and archaeological evidence that in certain circumstances, some types of refuse were required to be deposited in specific locations. This was often the case for sacred or cultic objects that were no longer in use. These types of discards often would be deposited in specially created pits known as favissae. There were also laws governing the disposal of objects with 'impurities'. In the laws of the Hittites, special edicts existed regarding the disposal of these types of materials in incineration dumps, and the punishments that would be applied if impure materials were dumped on another's property (Law §44, in Hoffner 1997:189).

Evidence exists as well that there were occasions when refuse would be removed from the walled cities. This was usually done in an effort to provide fertiliser to the surrounding fields. Refuse from the cities, particularly the organic refuse, was very high in phosphates and other important nutrients. As a result, this type of material was collected, particularly in times of environmental hardship, to help the growth of the nearby crops.[23] During the Roman period in Palestine, a system of organised removal of refuse from cities was put in place (Goffer *et. al.* 1983:253), but it continued nonetheless to accumulate within the city limits.

At some point in time, an occupied structure that was inhabited and going through the various processes of renewal and refuse creation would be intentionally or inadvertently destroyed or abandoned. The period of abandonment of that structure, and the land it occupied,

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[22] From Sperber 1998:11.

[23] It is for this reason that shard scatters can occur all around major archaeological sites, to distances as far away as six kilometres, without any evidence of actual occupation at the find spots (Wilkinson 1982).

could last for some time or the site could be selected for immediate construction of a new structure or development. Either way, a further important feature of the construction cycle would occur, that of scavenging. The expense associated with the acquisition of building materials, particularly wooden beams and stone, almost guaranteed that a site of building abandonment or collapse would be stripped clean of any useful objects in very short order (Ussishkin 1978:12, 45; Deal 1985:271; McIntosh 1977:191; Butzer 1982:92; Roaf 1996:31; Nissen 1968:107; Sperber 1998:114; and Netzer 1992:27). Indeed, in ancient Athens there is evidence that scavenging was a business enterprise, with the scavengers [*koprologoi*] profiting from their trade (Alcock, *et al.* 1994:149). The mudbrick and remaining roofing material, on the other hand, would be left to degrade on site, forming a small earthen mound as it could not be successfully re-used in that form. This process of degradation could be very rapid as unprotected mudbrick and mortar melt almost immediately when saturated by water (Carter and Pagliero 1966:67) and thus quickly degrade into their original grain components (Schiffer, *et al.* 1987:17). Experiments at Tell Harmel in Iraq have shown that a 1½ metre high wall can collapse to a pile of mud following only a week of rain (Gullini 1969:456).

If construction was to proceed immediately, the site would be levelled with holes filled in and excess materials carted off; the construction cycle would begin anew. If, on the other hand, no new construction was to take place immediately, the site would be left unoccupied, equivalent to a 'vacant lot'[24] until a period of development. It was these vacant, unoccupied areas that became the magnet for refuse accumulation (Kemp 1977:134; Wilk and Schiffer 1979:531). As these sites were scavenged for usable materials, and additional refuse accumulated, the degraded building material (mudbricks) and the non-degradable refuse (pottery shards, bones, etc.) would become increasingly mixed by such processes as shortcutting, child's play, and the stabling of animals (Deal 1985:271; McIntosh 1977:187; Butzer 1982:90; Wilk and Schiffer 1979:531-533). It was this material, a mixture of

[24] In the archaeological record, there is little evidence of the presence of vacant lots in ancient living cities (Wilk and Schiffer 1979:535). This is primarily the case because these open spaces are eventually reworked for subsequent construction, thus obliterating the evidence of their existence. A secondary reason that these types of areas are not found frequently, even in the case of abandoned and destroyed cities, is that it can be difficult to distinguish between deposits that accumulated subsequent to abandonment from those that accumulated prior to abandonment. A discussion of vacant lots within cities in antiquity can be found in: Hakim 1986:112; Kemp 1977:133-134. There are literary sources that imply the presence of such open spaces within ancient Near Eastern cities, see Sperber 1998:107; Roth 1997: 95 and 179; Hoffner, Jr. 1997:156 and 189; Tomlinson 1992:15.

construction debris and refuse, that was re-used as source material for filling in holes (e.g. foundation trenches), for raising the ground level (eg: during site preparation), and for the creation of new mudbricks and mortars (McIntosh 1977:191; Rosen 1986:75; Needham and Spence:1997:82; Tufnell 1958:45; Gitin 1990:15; and Reisner 1924:80, 87). In other words, this tertiary anthropogenic sediment became a primary source of constructional in-filling sediments. These sediments would be transported locally to various building sites that required material to fill in holes and trenches, or to be levelled off and raised. In the process of reconstruction on the site of collapse and refuse accumulation, the sedimentary debris located there would be further mixed and moved about during the processes of levelling, and could also be used to re-fill the trenches around foundation walls. Through these processes, the intra-site collapse/destruction debris would be constantly placed into a state of constructional re-use, and would thus rarely become a part of the archaeological record in an unaltered state.

These tertiary anthropogenic sediments, once deposited in a constructional setting, became entities that had a functional role, and an individual date of creation that is equivalent to the date of building construction. While the artefacts and other materials may pre-date the actual construction event by a considerable amount of time, depending upon the duration of the period allowed for refuse accumulation at the initial site of deposition, the process of transportation and construction often lent itself to the inclusion of artefacts that were contemporary with the construction event (Ussishkin 1977:30; and Kenyon 1981:3). In this way, although the deposits may not have been 'sealed' in the traditional sense[25], they can be useful in determining the date of construction, particularly when similar deposits for an entire structure are studied in context of each other.

3.2.2.3 Drawing Lessons from the Construction Cycle.

This deposit-based approach to site formation, in contrast to the artefact-based approach that has been the traditional focus of archaeological problem solving, assigns greater interpretive significance to the deposits created during the continued, uninterrupted occupation of the site. The traditional paradigm of site formation that emphasises the role of destruction in the formation of archaeological deposits relies heavily upon the placement of artefacts and

[25] In Near Eastern Archaeology, the term 'sealed' refers to deposits or features that lay directly beneath later elements, such as a floor. As these deposits can not have been interfered with by later anthropogenic activities, their artefactual content can provide useful chronological markers.

deposits of artefacts in *in situ* or sealed contexts for its source of archaeological interpretation. As a consequence, problems arise when artefact deposits are not found in these contexts. By viewing the deposits as whole entities, and as primary sources for site interpretation, more of the site becomes available and useful for analysis. By developing a method for recognising and creating accurate chronologies of construction stages, it can then become possible to identify the nature of spatial organisation within different stages of city growth (Saile 1977:168).

The study of the tertiary anthropogenic sedimentary deposits also can be useful in the traditional sense by assisting in the determination of functional activities that occurred in the local community within the larger city. Since both refuse material and constructional sediments were not transported far from their sources, this tertiary anthropogenic sediment could contain non-degradable artefacts that had been used locally, to the point of destruction. In this way, the artefactual components within the unified deposit could be utilised for archaeological problem solving, much like the artefactual deposits studied in the traditional manner of site studies based upon the destruction/construction formation process. The artefacts within the deposits would not be as location specific as those found on floors and in sealed contexts, but at least local information could be gleaned, whereas presently these data tend to be lost.

It is important to note at this juncture that the archaeological record does not reflect all phases of the construction cycle. As already alluded to above, some of the phases would tend to be destroyed during the processes of construction, primarily the occupation, collapse and refuse accumulation phases. Much like today, construction in the past involved the major movement of earth and the destruction of extant structures. Even if the resulting rubble was not transported, but incorporated into the sedimentary substructure of the new building, all superstructure (above ground) phases of the previous structure and the activities associated with it would be destroyed. It is for this reason that the importance placed upon the discovery of meaningful sealed and *in situ* remains can be so fruitless in many tel excavations. By studying the construction deposits, however, and gleaning the data that can be found from them, a greater quantity and enhanced quality of information potentially can be obtained from the excavation of tel sites.

3.3 Archaeological Context of Deposits.

The manner in which deposits appear in the archaeological context can provide important clues as to the systemic contexts that resulted in their deposition. By first having knowledge about the characteristics of different types of deposits (both physical and systemic) it is possible once in the field to identify accurately the deposit type and to have a good idea about the systemic context that caused its creation. In turn, other venues of archaeological interpretation become available as more refined identification of the context of the deposit is uncovered. The following sub-sections discuss some of the general characteristics of different types of deposits as manifested in the archaeological record, while also providing some of the systemic activities that potentially caused their creation.

3.3.1 *In situ.*

In situ deposits are those remains where there is a direct, unmediated relationship between the systemic and archaeological contexts of the deposits. In other words, the deposits are found in their place of last use and are thus primary anthropogenic sediments. Items found *in situ* form the basis from which the functional role of the structure or space in which they were located can be discerned. In most archaeological excavations, the term *in situ* is applied usually to features such as walls, floors, tabuns and kilns. These features, however, are not artefact deposits, and are thus not the concern of this discussion.

The most common *in situ* remains are those associated with undisturbed burials, where the artefacts were placed with the buried individual in a specific manner, covered and not interfered with until their recovery by archaeologists. In non-burial contexts, however, *in situ* artefact deposits are very rarely uncovered. In order for deposits of functional artefacts to be left in their "life-use" context, such as living quarters, workshops, etc., the depositions must have been the result of a sudden and unforeseen event that caused the immediate abandonment or destruction of the location. In addition, the site would have had to have been covered quickly so as to prevent later scavenging, which would disturb the remains, removing them from their functional context. The primary reason for positing this rapid scenario for the origin of *in situ* deposits is that given the opportunity, people attempt to protect their possessions, removing them to safety when destruction is imminent. The more important the various functional objects were to their lives, the more likely that they would not be left in a functional area if there was sufficient time to remove them. Thus, even if there were only a short period of notification prior to destruction, certain materials would be removed intentionally from the structures to be imminently destroyed.[26] The amount of material removed would have been relative to the

[26] Even the sites that are most closely identified with *in situ* remains, Pompeii and Herculaneum – destroyed and covered by ash due to the eruption of Mount Vesuvius in 79 CE, do not contain the remnants of cities 'frozen in time'. In actual fact, many of the citizens were

length of time that people had to collect their valuables. The best evidence that the deposits truly were *in situ* is to find associated human remains. This would be indicative of the sudden nature of the destruction.[27]

The most common events that caused *in situ* remains were earthquakes and other catastrophic events as well as destruction due to violent conquest. Due to the nature of the type of event that would be responsible for the development of *in situ* deposits in a city environment such as tels, the evidence for the destructive event would have been manifested across a large portion of the site. On a smaller scale, the ruins would almost certainly have been removed and/or undergone a scavenging process, but on such large scales, the resulting rubble would have been impossible to move due to its quantity (Legget 1973:375).

When material is found on surfaces of functional activity areas, beneath undisturbed collapse or destruction debris, the deposits are not usually in their functional positions, but rather in one of provisional discard[28] (Hayden and Cannon 1983:156; and Deal 1985:270). As expressed above, the functionally useful artefacts and materials would have been removed from the space prior to collapse, leaving only the artefacts and deposits that were of less importance. Artefacts related to storage of goods, be they foodstuffs, archives, etc., are more frequently found in *in situ* contexts beneath undisturbed collapse of destruction debris. It is, thus, not infrequent that remains of grain storage or of tablets from archives are preserved beneath destruction debris. One of the best measures of whether crushed artefacts beneath collapsed building material are truly *in situ* or provisional discard, is to discern if the vessels or artefacts are completely restorable. Should large pieces of the artefacts be missing (from a careful excavation that attempted to collect all the shards, etc.), this would be indicative of deposits in

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able to flee a few days before the actual destruction, taking many of their valuables with them. Some of the remains of people that have been found at these sites are of those who returned to the cities following the eruption to loot and plunder the valuables that were buried beneath the ashes. More often than not, they were overcome by the toxic gases trapped in the ashy debris, and killed. These remains represent the process of looting, rather than that of the living city. (Dr. R.F.J.Jones, the University of Bradford and Gary Devore, the Anglo-American Pompeii Project, personal communication.)

[27] An example of this is the "Burnt House" in Jerusalem, where during the excavation of archaeological remains from the Roman destruction of the city in 70 CE, the skeleton of a woman was found in her home, still clutching a knife – presumably for protection.

[28] Provisional discard is a term that is frequently used to denote deposits of broken pottery vessels or other artefacts that are kept in fairly close proximity to activity areas and are not immediately disposed of because of their potential to be reused in some other fashion (Hayden and Cannon 1983:156, 159; Deal 1985:253, 270; and Schiffer 1987:99).

provisional discard, rather than *in situ*.

The appearance of *in situ* artefact deposits in the archaeological record has the following characteristics.

- There is no mixing with earthen deposits or other architectural debris. The deposits are almost 100% artefact, with very little if any internal sedimentary component (Ussishkin 1978:64); see Figure. 3.8.
- These deposits sit directly upon an occupational floor or surface. (Zorn *et. al.* n.d.:38, 52; Reisner 1924:37).
- Although the deposits may be crushed beneath collapsed wall or roofing material, there should be no absent fragments from the vessels represented in the deposit. Some disturbance, however, may result due to natural processes, such as bioturbation.
- The presence or absence of organic matter, such as grains, bones, etc., will be dependent upon the functional activity of the *in situ* artefacts.

When *in situ* debris is found in archaeological excavation, it is possible to go beyond the functional inferences that can be made about the activities that occurred in that space. It is possible to discuss the nature of the events that resulted in them becoming part of the archaeological record; in this case, abandonment or destruction that occurred over a very short period of time rather than as a prolonged event. As well, the artefacts can provide a time frame for the last use of the surface prior to destruction, and a time frame for the destruction event itself (Zorn *et. al.* n.d.:52).

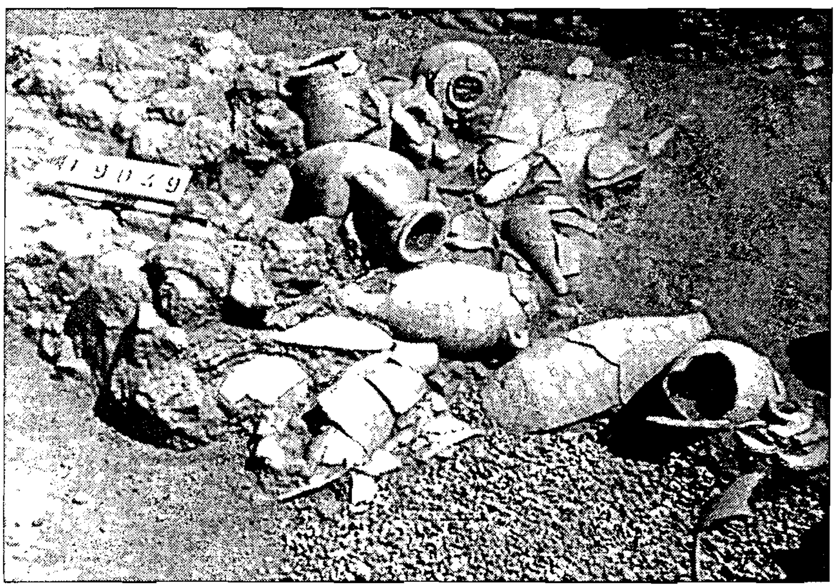

Figure 3.8 *In situ* remains from Tel Dor. Note the presence of crushed complete vessels on a stone surface. The contents (crushed murex shells) of some of the vessels appears to have spilled out. Photo courtesy of C.M. Foley.

The study of small (microscopic) cultural debris embedded into the actual matrix of the floor surface can be considered as *in situ* material. These tiny debris fragments, such as micro-pottery shard and bone fragments, ash, and food particles, can indicate functional and systemic activities that occurred on that surface through its life history. As our interest for this thesis, however, lies with the larger issue of macro-deposits, this element of *in situ* study will not be explored.[29]

3.3.2 Pits.

Pits are common features found in archaeological sites of the Near East. They often contain organo-cultural refuse associated with the disposal of domestic or occupational waste. In their original systemic context, however, pits were rarely created for the specific purpose of disposing of waste. Instead they usually served specific functions, such as: storage of grain, or fuel; holes for the placement of large vessels (Ben-Tor 1992:67); and for the acquisition of scavenged materials (Ussishkin 1977:45). It was only after the pits were no longer fulfilling their original purpose that they were filled in quite rapidly with refuse (Deal 1985:263, 266; Hayden and Cannon 1983:144-145, 159; Schiffer 1987:219; Stager 1971:86; and Blakely and Toombs 1980:23). Deposits that are found in pits fall into the category of secondary anthropogenic sediments for the artefacts within them were no longer in their primary functional context, but had entered their second systemic context as a refuse deposit.

Some pits were dug for the collection of special kinds of refuse. The most common of these in the Near East were *favissae*. These pits were built for the sanctified disposal of cultic objects. Favissae are easily identifiable by the large amount of cultic objects they contain, such as figurine fragments. Often these types of pits also have evidence of rituals associated with their creation, such as a burnt sacrifice at the bottom, or an ash lining of the pit.[30]

The appearance of pit deposits in the archaeological record has the following characteristics.

- They tend to appear circular in the horizontal plain, filled with anthropogenic sediment different than the surrounding deposits (Zorn *et. al.* n.d.:51); see Figure 3.9.

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[29] See Goldberg 1992, Macphail and Courty 1985, Macphail and Goldberg 1995, and Matthews 1992 for further studies in this field.

[30] Examples of favissae uncovered during excavation can be found in Ussishkin 1978:26 and Stern 1980.

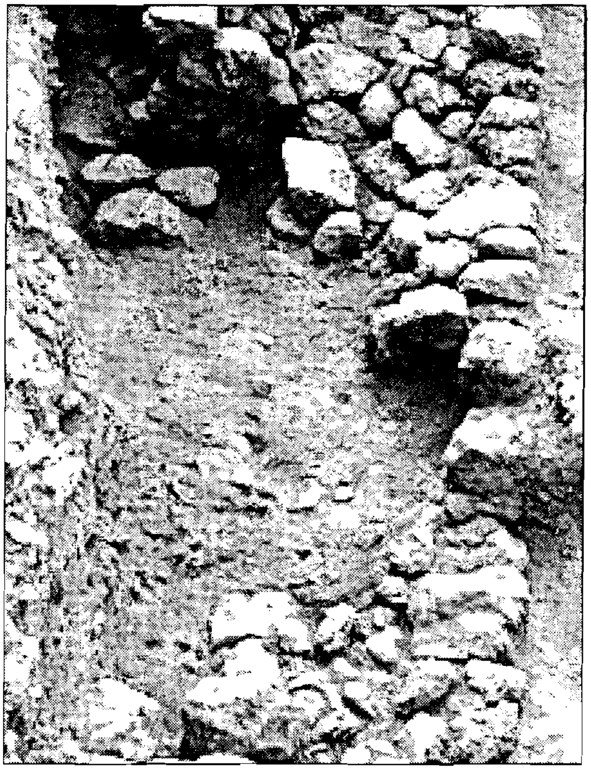
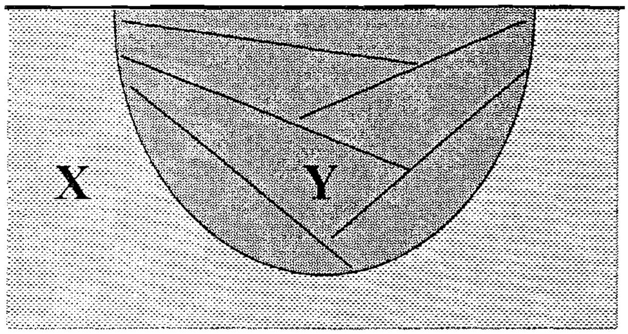


Figure 3.9 Photograph of a round pit. The pit consists of a dark greyish sediment with a large amount of pottery shards. The pit cuts into an earlier foundation wall and a reddish sediment.

- Their artifactual contents are chronologically more recent than that of the surrounding sediments.
- They may be lined with plaster, ash, small stones, etc., although this lining is not always present. (Stager 1971:86).
- The artefact contents of the deposit tend to be loosely packed relative to the surrounding matrix, with large quantities of ash, bones and shards. The bones and artefactual material tend to be larger than average, as they have not been subject to the same processes of re-working as have general refuse. (Goffer *et. al.* 1983:232; and Zorn *el. al.* n.d.:5, 39, 51).
- There is proportionately less earthen material (sand, silts and clay) mixed with the artefacts, with relatively little crude rubble other than the artefacts. (Butzer 1982:87-88).
- The deposits within pits are generally rich in organic refuse (as extrapolated via phosphorous and organic carbon content). (Butzer 1982:87-88; Goffer *et. al.* 1983:234).
- If the pit has been used for dumping over a period of time, there can be the development of layering (talus), from the individual dumping events; see Figure 3.10. (Reisner 1924:39; Blakely and Toombs 1980:23; Gilead 1989:382; and Chapman 1986:11).



- Deposit X is older than deposit Y.
- Deposit Y, the refuse disposal secondary anthropogenic sediment, cuts into the pre-existing sediments of deposit X.
- Layering may be present in deposit Y, if it has existed as a refuse dump for an extended period of time.

Figure 3.10 Schematic diagram of a pit.

The functional or systemic inferences that can be made from the presence of pits in an archaeological excavation are not as clear as those from *in situ* deposits. Unless some evidence remains of a systemic function of the feature, such as fragments of an original lining, that function can be difficult to infer. The nature of the deposit itself, however, can be used in a chronological fashion to help ascertain the date of the filling in of the pit, i.e. when it was no longer in functional use. The difference between this date, and that of the surrounding deposits can give a time frame for the systemic use of the pit. The general presence of a large number of pits in an area can be indicative of relatively large scale storage, regardless of the nature of the deposits found in their archaeological context.

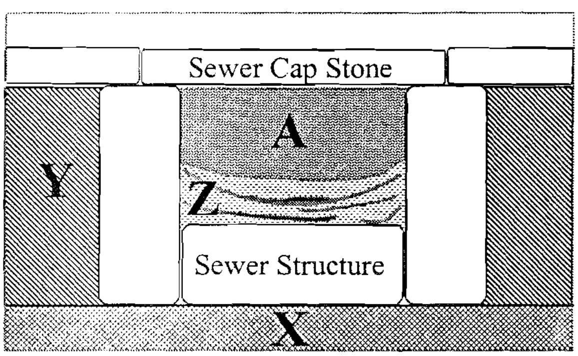
3.3.3 Sewer Deposits.

Sewer sediments are easily identified in archaeological contexts as they are usually surrounded by extensively built sewer installations. The nature of the sediments that are contained within these structures are dependent entirely upon the activities that occurred in the collection area of the drain. Unlike many other tertiary anthropogenic sediments, those that accumulate in sewers are strictly the result of happenstance. No intentional deposition occurs in these contexts. The sediments that are deposited in sewers and drains are the result of the washing down of the streets and alleys, and of material that is added to the mix by drains from houses and buildings that line the street.

While the actual content within sewer sediments may be quite variable, depending upon the area of the city or town in which it functions, some of the commonalities they share could include:

- a graded layering of sediments at the bottom of the sewer. This would be the result of particles that were too heavy to be carried the length of the sewer, dropping out of suspension (Bullard 1970:123). Lenses of some heavy elements may occur very near to the location in which they entered the sewer system. The depth of this layered deposit can be quite variable depending upon the rate/force of flow through the system; see Figure 3.11.

- an orientation of the particles within the sewer sediments in the direction of flow (Butzer 1982:100 and Wilkinson 1976:282). This orientation could be easily discerned at the micro-level of the sand, silt and clay sized particles, but larger artefacts could also display this feature.
- a relatively high inorganic carbon content, similar to that found in aquaducts, because of the precipitation of carbonates from water that runs through the drainage system (Wilkinson 1976:281).
- a relatively high phosphorous content, should the sediments be the result of raw sewage and refuse that would be washed in from the streets.
- the transition from small laminar deposits at the base of the sewer, to a larger rubble and loam matrix as the drain continues to collect material, while becoming increasingly clogged (Wilkinson 1976:281).
- macro-artefacts, including pottery shards and bones, were found to be relatively small compared to those in other anthropogenic sediments. Very large artefacts would be unlikely to be incorporated into sewer sediments due to the limiting factor of the size of the openings into the system.



- Deposit X is oldest, pre-dating the construction of the sewer structure.
- Deposit Y is contemporary with the construction of the sewer.
- Deposit Z, post-dates to construction of the sewer, and is contemporary with the use of the installation. Laminae of water-laid deposits will be present in this deposit.
- Deposit A, post-dates the construction of the sewer, and may or may not be contemporary with the use of the installation.

Figure 3.11 Schematic diagram of sewer installation and associated sediments.

Beyond the functional inferences that can be made based simply upon the presence of a sewer installation in a site, the systemic inferences that can be derived from sewer tertiary anthropogenic sediments are also of great use. These deposits are directly related to the activities that occurred in the immediate vicinity of the drainage system but are not reflective of an intentional deposition of material. In this way they can inform on general activities that occurred in the public areas of the city. As well, the chronology of the artefacts contained within these deposits can be very useful for identifying both the time span of the installation's life, and when the sewer system in that area was no longer functional. In this way, the potential for these anthropogenic sediments to inform on fundamental systemic issues, such as local industrial activities, demographic shifts and building phases is very high.

3.3.4 Collapse and Destruction Debris.

Undisturbed collapse/destruction debris is a secondary anthropogenic sediment, like the deposits found in pits. In its primary context, the materials from collapsed structures would have been *in situ* walls and roofs. Once these structures had been either abandoned and allowed to collapse, or had collapsed through a catastrophic destruction, these remains entered a secondary systemic context. To be considered truly as collapsed material, these deposits could not have undergone any later anthropogenic mixing, but rather were left undisturbed. If occupation of the site continued, new construction would have occurred above these remains, effectively sealing them beneath the later phases of occupation.

The actual process of a structure's collapse typically began with the collapse of the roof. The walls were then exposed directly to the elements, causing them to deteriorate more quickly, with great pieces of wall toppling off both externally and internally, until eventually the last remains fell *en masse*, covering the wall stumps. Throughout this collapse process, plaster pieces from the walls would fall as horizontal lenses or as mixed mottles. (McIntosh 1977:191).

In the archaeological record, collapse and destruction debris would display a number of characteristics, including the following.

- A distinct layering of architectural features directly above a floor or surface. The first layer will rest directly on the floor and consist of crushed *in situ* or provisionally discarded artefacts. The second layer will be of the collapsed and burnt roofing material. The third layer will be formed by collapsed wall material (mudbrick or stone). Interlayed within the last two layers will be fragments of plaster from the roof and walls; see Figure 3.12. (Butzer 1982:89; Gitin 1990:15; and Ussishkin 1978:13,52-53).

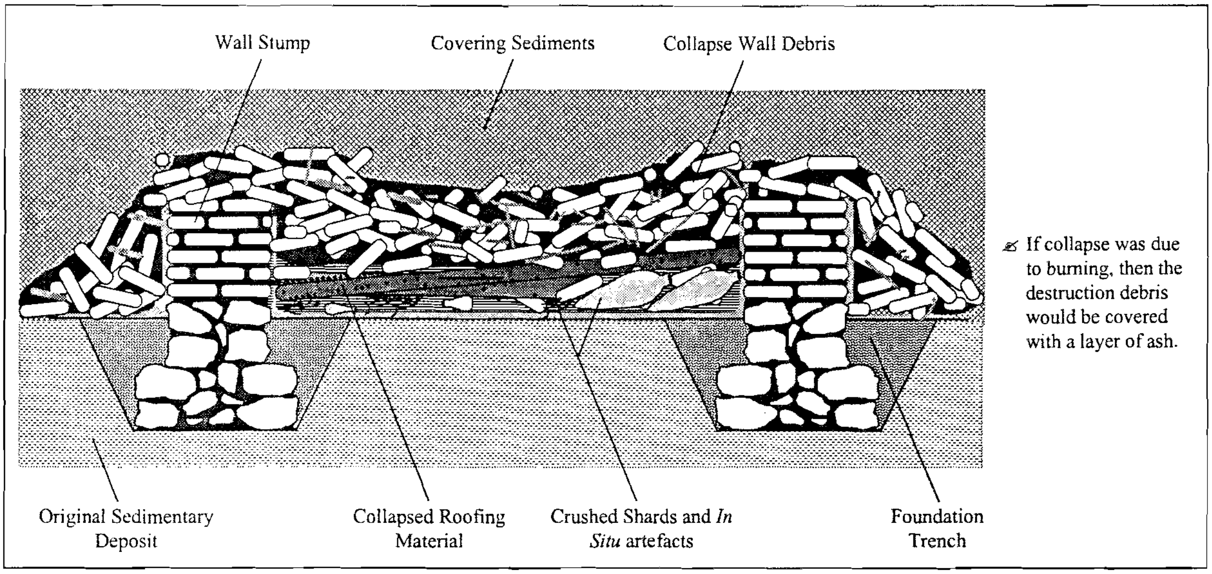


Figure 3.12 Schematic diagram of collapse debris.

- Other than pottery shards or other artefacts that have been included as architectural elements through re-use, there rarely will be any artefactual remains mixed in; these are 'clean' deposits; (see Figure 3.13). The exception to this would be the destruction of a multi-storied building, where the *in situ* artefacts and features from the upper floors collapse down as the inter-level floors fall. In these situations, like with other *in situ* deposits, there should be identifiable concentrations of crushed and broken artefact debris with the majority of the artefact fragments present in the deposit.

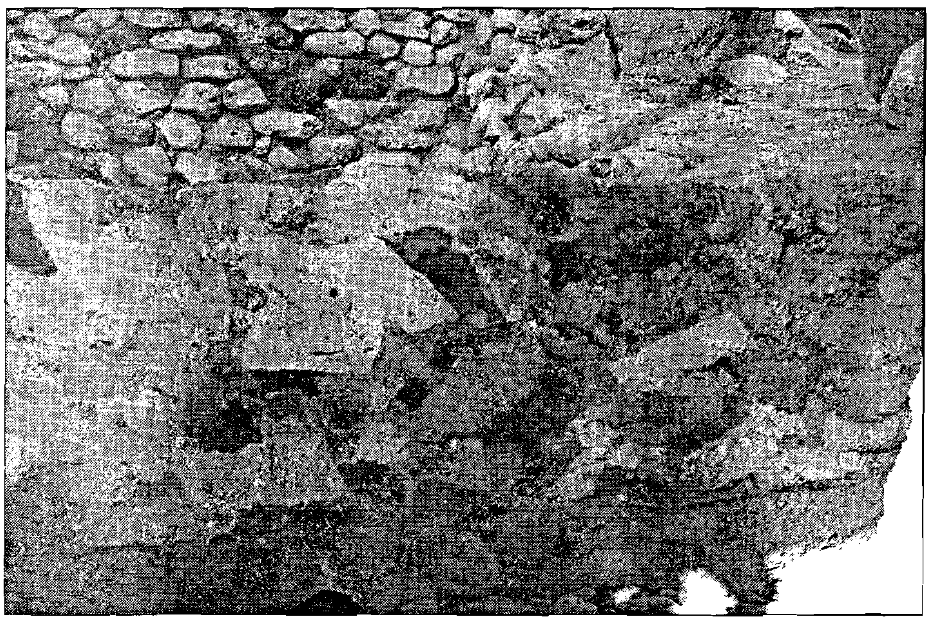


Figure 3.13 Photograph of a collapsed mudbrick wall from the Late Bronze Age at Hazor. Note that the mudbricks have maintained their structural integrity, and that there is absence of other artefactual inclusions. This destruction debris has been covered over by a later stone structure.

- There will tend to be very low levels of organic matter, as measured by phosphorous and organic carbon content. This is the case since the materials used for the original construction (as described in section 3.2.1) are not subject to the deposition of such organo-cultural refuse. The pH and calcium carbonate levels will be relatively high. (Butzer 1982:89).
- There will be large interstitial voids in the debris, created by the collapse of large chunky building materials, which may be filled by fine-grained decayed mudbrick and other architectural features over time.

The creation of collapsed debris can occur either very quickly or take a long period of time, depending on the individual circumstances. The manner in which the time involved in this formation process manifests itself in the archaeological record in quite distinct and easily identifiable ways. Sudden collapse was usually the result of a violent or catastrophic destruction of the site, via earthquake or other natural calamity or by the intentional razing of the site as the result of conquest. In both circumstances, fire and burning often would have played a major role in the destructive process. The actual thickness of the deposits is dependent upon later efforts of reconstruction in the area. In the archaeological record, these types of rapidly created collapse and destruction deposits would be characterised by the presence of a large amount of ashy material that would be scattered throughout and overlay the entire deposit (Ussishkin 1977:44; 1978:10, 53; Reisner *et. al.* 1924:87; and Zorn *et. al.* n.d.:38). As well, due to the conflagration the mudbricks from the walls likely would become baked, almost equivalent to kiln-fired ones and any wooden beams or other elements would be burnt with only charcoal residue remaining (Zorn *et. al.* n.d.:38). These types of catastrophic destruction events would tend to seal beneath their deposits the remains of *in situ* artefacts and human remains (Kenyon 1974:58; and Herr 1997:151). Finally, this type of destruction usually would be found to cover a larger area, rather than a single building, and thus other structures in the vicinity would be similarity affected (Ussishkin 1978:10-11).

Deposits created by the slow collapse of a structure, left to the natural processes of decay, will not have been subjected to a similar incineration. There will be very little evidence of extensive ashy elements or burnt brick and wood remains. In these instances the wood from roof beams and other architectural features will not have been preserved in the archaeological record in any form, but they could possibly leave a residual stain on the sediment upon which they fell (Blakely and Toombs 1980:21). Another main difference between the two speeds of collapse could be identified on the floor surface, along the line of the wall. In structures that had slowly deteriorated, there would be a build-up of fine-grained sediment from the mudbricks and mortar that decayed prior to the actual collapse. In situations of rapid collapse, these sedimentary build-ups would not have time to accumulate. During the process of excavating general architectural mudbrick collapse, the debris would be found to be much harder (denser) than most other secondary and tertiary anthropogenic sediments.

For collapse and destruction debris to find its way into the archaeological record, it must remain largely untouched by later phases of occupation, being quickly covered over to protect it from scavenging that would occur during the normal processes of reconstruction. Scavenging is one of the main reasons why on large sites that have been heavily occupied for an extended period of time, collapse debris is rarely uncovered. The primary exceptions to this situation are deposits from catastrophic destructions, which are not uncommon in tel sites. As mentioned in section 3.2.1, when a large amount of a city is destroyed at one time, the quantity of rubble and debris may be too great to be dealt with in any fashion, and thus is left. The new phase of occupation simply is built on top of the destroyed remains of the older city. There may be practical reasons for leaving destruction debris *in situ*, such as to keep from uncovering buried human remains, or the material may simply be too difficult with which to work (in the case of burnt mudbricks).

The functional or systemic inferences that can be made about the occurrence of collapse and/or destruction secondary anthropogenic sediments in an archaeological site relate to the site's demographic history. The presence of slowly accumulated collapse deposits would be indicative of a complete abandonment of the site or area of the city. Similarly, evidence for a catastrophic destruction of the site or part of the systemic city would be indicative of events that may be tied to broader political and/or environmental processes on a regional level. In principle, these types of deposits are welcomed by archaeologists as they can be very useful in developing reliable chronologies within a site and across geographic regions (Zorn *et. al.* n.d.:52-53; Ussishkin 1977:35).

3.3.5 Construction Fills.

Although the word "fill" has been identified in this thesis as being uninformative and not applicable for an archaeological description of materials, I have chosen to use it in this context as a descriptive noun denoting the function of the sediments under discussion. The term is not meant to be descriptive of the material itself. The sedimentary deposit it refers to is defined as: "material used for filling something, especially earth used to fill a hole or raise the level of the ground." (Canadian Oxford Dictionary, 1998). Indeed, these are the functions in which this class of deposits has been used from antiquity up to the present day.

As mentioned in section 3.2.1, constructional fills can be composed of primary anthropogenic sediments that were brought to the site for their specific physical or aesthetic qualities. In this situation, they are derived from clean sedimentary materials brought to the occupation site from elsewhere. The vast majority of constructional fills, however, are the result of reworked collapse/destruction debris that has undergone a variety of cultural transformations, including: scavenging, decay, trampling, dumping, etc. (as described in section 3.2.2). All of these processes result in great mixing of the sedimentary elements, creating tertiary anthropogenic sediments.

During the process of construction, the source of constructional fills can be from the demolition of existing structures, either standing or in a state of decay and re-use or from the collection of sediments from areas of the city that were unoccupied at the time. These fills may be found on the chosen site of construction itself or from other areas of the city, usually not too far removed. Since the source material for constructional fills was not created at the time of the construction event, and indeed could often pre-date it by a considerable amount of time, there is a general unease within archaeology when it comes to relating this material in any way chronologically to the actual structure or installation (Sharon 1995a). This reticence does not stop most archaeologists, however, from using the artefacts within these deposits to establish a rough date for the time of construction (Kenyon 1974:56-57; Gitin 1990:18). This practice is due to the general consensus that during the process of construction (including the period of transportation of sediments from one location to another) a few artefacts contemporary with the construction event probably were inadvertently included with the sediments as they were laid down.[31] In this way, the most recent chronological period represented in the artefact assemblage of a deposit, even if quantitatively very small, would be indicative of the date of construction. In other words, the artefacts would be used as a *terminus post quem* for the construction event.

In the archaeological record, constructional fill deposits would display a number of characteristics, which would include the following.

[31] This particular phenomenon continues to this day. I have recently had the opportunity to observe modern day construction practices, as a water main was replaced outside my home. While the earth that was initially removed was replaced (and thus pre-dated the construction event) upon completion of the job, the workers threw any garbage that had accumulated in the area (notably "Tim Horton" coffee cups) into the hole as they were re-filling it (inserting objects that were contemporary with the construction event).

- A very mixed matrix, consisting of completely degraded constructional material (e.g. earthen sediments from degraded mudbricks, small stones and gravel from mason's debris, charred wood fragments, plaster, etc.), artefactual refuse (e.g. broken pottery vessels and other discarded artefacts), ash, and organo-cultural refuse from bones, feces and other organic remains. Within this mixed matrix, pockets of the individual elements may remain, but the overall homogenous heterogeneity of the deposit will remain intact (see Figure 3.14 as compared with Figure 3.13)
- Moderately sized artefact fragments, primarily pottery shards, due to the process of exposure and the resulting number of transformational processes they have undergone.
- Moderate levels of organic elements, as represented by phosphorous and organic carbon levels. These would be higher than in pure collapse or destruction debris, as they have been exposed to greater anthropogenic processes, but lower than pure refuse deposits, which would have the highest level of anthropogenic input.

Figure 3.14 Photograph of constructional fill from the Keramicos area of ancient Athens. Note the presence of a variety of objects relating to constructional and domestic/commercial rubbish, including small stones, pottery shards and shells; all in a very mixed deposit.

It is possible that constructional fills also will display a phenomenon known as *reverse stratigraphy*. This is the archaeological situation where the most chronologically recent materials are physically buried beneath older deposits. As materials are permitted to accumulate, as in the construction cycle in section 3.2.2, over a long period of time they can develop their own internal stratigraphy whereby the oldest material is deposited first, and the more recent remains placed on top. If this sedimentary deposit is then transported to a new location, the top-most material will be redeposited first (into the bottom of the space to be filled), followed eventually by the bottom-most material.[32] This type of stratigraphy can occur only if the source of constructional fill has existed for a sufficiently long period of time as a location for dumping of disused artefacts to allow for the creation of an internal stratigraphic sequence.

The functional or systemic inferences that can be made about constructional fill, that is, tertiary anthropogenic sediment, are numerous and are mostly related to the activities associated with source material. It can be possible to identify, based upon the nature of the artefactual elements in the matrix of the sediment, the nature of the functional activities in the areas in which this material had been located as a refuse accumulation. For example, if the pottery shards in the tertiary anthropogenic sediment were primarily associated with domestic activities, such as cooking, it could then be inferred that the sediments were originally in an area of domestic rather than industrial activity.[33] In addition, the nature of both the construction and destruction processes for the structures whose decay contributed to the formation of the tertiary anthropogenic sediment may be inferred. For example, the presence of many small pebbles and masonary debris would be indicative of the use of a large amount of stone in the area at that time. In addition, the presence of a large quantity of ash mixed in with the tertiary anthropogenic sediment could indicate that the structure that provided a quantity of the source material had been destroyed by fire. Further systemic inferences that could be made based upon the characteristics of constructional fills could be related to the representativeness of the pottery shard types (handles, body shards, etc.) or other artefacts found in the deposits. Proportions of shard types that differed from that of the original vessels could be indicative of selective processes associated with re-use and disposal of the artefacts.

In the process of studying constructional fill/tertiary anthropogenic sediment, inferences could be made about the processes of construction, both for the individual structure and for the

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[32] Examples of reverse stratigraphy found in archaeological contexts can be found in Tufnell 1958:45 and Ussishkin 1978:34.

[33] David Ussishkin (1977) was able to identify the source for various constructional fills of structures he studied at Lachish.

ancient city as a whole. The identification of different sources for adjacent fills, as well as the identification of the same source for fills of different structures that may or may not be in close proximity to one another, could yield data that would be helpful for understanding the 'living city' of the past. This type of correlation would be similar to studies that are done regarding source material for ceramic and mudbrick manufacture.[34] The study of tertiary anthropogenic sediments also could shed light on functional changes that occurred within the city over time.

Further inferences based upon these sediments concerning their final systemic context and the structure or installation with which they are associated is dependent upon the specific manner in which they were used. The next four sections examine how constructional fills were used in antiquity, and how they manifest themselves in the archaeological record.

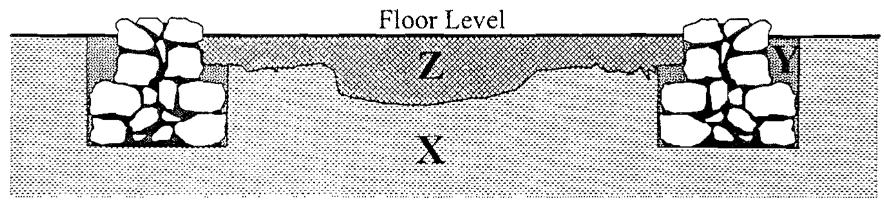
3.3.5.1 Levelling or Raising Surfaces.

Often constructional fills were brought to the site of construction for the purpose of smoothing or raising the level of a floor or surface[35], as well as for filler between subsequent re-surfacings of the floors. Depending upon the nature of the building or installation being created, the requirements of the anthropogenic sediment used in this context could be very specific. This was the most common use of primary anthropogenic sediments as constructional fills (as noted in section 3.2.1.5).

Tertiary anthropogenic sediments, on the other hand, had a variety of uses. In order to adequately serve their functional purpose, there may have been a sorting or selection process that would result in the inclusion of fewer large or irregularly shaped clastic elements that could have impeded the effectiveness of the deposit as a floor foundation. Otherwise, tertiary anthropogenic sediments employed in this context share most of the characteristics of constructional fills. In the identification of this type of deposit, levelling tertiary anthropogenic sediment would be identified as a distinct layer of sediment covering an older deposit that had an uneven surface (see Figure 3.15). The shards and other artefacts contained within the matrix of the deposit may be relatively smaller than that of other constructional anthropogenic sediments.

[34] See Bullard 1970; and Rosen 1986.

[35] For archaeological examples of this type of constructional deposit, see Reisner *et.al.* 1924:73 and 79; and Aharoni 1972:122.

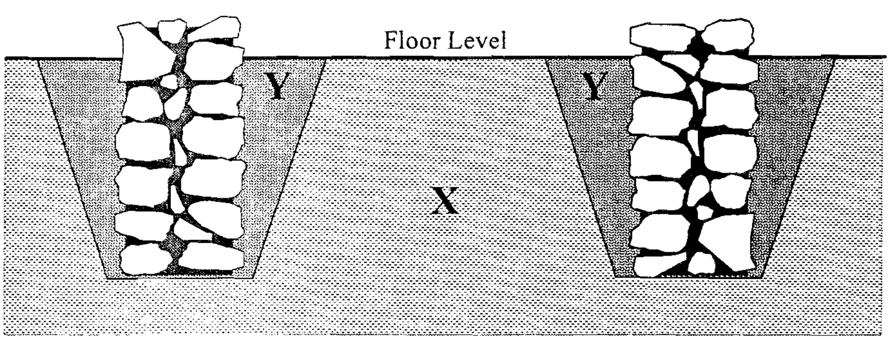


- Deposit X is oldest, cut by the foundation trench for a wall, deposit Y, and covered by the levelling tertiary anthropogenic sediment, deposit Z.
- Deposits Y and Z could be contemporary, but would most likely not be from the same source.

Figure 3.15 Schematic of levelling tertiary anthropogenic sediments.

3.3.5.2 Foundation Trenches.

These are the systemic contexts of sedimentary deposits that are used to fill in the trenches created by foundation wall construction.[36] The properties of this material would not require any obvious selective process in the type of tertiary anthropogenic sediments employed, as with those used for levelling. These deposits are identified on sites as narrow bands of sediment on either side of a wall, distinct from the sedimentary deposits that occupy the majority of the area between walls (see Figure 3.16). The width of the bands on either side of the wall will be dependent upon the width of the foundation trench that was originally dug. As well, the sediments in the foundation trenches will have been laid more recently than those of the surrounding material, and thus may contain diagnostic artefacts of the construction event. It is important to realise that the deposit of the foundation trench tertiary anthropogenic sediment is contemporary with the construction of the wall, and may yield systemic information about the construction process.



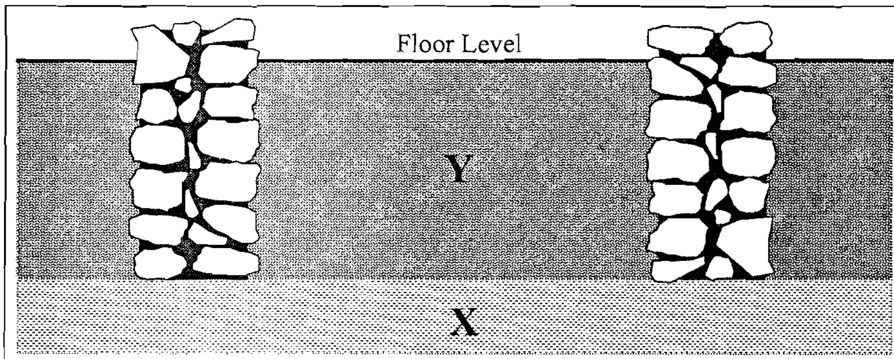
- Deposit X is older than deposit Y.
- Deposit Y, the foundation trench tertiary anthropogenic sediment, is contemporary with the construction of the wall.
- Deposit X predates the construction of the wall, and has no direct relationship to it.

Figure 3.16 Schematic of foundation trench tertiary anthropogenic sediment.

[36] For archaeological descriptions of foundation trench tertiary anthropogenic sediments see Reisner *et.al.* 1924:40-41, 77; and Kenyon 1974:56.

3.3.5.3 Standing Foundations.

Sedimentary deposits can have a systemic context of filling in the area created by the erection of standing foundation walls.[37] The general purpose of, and systemic inferences from, these standing foundation tertiary anthropogenic sediments are very similar to those of foundation trench tertiary anthropogenic sediments. The primary difference between the two deposits however, is the manner in which they manifest themselves in the archaeological record. The deposits associated with standing foundations are not interrupted by earlier deposits between the walls of a structure. The same material occupies the entire foundation area, forming a box-like support for the foundation walls (see Figure 3.17).



- Deposit X is older than deposit Y.
- Deposit Y, the standing foundation tertiary anthropogenic sediment, is contemporary with the construction of the wall.
- Deposit X predates the construction of the wall, and has no direct relationship to it.

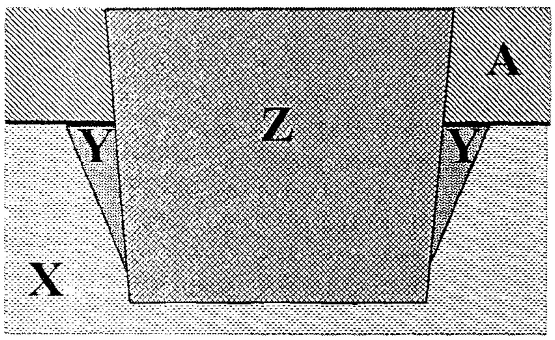
Figure 3.17 Schematic of standing foundation tertiary anthropogenic sediment.

3.3.5.4 Robber Trenches.

Unlike levelling, foundation trenches and standing foundations, robber trenches are not related directly to the construction process, and are not contemporary with the structures with which they are associated. Robber trenches were dug in order to acquire building materials (such as stones and ashlars) from pre-existing, buried walls for the purpose of re-use in new structures. The creation of these trenches was part of the construction process analogous to the quarrying of stones for building purposes but in this case the quarried stones are the remains of previous construction. Robber trench deposits can be very similar to pit deposits (section 3.3.2), but rather than having a circular form, they tend to have a straight and narrow shape, as they follow the path of the robbed wall. Unlike pits, these trenches can be quite large and were not usually left unfilled long enough to serve as prolonged areas of refuse accumulation.

[37] For descriptions of observed standing foundation deposits, see Reisner *et.al.* 1924:73; Ussishkin 1977:36-38 and 1978:30.

Robber trenches were often rapidly filled in with available constructional fills.[38] Robber trench tertiary anthropogenic sediments would manifest themselves in the archaeological record as a fairly straight trench-shaped deposits that may or may not follow along the line of a wall that appears to end abruptly. The contents of the trench, as already mentioned, would be similar to general constructional anthropogenic sediments, but may contain an increased refuse element if the trenches did serve as a collection point for refuse disposal. The robber trench will be chronologically younger than the surrounding deposits, but how much later would only be possible to determine through an analysis of chronological indicators such as pottery shards. Careful excavation of the deposits around a robber trench may reveal the remains of the original foundation trench of the robbed wall (see Figure 3.18). This in turn could help further the understanding of the various phases of construction and use of that area over time.



- Deposit X is oldest, cut by the foundation trench for a wall, deposit Y.
- Deposit A, is the material that accumulated around the wall, founded in foundation trench Y.
- Deposit Z, the robber's trench tertiary anthropogenic sediment, was deposited to fill in the hole created by the removal of the wall.

Figure 3.18 Schematic of robber trench tertiary anthropogenic sediment.

3.4 Conclusion.

This chapter has identified the materials that become incorporated into an urban archaeological site, the methods and processes of use, re-use and decay of these materials in the living city, and finally the systemic interpretations that can be made from their discovery in an archaeological context. Through this knowledge of formation processes, archaeologists can begin to place their discoveries of archaeological sediments into a behavioural context that will allow them to interpret their data in a more comprehensive and inclusive manner. It is hoped that this approach will go some way toward addressing Professor David Ussishkin's fear that "many excavators in Israel and Jordan dig badly because they simply do not understand what a *tell is*." (Dever 1996:41).

[38] For examples of robber trench tertiary anthropogenic sediments see Reisner *et.al.* 1924:75; Kenyon 1974:63; Ussishkin 1977:45 and 1978:31.

CHAPTER FOUR

4. Elements of Site Analysis.

Now that many of the formation processes that have led to the creation of anthropogenic sedimentary deposits have been discussed, along with general descriptions of their gross appearance in excavation contexts, it is important to examine them with a higher resolution. The roles that the various elements/materials and objects found in archaeological deposits play in framing our ability to characterise and interpret the deposits are significant. These roles range from the obvious, such as an examination of the functional aspects of the artefactual objects, which can indicate potential activities performed in the past in the area of the deposit, to the more obscure, such as the identification of the pH of the deposit, which can inform about the potential level of artefactual and ecofactual preservation that can be expected in the deposit. From the macro to the micro level of observation, and from the physical to the chemical analysis of the sediments, the description of the deposits can be an essential preliminary step, leading to all further study and interpretation of the archaeological site. To this end an analysis of both the artefactual content and the nature of the earthen sediment material must be undertaken in order to be able to describe fully the archaeological deposits. What follows in sections 4.1 and 4.2 is a discussion of some of the types of data collection and analysis that can yield useful information about the nature of different deposits.

4.1 Artefacts.

The artefacts uncovered in sedimentary deposits are the most studied elements found in archaeological sites. The presence of various artefacts and ecofacts in anthropogenic sediments is used traditionally to identify functional activity areas, subsistence patterns, foreign/external relations and for dating evidence (Orton *et.al.* 1993). Special items such as jewellery, figurines, and coins can be used to establish wealth or status of areas within a site, or of specific individuals in burial contexts. Functional artefacts such as metal hooks, loom weights, grinding stones, and sickle blades can be used to identify methods of subsistence and/or specific activity areas. The presence of non-local or imported artefacts in archaeological deposits is indicative of foreign trading relationships, which can also be indicative of subsistence patterns. Most of these types of artefactual analyses are conducted on materials found in identifiable occupational contexts (on floors, sealed beneath destruction debris, etc.). As has been mentioned in the previous three chapters, artefacts found in anthropogenic sediments, particularly tertiary anthropogenic sediments, have not been regarded as reliable archaeological informants due to their 'distance' from their original systemic function. Thus the relative significance of artefacts found in mixed sedimentary deposits to site interpretation has been perceived as quite low, and they are often used as pretty museum pieces, rather than as research resources. In the context of deposit analysis rather than functional analysis, however, artefacts within anthropogenic sediments are intrinsic interpretational components. The contribution of their study to the understanding of sedimentary deposits is equivalent to the study of ceramic fabric (petrology, firing, etc.) to understanding/elucidating pottery vessels.

The traditional areas of artefact study mentioned above are useful in depositional analysis as they help to identify some of the types of activities that occurred in the area around the sedimentary deposit at the time of its initial formation. This type of information is particularly useful in determining the systemic activities that provided the source material for the deposit. For example, tertiary anthropogenic sediments, which contain relatively large quantities of metal slag or other manufacturing refuse, would indicate that the immediate area around the deposit was likely an industrial part of the city.

In tel sites in the Near East, the broken shards of ceramic vessels are overwhelmingly the most ubiquitous artefact found in anthropogenic sediments, with hundreds of thousands found in a single tel. Because of their quantity, the taphonomic study of pottery shards is especially useful for providing even more information about the systemic contexts of anthropogenic sediments than many other artefacts. As a result of the large amounts of shards present in historic urban sedimentary contexts, the traditional approaches of pottery analysis (such as identifying joins and links, and then the minimum or maximum number of vessels present in the assemblage)[1] has very little potential for success when realistic time and cost

[1] See Orton *et. al.* 1993 for a extensive discussion of the methods of pottery analysis in

budgets are considered. As attributes of sedimentary deposits, however, a number the aspects of shards can be explored to help clarify the archaeological significance of anthropogenic sediments.

One of the biggest obstacles in the way of proper taphonomic analysis of pottery shards from existing archaeological excavations is their manner of quantification. In many published reports and privately held data, the amount of shards that were uncovered is not recorded. Instead vague comments like, "common" or "rare" are the only indication of their measure (Evans 1973:131-132).[2] The importance of identifying the total amount of pottery shards and all other artefacts in anthropogenic sediments cannot be stressed enough. For not only does this information help to differentiate and characterise deposits, but it is an important first step in the process of depositional analysis.

There are two main methods of shard quantification that are commonly used by archaeologists engaged in artefact quantification; count and weight. The total count of all artefacts is by far the prevailing manner in which the amount of pottery shards is identified (Berlin 1997; Green and Lockyear 1994; and Bradley and Fulford 1979). It is both a fast and easy way of accomplishing what can be a monumental task when dealing with artefact-rich sediments. The use of total shard weight is a less frequently employed quantification method, as it is a more time consuming process. Total weight, however, is considered by some to provide a more accurate description of the nature of ceramic material within a deposit (Evans 1973; Solheim 1960:325). Neither method is perfect on its own; count does not reflect variation in mass of similarly sized shards made of different fabrics, while total weight can result in distorted data sets, as a few very large shards can out weigh a deposit of 200 very small ones since different wares can have different specific gravities (Evans 1973:133). The question as to which is the better method of quantification has rarely been investigated, and the ramifications of doing one versus the other is poorly understood in terms of the biases they introduce into the final analysis of the data. In order to avoid the problems associated with one method or the other, it has been suggested that both weight and count of shards be recorded, as they each tend

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archaeology.

[2] More often than not, a record of the total quantity of shards excavated is never recorded and the shards themselves are discarded swiftly after excavation. This has been my personal experience at Tel Dor, and appears to be the recommended course of action in many other situations with large quantities of pottery shards (Caesarea, Tell el- Hesi, Gezer, and by Orton *et. al.* 1993). As a result, any effort to study the shards as features of anthropogenic sediment is made almost impossible to carry out.

to nullify the other's potential problems.[3] It has been suggested by one author that together, the two methods yield more information that either method by itself, by seeking the reasons for differences between deposits in such things as percent total weight and count (Solheim 1960:325).

Among the specific characteristics of pottery shards that are useful in understanding the systemic context of anthropogenic sediments, both shard form and shard size are two important indicators. The identification of the relative quantity of shard forms (i.e., the different portions of the vessels each shard represents – handles, rims, etc.) can be a useful tool in elucidating depositional formation processes. Drastic differences in the proportion of shard forms between anthropogenic sedimentary deposits would indicate that their source material and the behavioural activities that resulted in their deposition were not related. If the shard assemblage in a deposit was quantified on the basis of surface area, it would be possible to assess quite accurately the proportions of the forms relative to complete vessels. If the relative proportion of different shard forms within a deposit differed substantially from that of complete vessels, it could be indicative of pre-depositional sorting, or other systemic processes. For example, the lack of base shards in a deposit may be denotative of the re-use of these forms, rather than being discarded as rubbish (Stig Sørensen 1996:62); in contrast, a deposit that has significantly more body shards than would be expected may be indicative of an anthropogenic sediment that saw very little disposal of garbage, and the shards present were those that were incorporated as architectural elements in degraded building material. Shard form variation in pits could be indicative of scavenging processes.

The size of shards found in anthropogenic sediments is another taphonomic feature that can provide useful information about the systemic history of the deposits. Shard size is reflective of both the level of artefact reuse or disturbance and the processes of refuse deposition. There is general agreement that large rubbish items (pottery shards, rocks, etc.) tend to be disposed of in areas that keep them out of the way (Schiffer 1987; Rowley-Conwy 1994:30), so as not to interrupt the flow of activities within both domestic and public areas. Smaller items and easily broken objects could have been left in areas of high traffic, such as roads and pathways, where they would be reduced to much smaller elements by trampling (Stig Sørensen 1996:62; Rowley-Conwy1994:28; Kirkby and Kirkby 1976:236-238). The reduction

[3] A number of archaeologists have employed both methods in their data analysis, including Solheim 1960; Evans 1973; Rowley-Conwy 1994; and Stig Sørensen 1996.

in size of shards that occurs in these high activity areas has been shown to be reciprocal to the number of episodes of disturbance (Bradley and Fulford 1979:86).

With the collection of this type of information about deposits, the use of shard size in the systemic interpretation of anthropogenic sediments can begin. The size of shards can be associated with the pre-depositional processes that occurred to the constituent components of an anthropogenic sediment prior to their incorporation into the deposit. This association can be particularly useful when attempting to differentiate between secondary and tertiary anthropogenic sediments. For example, the variance of shard size can represent the amount of disturbance a deposit has undergone. It has been suggested that artefact assemblages within deposits that have small average shard sizes and that also display small variation in shard size have been subject to frequent disturbances and thus most likely represent a repeatedly tertiary sediment (such as occupational road sediments), in contrast to those that have been subject to slightly less disturbance (Green and Lockyear 1994:97). By this manner of interpretation, it can be proposed that shard assemblages in anthropogenic sediments that have a large average size and a small variance would be indicative of very little pre-depositional working, as in the case of secondary anthropogenic sediments, such as a refuse pit.

Shard size also can be used to indicate the systemic sources of the anthropogenic sediment. Some studies have shown that shard fragments less than 4 cm in size are usually brought to sedimentary deposits as inclusions in degraded mudbricks (Kirkby and Kirkby 1976:230), while others have shown that larger shard fragments are the result of undisturbed refuse disposal (Schiffer 1987). As it has been proposed that constructional anthropogenic sediments are the combined result of building collapse, rubbish disposal and some (but not extensive) trampling as the result of transportation, scavenging, etc., a general perception of the pattern of size distribution and their concomitant systemic sources emerges. Some constructional anthropogenic sediments, such as those used for levelling, as already mentioned in section 3.3.5.1, may have been pre-sorted or filtered, so that only relatively small artefactual inclusions remains. By understanding the processes of sediment formation this type of anomaly becomes another systemic layer in the archaeological interpretation.

4.2 Earthen Material.

The earthen sediments found in archaeological contexts have been identified as the "most commonly wasted resource" (Macphail and Goldberg 1995:1) of archaeological sites. This material, which primarily comprises the fraction of earthen material that is less than 2 mm in size, not only surrounds artefacts, providing them with a context, but is itself an anthropogenic feature. Following the discussion in chapter 3, it should be apparent that in tels, where the decay and disintegration of earthen primary elements (mudbricks, mortar, etc.) causes the development of the site, the omission of the analysis of these sediments is a significant issue. Increasingly in recent years more emphasis has begun to be placed on earthen materials as archaeological informants. Much like the analysis of artefacts and ecofacts, this earthen aspect of anthropogenic deposits has revealed information on three major areas of archaeological inquiry: 1) the characteristics of the sedimentary deposits, allowing for the differentiation between two or more deposits; 2) the physical processes of deposit formation; and 3) the functional (systemic) activities associated with the creation of the anthropogenic deposits (Quine 1995:78).

In order to take full advantage of the potential offered by earthen materials as sources for archaeological information, two different areas of inquiry must be examined: physical and chemical analysis. Physical analyses of earthen material are those studies that involve its visual or physical properties, while chemical analyses create data regarding the elemental or chemical properties of the sedimentary deposit.

4.2.1 Physical Analyses.

The colour of archaeological sediments has long been used to differentiate between deposits, both horizontally and vertically. Differences in colour can indicate different origins and histories of the sediments. These colour differences may be the result of the type of source rock for the grains of sediment or may be the result of anthropogenic additions. Some of the colours that soils can display, which identify specific indicative features are: black, which usually indicates the presence of high levels of organic matter and/or pure carbon content (Rapp and Hill 1998:37); grey, which indicates sediments and soils that are low in organic content, as the nutrients have been removed (usually via leaching); a light grey, which can mean that the sediments have a high carbonate content; and red, which can mean the soils have a high iron content (where the colour is the result of oxidation) or the sediments have undergone intense firing (Dr. Dan Pennock, Dept. of Soil Science, College of Agriculture, University of Saskatchewan, personal communication). No matter the specific reasons for the variations in colours found between different deposits, the identification of their colour is an important first step toward defining characteristics of the deposits and beginning to understand their formation processes.

In order to systematise the potentially subjective classification of different colours, Munsell colour charts and other standard colour charts are used to ensure a degree of consistency in identification. The Munsell system classifies soil and sediment colours based upon three attributes: the *hue*; the *value*, which is degree of lightness or darkness; and the *chroma*, which is the degree of departure of a given hue from a neutral grey of the same colour (Shackley 1975:13). In this way, each colour has a specific code and a corresponding verbal description by which it can be identified. When determining the colour of sediments it is important to realise that drying dulls the colour, resulting in readings that are about two units higher in value than when the same sediment was wet or damp (Rapp and Hill 1998:37), as well as a variation in the chroma reading. Because of these differences between wet and dry sediments, careful note should be taken of colour both in the field and in the laboratory, as one or the other alone, can be misleading.

A second level of physical analysis of archaeological sediments involves a description of its texture. In the field this can be done at a gross level, involving the identification of inclusions, such as stones and other visible objects, and also the density or packedness of the sediments during excavation. The relative density of the sedimentary deposits, as noted during excavation, can give a rough approximation of the relative proportions within the fine earth fraction (sand, silt and clay). Due to the nature of clay particles, specifically their ability to hold large quantities of water, they can be quite 'heavy', being perceived as very hard packed during the process of excavation. This is in contrast to sediments that contain proportionately more sand, which do not retain water, and are thus much lighter and loosely packed. The relative packedness of a sedimentary deposit can also be indicative of past activities in the area. Sediments that formed the basis of a path, or were beneath a heavy object for an extended period of time, could be much denser than surrounding material. In this way, the gross texture identified during excavation could be indicative of systemic processes.

Sediment texture can be measured precisely in the laboratory through various processes of particle size analysis. These procedures examine the sediment fraction that is less than 2 mm in diameter, and provide the relative percentages of grains from the sediment sample that fall within the size ranges of sand, silt and clay.[4] This fractionation of the sediments ultimately

[4] The scales for particle size analysis can vary somewhat depending upon the individual scale employed. Both the British Standard and the USDA soils scale agree on their definitions of the ranges of sand, silt and clay sizes, and will be the scale used for this thesis (see Shackley 1975:90 and Rapp and Hill 1998:22). Both the British Standard and USDA scales identify the

allows for their classification into various textural categories that identify their primary characteristic. In the USDA classification system (Figure 4.1) standardised names are given to the sediment matrix based upon the relative percentages of sand, silt and clay in the sample, with the major constituent of the sediment matrix occurring at the end of the name. Many of the sediments are identified as loams, which is a general term for sediments with approximately equivalent amounts of all three fractions (Waters 1992:23). In this system, a sediment with 50% sand, 20% silt and 30% clay would be recognised as a sandy clay loam, while a sediment with 40% sand, 20% silt and 60% clay would be simply known as a clay.

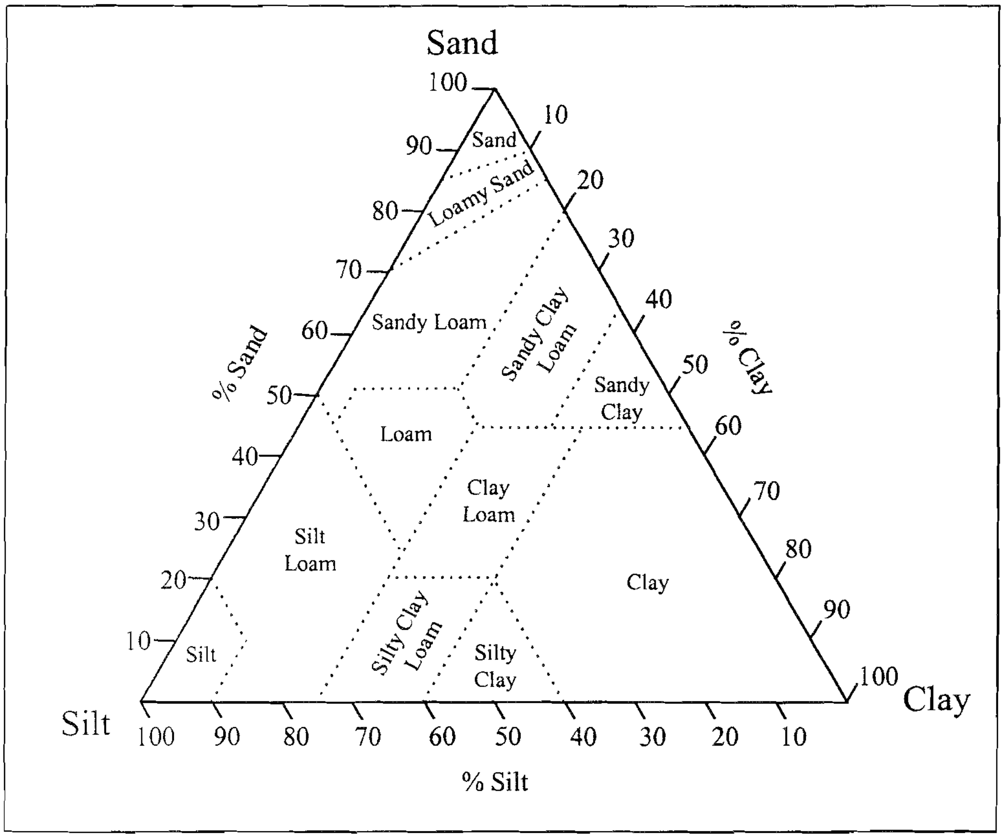

Figure 4.1 US Department of Agriculture textural classification of soils. Adapted from Waters 1992:23.

The analysis of particle size is one of the most useful ways of acquiring very detailed data about the nature and characteristics of sedimentary deposits, allowing for the correlation between similar deposits that have been produced by similar sets of processes (Shackley 1975:87). It is useful to remember that grain size analysis only identifies the size and not the

size of sands as 2 mm - 0.06 mm, silts as 0.06 mm - 0.002 mm, and clays as <0.002 mm. Within each of these ranges there are smaller subdivisions (such as course, medium or fine sand), and there are various techniques available to identify them (see Shackley 1975).

mineralogical composition of the sediments, and thus while different deposits may share a similar texture, the actual origin of the grains may be quite different. The size of the particles indicates a similarity of formation processes. In this way particle size analysis provides a broad stratigraphical provenience of the sedimentary deposits and important background information about the processes of creation (Canti 1995:185).

A final method of physical analysis of sedimentary deposits is the study of undisturbed samples in thin section, which allows for the study of its *in situ* properties.[5] Through the maintenance of the stratigraphic structure of the sediment, with the use of kubiena blocks for sample acquisition, the micro-stratigraphy of the sediments can be observed.[6] By studying the samples under light microscopy, using various lighting methods, it is possible to address many different archaeological issues. Recently a number of studies have been done which have employed micromorphology as the main analytic tool, usually with the aim of addressing topics related to the past functional use of an area. Thin-section studies have helped archaeologists to identify: the particles (organic matter, micro-artefacts of pottery, minerals, ash, coprolitic material, etc.) that make-up a sediment sample (Macphail and Courty 1985; Macphail and Goldberg 1995); the micro-stratigraphy of the deposit that were associated with their formation processes (Goldberg 1992; Courty 1992; Macphail *et.al.* 1990; and Matthews *et.al.* 1997); taphonomic alterations (Canti 1995:183; and Macphail *et.al.* 1990); and functional areas within a horizontal exposure (Davidson *et.al.* 1992; Gé *et.al.* 1993; Matthews 1992; and Matthews *et.al.* 1997).

Although the use of micromorphology in the analysis of sedimentary deposits at sites does hold a great deal of potential in the effort to elucidate all aspects of the archaeological record, there are a number of problems that can limit its applicability. The biggest difficulty with this type of study is the very small size of the sample that each thin section represents (they can be as large as 13 x 6 cm; Macphail and Goldberg 1995) relative to the size of the actual site. In order to ensure the applicability of the results from a single thin-section to the larger scale of the activity area, or site as a whole, a large number of samples must be collected and analysed. This necessity is tempered by the large cost associated with the preparation and preservation of

[5] The previous physical analyses (colour and particle size analysis) are conduced on disaggregated bulk samples, as are the chemical analyses discussed in section 4.2.2.

[6] For a general explanation of the methodology of thin-section acquisition and preparation see Macphail *et.al.* 1990; and Goldberg 1992. For a detailed description of the methodology see Murphy 1986.

the thin-sections (Canti 1995:183). In many cases this can create a ceiling as to the potential use of this method of physical analysis.

4.2.2 Chemical Analyses.

This aspect of the analysis of archaeological sediments is related to the identification of the chemical components that it contains. In the creation of archaeological deposits various elements are added (or removed) from the natural soils or sediments that cause them to display different characteristics, making them distinguishable from one another, and from the natural parent material (Rapp and Hill 1998:195). Some of the more common chemical tests applied to anthropogenic sediments, which will be discussed below, include: pH, carbon, phosphorous and organic residues.

The most basic chemical analysis that can be performed on archaeological sediments is that of a pH test. This is known as the 'soil reaction', which identifies the relative level of acidity or alkalinity present in the soil and is customarily expressed on the pH (*pouvoir hydrogéne*) scale. Acidity denotes an excess of H^+ ions over OH^- ions and falls within the pH range between 7 and 0, as the soil is increasingly more acidic. Alkalinity denotes the opposite, and excess of OH^- ions over H^+ ions, and has a pH range of 7 to 14, as the soil is increasingly more basic. When the H^+ and OH^- ion concentrations are equal, the solution is neutral with a pH of 7.0 (see Table 4.1).

	pH		**pH**
Slightly Acid	6.0 - 7.0	Slightly Alkaline	7.0 - 8.0
Moderately Acid	5.0 - 6.0	Moderately Alkaline	8.0 - 9.0
Strongly Acid	4.0 - 5.0	Strongly Alkaline	9.0 - 10.0
Very Strongly Acid	3.0 - 4.0	Very Strongly Alkaline	10.0 - 11.0

Table 4.1 Identification of common pH levels.

Most naturally occurring soils have a pH range of between 4 and 8 (Bruckert and Rouiller 1982:399). In arid regions, however, the pH levels skew upwards as cultivated soils tend to range between 7 and 9 (Dr. Carl Heron, Dept. of Archaeological Sciences, University of Bradford, personal communication). The pH of a soil or sediment has a strong impact on the nature of the various chemical elements that exist within it as the pH effects the level of solubility of the various elements, and thus can play a role in the acceleration or deceleration of the process of mineral leaching. In this way, the pH of different soils is important for soil scientists as it is related to nutrient availability for plant growth. For archaeologists the pH of sedimentary deposits is of great interest because it is a factor in determining the taphonomic conditions in which the artefacts and ecofacts were (or were not) preserved (Canti 1995:185). For example, acidic soils can cause high levels of leaching of such minerals as calcium, magnesium and potassium, which could totally eliminate some important archaeological materials (such as bone) from the archaeological record (Stein 1975:66; Chaya *et.al.* 1996:132). In contrast, alkaline sediments and soils can reduce the leaching of these cations (Gladfelter 1992:181), helping to preserve ecofacts like bone. The taphonomic role that pH plays is not only important for the preservation of gross objects, but is also important for the preservation of various chemical elements that may indicate the presence of humans and their varied activities on ancient sites.

The pH of anthropogenic sediments can be altered by the addition of different materials. In ancient agricultural fields that saw the continued addition of nutrient material, the pH may have risen or fallen in contrast to similar soils from undisturbed contexts. In archaeological sites that had substantial construction and destruction (such as tel sites in the Near East), the pH would have had a tendency to gradually increase as lime molecules and other negatively charged anions from mortars and other building materials would be added to the sedimentary matrix as structures were destroyed and disintegrated (Limbrey 1975:321). The addition of lime, especially quicklime, to acidic sediments and soils can cause the rapid increase of the pH level (Dutil 1982:424). If this process continued, intentionally or not, over time it would have a significant impact on the resultant pH of the sediments.

Further chemical analyses can be used to identify the types of minerals that are present in archaeological sediments. The addition and removal of naturally occurring chemical elements and nutrients to/from sediments and soils that have been impacted by human activity is well documented (Rapp and Hill 1998:195).[7] One of the elements that has been frequently looked at in the chemical analysis of sediments from archaeological sites is that of carbon. This element is present in soils and sediments in two forms: organic carbon, which is derived from, or contained within organic material; and inorganic carbon, whose atoms are bound up in carbonates and as charred ash.

[7] Numerous studies have been conducted looking for alterations and differences in the chemical make-up of archaeological sites; see Barba *et.al.* 1996; Goffer *et.al.* 1983; Middleton and Price 1996; Entwistle *et.al.* 1998; Linderhold and Lundberg 1994; Chaya 1996; etc.

The presence of organic carbon in archaeological sediments can be a measure of the presence and intensity of past occupation of a site, with high levels relative to surrounding soils indicating a past anthropogenic settlement in the area. Organic carbon becomes incorporated into sediments in the form of organic compounds such as humic acid, tannins and residues (Goffer *et.al.* 1983:233), which are formed during the pedogenic microbial processes that cause the decay of organic matter. In natural soils, the cycling of organic carbon from organic matter to organic compounds and back again as it is remobilized through the activities of microbial biota in soils, is a constant process that sees the renewal of organic carbon in the soils. In archaeological sediments such as those found at tel sites, however, anthropogenic deposits can be quite deep with limited exposure to the microbial fauna of soils. In these cases, the organic carbon content is not involved in a cyclical renewal, being solely the result of the decomposition of the systemic deposition of organic materials such as: wood, bones, shells, seed, animal and plant tissues, etc. that were part of an initial deposition prior to burial (Stein 1992:195-201). Further, traditional pedogenic processes that would see the continued addition of organic matter and its decomposition do not occur, and do not result in the continual addition of organic carbon to the deposits. During the process of the decay of organic matter, the majority of the molecular carbon that it contains is released to the atmosphere as CO_2 or is leached out of the soils, thus leaving only a fraction of the amount of organic carbon that was originally present.[8] Thus, it is not possible to make a direct correlation between the amount of organic carbon found in a deposit and the amount of organic matter that was originally deposited. Nonetheless, as organic carbon is the biggest constituent of organic matter (along with other elements such as: hydrogen, oxygen, nitrogen, phosphorous, and sulphur, in smaller quantities)[9], its measure does provide a useful and cost effective approximation of the comparative quantity of organic matter found in different anthropogenic deposits.

Inorganic carbon is the carbon present in the sediment that is bound up in carbonates and in its elemental form as charred ash and cinders. In most archaeological contexts carbonates are usually present as the source material for the sedimentary particles (from weathering of parent rocks) incorporated into the site by the building processes or as chemical

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[8] In temperate regions ½ of the organic carbon from organic matter is lost in three to four months, while in tropical areas the loss of ½ to organic carbon would take only three to four weeks (Stein 1992:200).

[9] In organic matter, the quantity of organic carbon, nitrogen and phosphorous is approximately 100:10:1 (Conesa *et.al.* 1982:443).

precipitates. As charred ash and cinders, inorganic carbon is unavailable to life processes and can remain forever in its place of deposition as it is not destroyed by solution or oxidation in the soil (Limbrey 1975:322-323). In many archaeological contexts, comparatively high levels of inorganic carbon may indicate higher levels of ash in the sedimentary deposit.

Other chemical elements that are analysed in sedimentary archaeological contexts include almost all of the elements found on the periodic table. The remaining elemental residues of organic matter (nitrogen, sulphates, sodium, calcium, potassium, etc.) are often studied, as are metals (such as: iron, zinc, aluminum, copper, mercury and cadmium, which can, among other things, indicate industrial processes associated with metallurgy), and many other nutrients associated with plants. Much of the literature is contradictory as to the potential systemic information these numerous chemical elements can provide. Indeed, there is little agreement as to which ones actually are indicative of anthropogenic activity and which ones are not. As a consequence, much of the current research in multi-element analysis focuses on looking for significance, without having a preconceived notion of the potential results (see: Linderhom and Lundberg 1994; Middleton and Price 1996; James 1999; and Entwistle *et.al.* 1998). Irrespective of the difficulties associated with the anthropogenic identification of the different elements, there is often a larger problem associated with the removal of these materials, including carbons, from ancient sites through the natural processes of leaching. The quantity and level of leaching of different nutrients and metals is often quite dependent upon the pH of the sediment. Calcium, magnesium and potassium are especially deficient in soils as acidity increases, while aluminum, iron and manganese may exist in very high amounts in strongly acid situations. In alkaline sediments, the opposite holds true, iron, zinc, copper and manganese can be quite reduced, while the levels of calcium and other cations tend to be quite high (Dr. Carl Heron, personal communication). Due to this type of fluctuation, great care must be taken in understanding the depositional environment prior to placing significance on these types of findings.

There is one element that is used extensively in archaeological research of sediments and soils, often to the exclusion of other chemical additives, which is the important plant nutrient, phosphorous. For centuries in the Near East, Arab farmers have recognised that soils excavated from sites of ancient ruins provided excellent fertiliser for their fields (Hertz and Garrison 1998:181). The scientific identification of the relationship between past human occupation of an area and the presence of enhanced amounts of soil phosphorous was first discovered in 1931 by a Swedish agronomist, Olaf Arrhenius.[10] Following this early discovery, further research has indicated that phosphorous is particularly useful in archaeological investigations because, unlike carbon, nitrogen and other chemical elements, it is not subject to extensive leaching and volatization following deposition (Eidt 1984:27; Shackley 1975:68; Proudfoot 1976:93), particularly in carbonate rich environments (Davidson 1973:143). Instead, phosphorous becomes fixed in the soil remaining almost exactly where it was applied to the soil (Eidt 1984:27; and Hertz and Garrison 1998:183). Some studies on anthropogenic sediments that have been badly disturbed by post-depositional activity, such as ploughing, have shown that phosphorous is subject to less degradation and removal than pottery shards and other artefactual material (Craddock *et.al.* 1985:363; Hertz and Garrison 1998:187).

Like carbon, phosphorous occurs naturally in two different forms, organic and inorganic. Inorganic phosphorous (more commonly known as phosphate) is the most common form of the element. It is present in both rocks as well as in animal and plant tissue. In animals, elemental phosphorous makes up 23.5% of bone, 22.1% of liver tissue and 4.5% of blood, and is also present in excrement (15.8%), urine (4.9%) and milk (8.3%). In plants the amount of phosphate is much smaller, as plants tend to have larger quantities of organic phosphorous.[11] Organic phosphorous is the form of the elements found in organic compounds like phytin, phospholipids and nucleic acids (Conesa *et.al.* 1982:443). The majority of the organic phosphorous that finds its way into sediments is, as already mentioned, from plants. Upwards of 97% of all phosphorous in plants is organic (Eidt 1984:28).

The average amount of phosphorous that occurs naturally in soils is 0.05%, with a range of between 0.005% - 0.12%, depending on the derivation of the soils (Conesa *et.al.* 1982:443). Additional phosphorous becomes incorporated into anthropogenic sediments by the deposition and subsequent degradation of domestic refuse, food wastes, plant and animal remains (including cadavers), and excreta (Proudfoot 1976:93; Weston 1995:20). The quantity of phosphate that people and their livestock deposit during the course of normal activities can be startlingly large. In one year the average cow excretes as much as 10 kg of phosphate, and one study has shown that a settlement of 100 people occupying a 0.81 hectare site would have likely contributed a total of 164 kg of phosphate (from excreta, food residues, etc.) annually per

[10] For an historical review of the use of phosphorous in archaeology see Bethel and Máté 1989.

[11] These and other statistics about the quantities of elemental phosphorous found in animal tissues and products and plants can be found in Eidt 1984:28.

hectare (Proudfoot 1976:94). Once the organic matter deposited by anthropogenic processes was broken down, the resulting phosphate ions would be quickly bound up by iron and aluminum ions (in acidic soils) and by calcium ions and adsorbed on $CaCO_3$ surfaces (in alkaline soils) (Weston 1995:20). The organic phosphorous ions would be fixed as tightly bound ester molecules (Chaya *et.al.* 1996:132). Because of this quick fixation of phosphorous, very little remains in a soluble state that is susceptible to leaching and bio-uptake as nutrients for plants. The actual rate of adsorption and fixation can fluctuate a little depending upon the pH and texture of the sediment (Weston 1995:20). Soluble or available phosphate is maximised at a pH of 6.5, but this quantity is still quite small relative to that which is tightly bound up in insoluble molecules like calcium phosphate and aluminum phosphate.[12] Over time, the organic phosphorous fixed in soils and sediments becomes mineralised into phosphate. This processes, however, is not well understood (Weston 1995:20; Chaya, *et al.* 1996:132), and organic phosphorous can still be identified thousands of years after deposition (Proudfoot 1976:103; Bethel and Máté 1989:18).

Due to the numerous advantageous qualities of phosphorous for archaeological purposes, it has been used in a number of different ways. Initially, testing for phosphates was done to help locate potential sites and to delineate their boundaries (Craddock 1985; Weston 1995). Other early uses of phosphate quantification was to describe shifts in intensity of occupation in vertical exposures, where higher concentrations of phosphate was equated to higher intensity/density of site occupation (Davidson 1973 and 1976). More recently, the identification of specific activity areas by way of changes in phosphate quantity on occupation surfaces has become quite common (Shackley 1975; Sánchez Vizcaíno and Cañabate 1999; Middleton and Price 1996; Conway 1983; Weston 1995; among many others). Robert Eidt has differentiated specific activity areas, as associated with different levels of total phosphate content: in sites with a total P less than 0.002%, ranching or hack farming may be occurring (as farming and the removal of crops would cause the depletion of phosphorous from the soil); sites with more than 0.002% P would indicate dwelling areas, intensive gardening and manufacturing; and sites with more than 0.02% P would be associated with burials, garbage pits, slaughter areas, battlefields, urbanised zones, etc. (Eidt 1984:43). As a word of caution with this type of classification, it is extremely important to identify the level of natural

[12] For more information on the chemistry of phosphorous in soils, see Bethel and Máté 1989; Conesa *et.al.* 1982; and Proudfoot 1976.

phosphorous in undisturbed soils, so as to remove background 'noise'.

Another manner in which phosphorous has been studied in archaeological contexts is to examine the different fractions of the element found within sediments. Initial efforts at fractionation identified the soluble P, the inorganic P and the organic P quantities in each soil sample. More recently, work pioneered by Robert Eidt in his book *Advances in Abandoned Settlement Analysis* (1984), has focused on the fractionation of inorganic phosphate, based upon the strength of the bonds. He has identified three levels of bound phosphate: Fraction 1 – easily extractable, loosely bound aluminum phosphate, iron phosphate and phosphate resorbed by $CaCO_3$; Fraction 2 – tightly bound or occluded phosphate with aluminum and iron oxides, and hydrous oxides; and Fraction 3 – calcium phosphate and apatite. It has been shown that there is some evidence that the fractionation 'signature' may be a valuable tool for identifying different land use activities. Eidt has also proposed that the ratio between Fraction 1 and Fraction 2 could be used as a means of relative dating.[13]

Before completing this discussion of phosphorous and its applicability to archaeological site analysis, it is necessary to provide a word of caution. Many phosphate analyses, particularly early in the development of this field, only tested for the presence of available phosphate in the sample. As noted above, the soluble or available fraction of phosphate is actually quite small when compared with that which is present in the form of insoluble phosphate. As a result, although soil scientists are often most interested in the available fraction because of its impact on agriculture and plant growth, for archaeological purposes total phosphorous is the best measure of anthropogenic activity (Conway 1983; James 1999).

A final area of chemical analysis that is just beginning to be developed and applied to archaeological research is that of the study of organic residues. Although very expensive and time consuming at present, it potentially yields very promising and detailed information about ancient food consumption (by both people and their animals) and activity areas associated with organic residues (cultic areas, butchers, tanneries, etc.). Lipids, carbohydrates and proteins that were deposited as faeces, blood, or any kind of plant or animal tissue, can be collected from anthropogenic sediments. Tests have been developed recently that make it possible to differentiate between plant and animal organic residues in faecal material with a high level of specificity, even to the *Genus* level. As food passes through the digestive tract the lipids and

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[13] Examples of this type of fractionation analysis can be found in Lillios 1992 and Overstreet *et.al.* 1988.

other organic elements are also altered according to the digestive system of the animal consuming the food; in this way it may also be possible to differentiate between the diets of different animals through their coprolitic material (Dr. Carl Heron, personal communication).[14] This type of chemical analysis of archaeological sediments could prove to be very informative about the intimate details of past peoples daily lives.

4.2.3 Summary of Earthen Materials Analyses.

Chemical and physical analyses of anthropogenic sediments are very useful tools when it comes to helping to distinguishing between different depositional events, and to identifying the source/nature of the deposits. pH is particularly useful in helping to establish the taphonomic conditions of preservation that affect the ultimate nature of the site as a whole. While traditionally many of these tests and observations about the earthen sedimentary material have been employed to help identify the presence or the boundaries of a site in a given environment, for large urban sites this is obviously not an issue. Rather these analyses provide a further set of archaeological data by which to reconstruct the behaviour of past peoples and civilisations.

As discussed at the beginning of section 4.2, the study of earthen material can provide extensive detailed information about the deposit's characteristics, its formation processes and the functional activities associated with the deposit. The following diagram (Figure 4.2) outlines the associations between the various techniques of analysis that can be employed and the type of archaeological questions they tend to address.

In preparing to study archaeological soils and sediments, the relationship between analytical methods and archaeological research goals should be borne in mind. While cost may be a prohibitive factor in achieving a complete analysis of the earthen material, a balanced approach which supplies some information across deposit characterisation, process elucidation and functional differentiation, provides the best opportunity to glean the most information possible from the archaeological resource. It is from this foundation of site analysis that the framework for the development of the methodology employed in data collection and analysis for the case study at Tel Dor is based.

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[14] For some examples of these types of studies see Nolin *et.al.* 1994; Barba *et.al.* 1996; and Evershed and Bethell 1996.

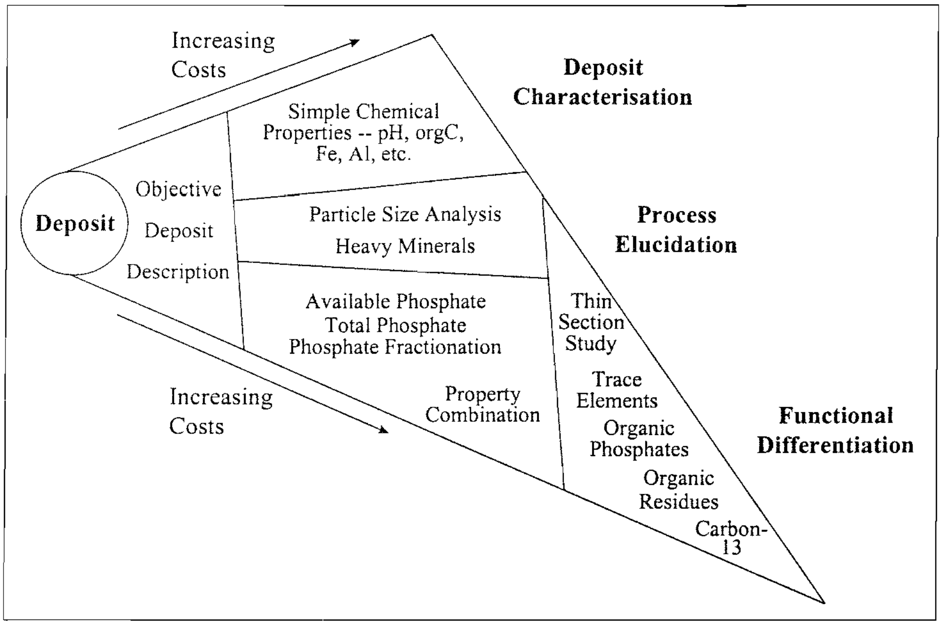

Figure 4.2 Schematic relationship between questions asked, techniques chosen and cost of deposit analysis. Adapted from Quine 1995:78.

CHAPTER FIVE

5. Case Study.

In order to evaluate the theoretical framework outlined in Chapter 2 and the applicability of the archaeological framework outlined in Chapter 3, a case study was designed. The study of anthropogenic sediments from a complex tel site was selected as anthropogenic sediments from tels have not been perceived as systemically important elements for archaeological interpretation of these types of sites, and thus have received little attention by archaeologists in the past. Additionally, most previous efforts to study these types of deposits have been limited to sites without complex stratigraphy, and thus their full systemic potential have not been properly realised. By carefully examining a small selection of tel anthropogenic sediments, it is hoped that the potential of the methodological approach outlined in chapters two through four will be demonstrated.

5.1 The Study Site.

The material for this study was collected from the site of Tel Dor in Israel. This site was selected for this research for a number of reasons. The first and most compelling factor was that it was the location for the Classical and Near Eastern Archaeology field school for the University of Saskatchewan during the 1996 and 1997 field seasons in which this research was conducted. The field school provided plenty of helpful and eager undergraduate students to help in the retrieval of the raw data for this study. A second equally important factor was that I had participated in the excavation of this site for three seasons prior to commencing work on this project, and as a consequence I was very familiar with both the site itself, and the types of architectural and artefactual remains that it yielded. Due to this experience I was well aware of the complex nature of the architecture at Dor, and was just as cognisant of the numerous constructional anthropogenic sediments that were to be found. Tel Dor was deemed an ideal site for this study.

5.1.1 Tel Dor.

Tel Dor is located on the southern Levantine coast 30 km south of Haifa and approximately 15 km north of Caesarea (Figure 5.1), adjacent to the Kibbutz Nahsholim. Dor was an ancient port city that was most likely founded in the Middle Bronze Age (ca. 2000 B.C.E.), maintaining a relatively continuous occupation through to the Roman Period (ca. 325 C.E.). At this time the city fell into decline since its role as a major trade centre had been usurped by Caesarea. Prior to this, Dor was a prominent city due to the topography of the region, which made it strategically important in the extensive trade networks of the ancient Near East. Flanked by two naturally protected bays on both its north and south sides, it was one of the few sites with natural harbours along the western coast of the Levant. As well, this site was adjacent to one of only three land routes passing through the Carmel Mountain range to the east. Thus, Dor was a cross-roads for both land and sea trade. The economy of Dor was further enhanced by the temperate climate of the Carmel Coast. With an annual precipitation rate of 600-700 mm, and a large amount of ground water, the city was in close proximity to good agricultural land (Orni and Efrat 1971:49).

There is archaeological evidence that following the Roman Period the site of Dor saw sporadic occupation during both the Byzantine and Crusader Periods. At the base of the eastern edge of the tel there are remains of a Byzantine church, indicating that bishops resided at Dor from approximately the fourth to the sixth century CE. As well there are scattered Byzantine pottery shards found on the surface of the tel itself. During the Crusades a fortress was constructed on the southwest corner of the tel. After having been in the possession of a number of competing groups, including the du Merle family, the Templars, and the Mamluks, the site was ultimately abandoned in 1291 C.E. (Stern 1995b:4).

The city of Dor has been referred to in a number of ancient literary sources. It is first mentioned in an inscription of Ramses II (1304-1237 B.C.E.) as one of the settlements along the Via Maris. Another Egyptian reference to Dor is in the 12th century B.C.E. story of Wen-Amun, which is a narrative about an unfortunate Egyptian priest-dignitary who had been sent north in search of timber. According to this tale Wen-Amun was held captive by a group of Sea Peoples, known as the Sikil, who had established themselves at Dor (Wilson 1969). In the Bible, Dor is first mentioned in the context of the Israelite conquest as one of the cities defeated by Joshua (Josh. 12:23), after which it was allotted to the tribe of Manasseh (Josh. 17:11). The Canaanite

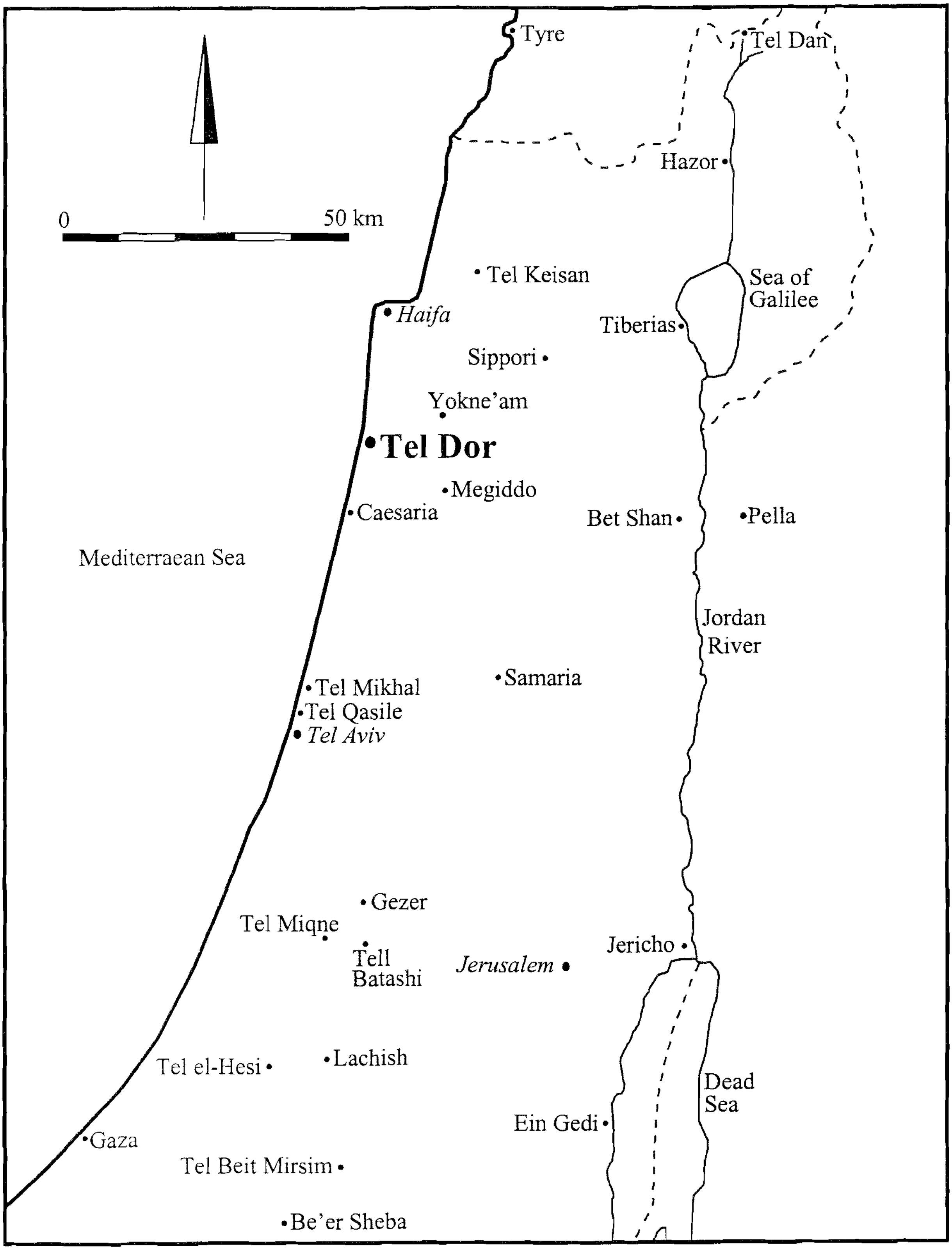

Figure 5.1 Map of Israel, with the location of some important archaeological sites identified.

inhabitants of Dor, however, could not be removed from the city (Josh. 17:12; Judg. 1:27), and thus it remained a Canaanite city until the United Monarchy of King David (ca. 1100 B.C.E.).[1] The Bible later notes that during the reign of Solomon, Dor was the capital of an administrative district governed by his son-in-law (I Kings 4:11). Dor continued its role as a provincial capital for the region following the conquest of the coastal areas of the kingdom of Israel by the Assyrian king Tiglath-Pileser III in 732 B.C.E. During the Persian period (538 - 333 B.C.E.) the control of the city and its harbour was given to the Phoenician cities of Tyre and Sidon by the Persian kings (Stern 1995b:2). This transaction was done to help the Phoenicians in their commercial maritime competition with the Greeks (a main enemy of the Persians). Following the conquest of the region in 333 B.C.E. by the Macedonian Alexander the Great, Dor fell under Ptolemaic control until acquired by the Seleucids of Syria in 201 B.C.E. In 138-137 B.C.E., the unsuccessful siege of Dor by Antiochus is recorded in the Apocrypha (I Macc. 15:10-38) and by Josephus (*The Jewish War* I:55). The city of Dor came to be part of the Roman Empire when it was liberated by Pompey in 63 B.C.E., at which time it was given the right to mint its own coins (Murphy-O'Connor 1986:353). Although Dor was described by Pliny the Elder as a 'mere memory' in 70 C.E., it had a large pagan and Jewish population during the reign of Agrippa I, 37-44 C.E. (Josephus, *Antiquities* 19:300) and continued to mint its own coins until 222 C.E. Dor is mentioned in a number of ancient literary sources, including in works by Josephus (*Antiquities of the Jews* 15:333, and *The Jewish War* I:156, I:409), and Polybius (*History*, V, 54-86).

Today the archaeological mound of Tel Dor is approximately 16.2 hectares (40 acres) in size with a depth of uninterrupted occupational debris of no less than 18 metres (Figure 5.2). It is believed that the unexcavated remains of the lower city extend for over a kilometre to the east (Stern 1995b:9-10). Early excavation of Dor began in the 1920s by J. Garstang under the auspices of the British School of Archaeology in Jerusalem. He was the first to identify the large mound as the ancient city of Dor and through excavation, Garstang established the general parameters of Dor's occupational history. Garstang also uncovered a large temple structure on the western edge of the tel. In the 1950s, soundings conducted on behalf of the Israel Department of Antiquities uncovered a large Roman theatre at the northern edge of the site (Stern 1995b:11). The present excavation of the tel began in 1980 under the direction of Professor Ephraim Stern of the Institute for Archaeology at Hebrew University on behalf of the Israel Exploration Society. Over the years

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[1] Archaeological information indicates that the city of Dor remained a part of Phoenicia well into the Iron Age.

a number of universities have participated in the excavation of this site. These have included Boston University, California State University Sacramento, University of California Berkley, Southern California College, McMaster University and the University of Saskatchewan. Personnel from these universities were supplemented by hundreds of individual volunteers from around the world. The University of Saskatchewan's participation commenced in 1987 when Professor C.M. Foley first joined the consortium and initiated a field school in Near Eastern archaeology.[2]

Figure 5.2 Aerial photograph of Tel Dor, looking southwest. The Kibbutz Nahsholim can be identified as the series of buildings to the southeast of the tel. Photograph courtesy of E.Stern.

5.1.2 Area D1.

The area of the tel from which the material for this study was taken is known as D1. It is located on the southwestern edge of the site overlooking the southern harbour (Figure 5.3). This area, like the tel as a whole, has remains dating from most attested periods of occupation of the city, from the Late Bronze Age to the Roman Period.

The main features (refer to Figure 5.4) of D1 include: a Roman street and sewer system (in squares AV11-13) associated with a Roman building complex (possibly residential or commercial in nature), a murex dye installation (in square AU10), a large (15 m x 15 m) structure

[2] For further information on the ancient history, geography and excavation of Tel Dor see Stern 1994 and 1995a.

with foundation walls of *ateleo* construction standing more than two metres in height and at least four large rooms (in squares AU12 to AS14), and an Early Iron Age industrial complex, which is noted for a series of 21 plastered sloping floors (in squares AV9-10). The proximity of this area to the southern harbour suggests that D1 had an important role in the maritime commerce that was so vital to ancient Dor (see Figures 5.5 and 5.6).

For the case study three areas of D1 were selected for detailed excavation.[3] These areas were chosen prior to the commencement of the 1997 field season based upon preliminary evaluative excavations and data analysis conducted during the 1996 field season. The primary criterion for their selection was the expectation that the sedimentary material in these areas would provide contrasting examples of tertiary anthropogenic sediments. The areas examined were:

i) the area immediately surrounding a Roman sewer system in square AT11;
ii) two intersecting trenches in squares AT12 and AT13, forming a T-section in these squares; and
iii) the baulk between squares AU12 and AU13. (refer to shaded areas of Figure 5.4).

The first of these units, located in square AT11, was 2.9 x 4.8 metres in area with an opening elevation of 15.23 meters above sea-level. The excavation involved the removal of a portion of the Roman street and sewer system (Figure 5.7). This area provided an ideal opportunity to examine an explicit example of Roman constructional tertiary anthropogenic sediments as they related to this structure. As well, the excavation of the sealed sewer contents provided a potential example of comparative, non-constructional anthropogenic sediment.

The second unit selected for this study was located in the *ateleo* building; in the northern section of its second chamber, Square AT12/13 (Figure 5.8). The T-section that was delineated for excavation had a southern portion, which measured 4.0 x 1.5 metres in area and a northern portion, which measured 2.8 x 1.5 metres in area. The opening elevation of the sediments in this area was 13.76 meters above sea-level. In the 1996 season the last of the later architectural elements that overlaid the anthropogenic sediments to be studied had been removed. As a result, what remained was an unobstructed room of sedimentary material that was well beneath all later walls and floors, and was contained by the foundation walls of the *ateleo* structure. This context, along with previous excavation of these squares in 1995 and 1996, suggested that these archaeological remains were constructional tertiary anthropogenic sediments dating to the Persian and Early

[3] These three excavation units comprised less than half of all the anthropogenic sediments excavated in the 1997 field season in D1.

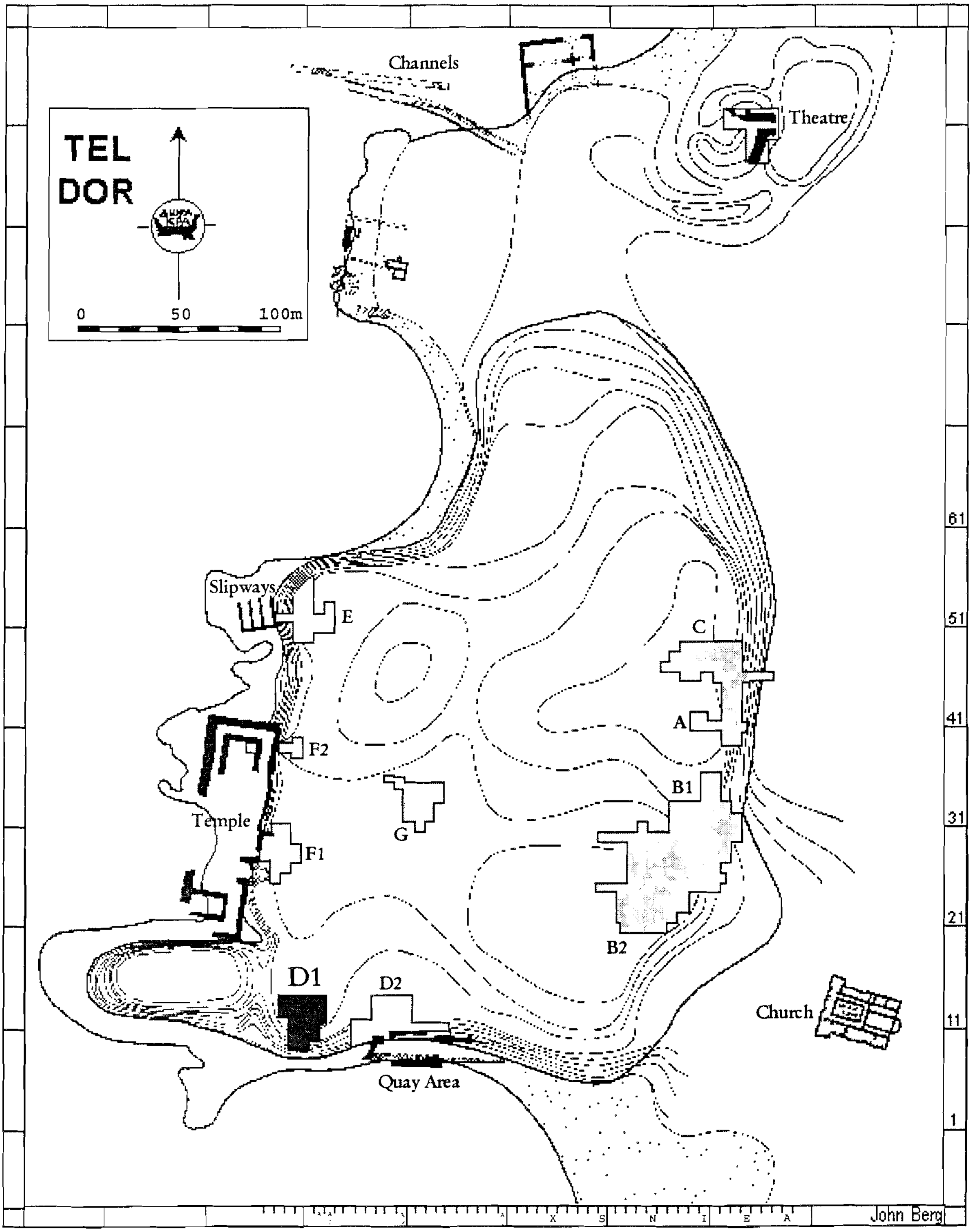

Figure 5.3 Schematic of Tel Dor, adapted from Berg 1995:24. D1 is located in the southern part of the tel. The shaded blocks represent other areas of excavation.

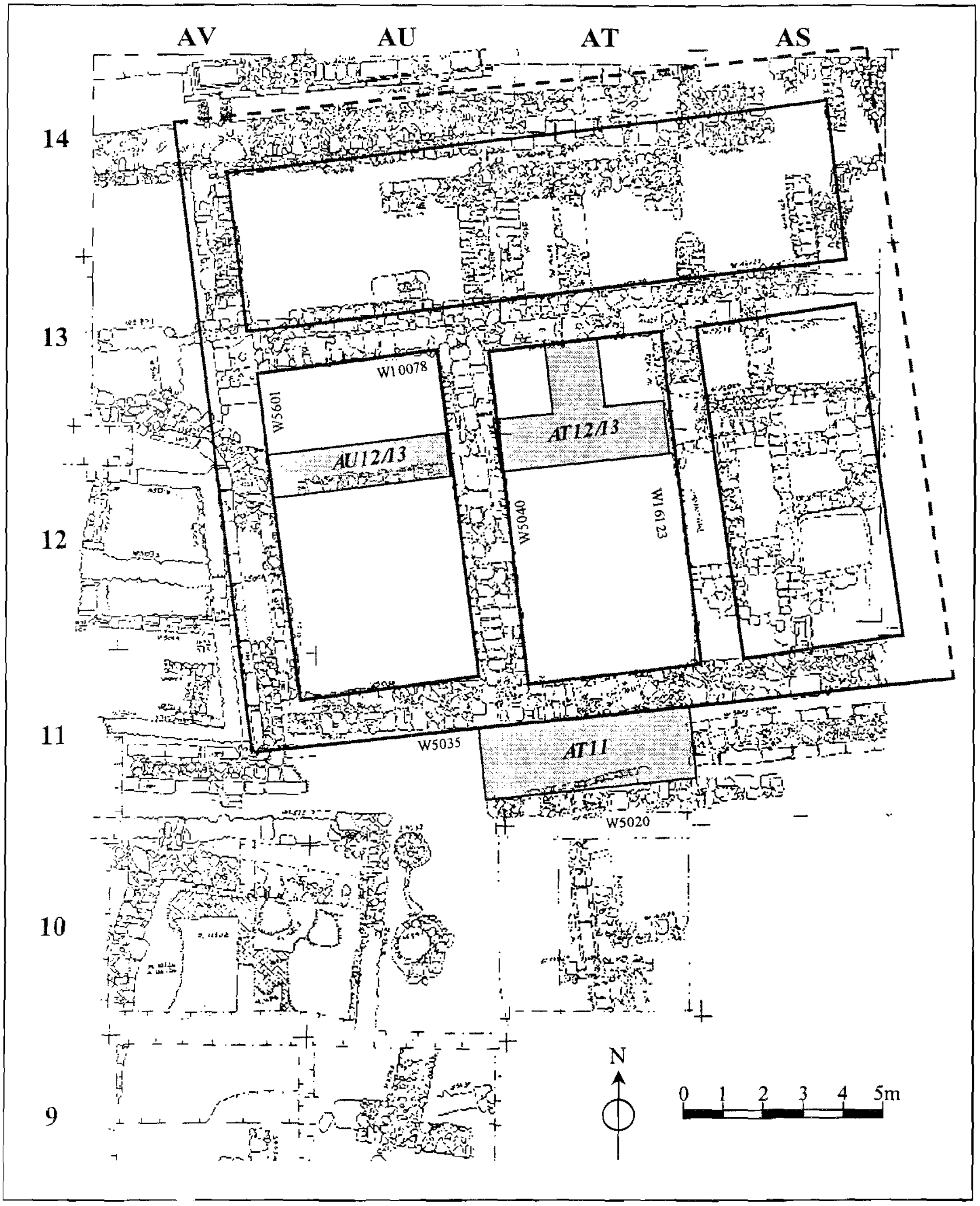

Figure 5.4 Schematic of area D1. The shaded areas represent the areas that were examined in this case study. The area outlined in black indicates the known parameters of the large *ateleo* structure as of the end of the 1997 field season.

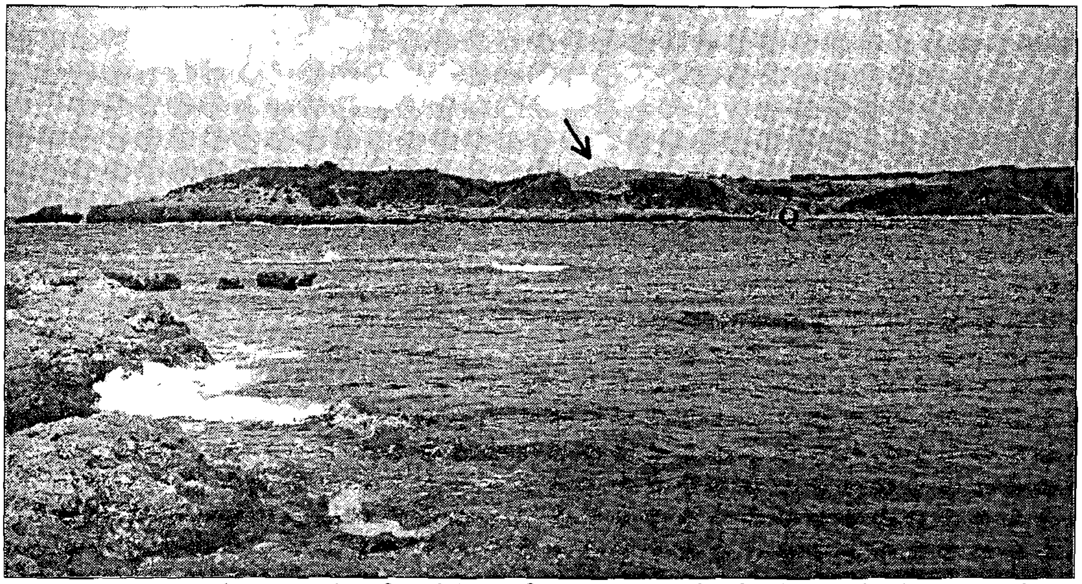

Figure 5.5 Photograph of Tel Dor from across the harbour, looking north. Area D1 is identified by an arrow. Note its proximity to the quay, identified by the letter Q.

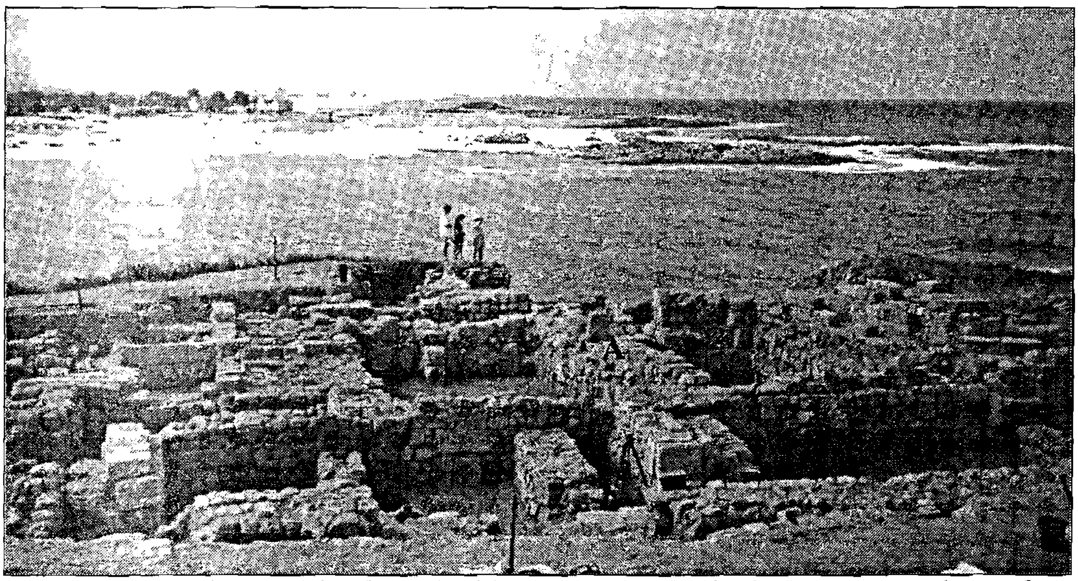

Figure 5.6 Photograph of D1, looking south across the harbour. Not the reefs that formed a natural wave break against the Mediterranean Sea. W5040 is indicated by the letter A.

Hellenistic Periods.

The excavation of this unit in a T-section was to serve two purposes. The first purpose was to create a large number of stratigraphic profiles. This was considered to be important so as to assist in the determination of potential layering events. The second purpose was to maximise the view of the relationships of this sediment to the foundation walls. The northern rather than the southern portion of this room was selected for study because the southern wall displayed signs of disturbance. This southern wall of the *ateleo* building's construction style was not *ateleo* in nature and there were obvious architectural intrusions dating to the Roman Period, likely due to the construction of a street and sewer.

The third excavation unit selected was the 4.4 x 0.9 meter baulk between Squares AU12 and AU13 (Figure 5.9), which had an opening elevation of 14.85 meters above sea-level. This baulk was chosen because the anthropogenic sediment in both the south (in Square AU12) and the north (Square AU13) had been tentatively identified as 'constructional fill' from the Early Hellenistic/Persian periods. This area's selection allowed for an interesting comparison with the sedimentary material from AT12/13, which was bound by the foundation walls of the same structure (although in a different room), and was similarly dated but close to one metre below the material in AU12/13, in elevation.

Figure 5.7 Photograph of sewer area in square AT11. The sewer structure (A) comprises the left half of the photo. The pavement that covered the sewer and formed the road can be seen in the upper portion of the photo.

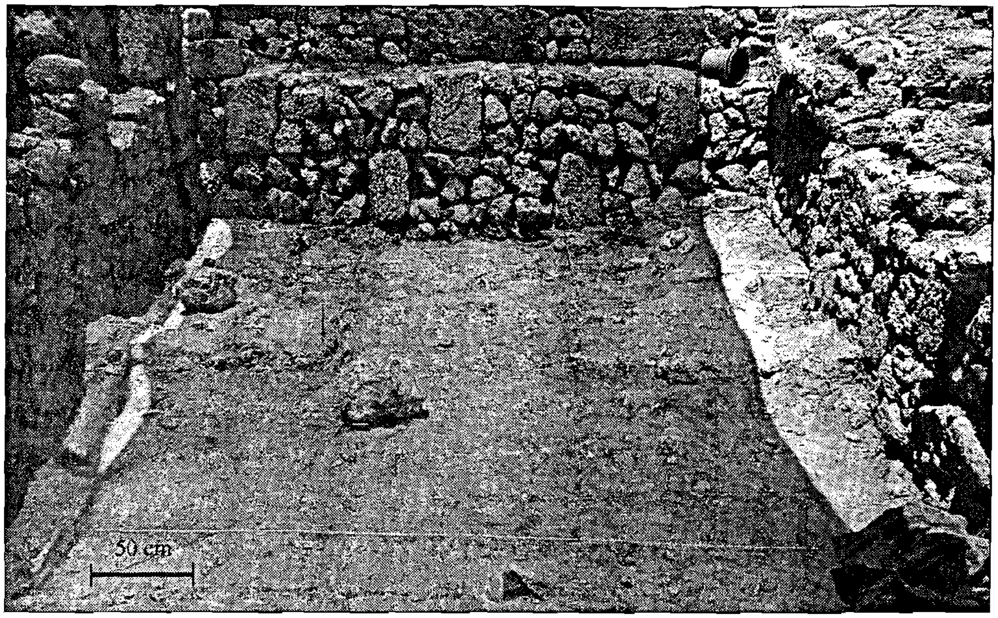

Figure 5.8 Photograph of T-section in square AT12/13, looking north. Note the *ateleo* construction style of the surrounding stone foundation walls.

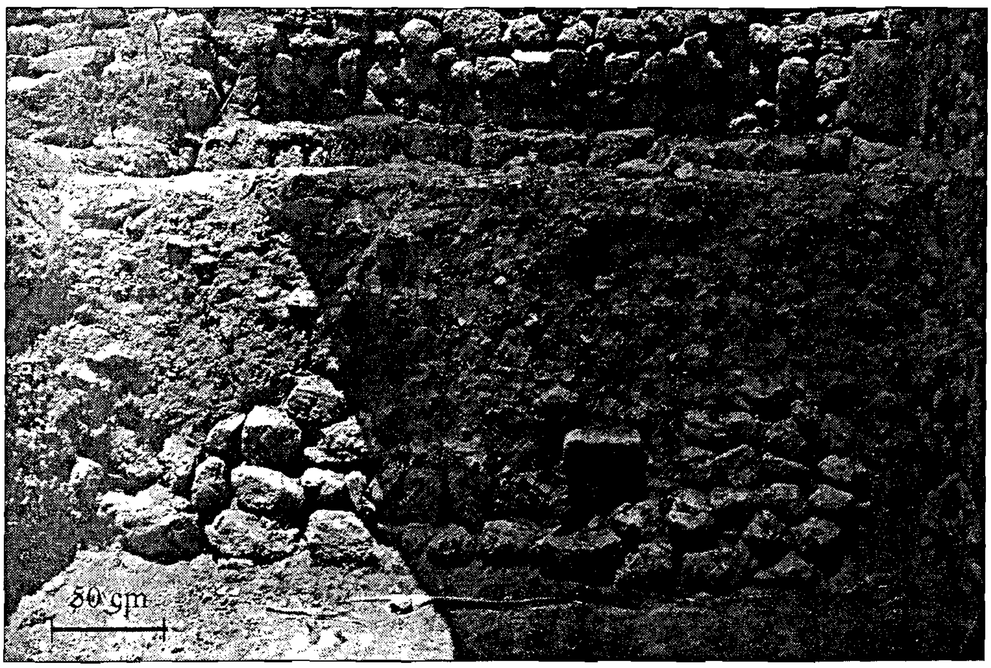

Figure 5.9 Photograph of baulk between squares AU12 and AU13, looking north. W10855 can be seen emerging beneath the constructional anthropogenic sediment.

In order to provide more comparative sediments for the anthropogenic sediments from the excavation units in D1, mudbricky material from AV14 was also sampled, as were two mudbricks from the adjacent area of D2. While the mudbrick-like material dates to the Persian, the mudbricks from D2 belong to the Iron Age. The collection of these anthropogenic sediments was conducted so as to provide more comparative samples of their micro-sedimentary aspects; no external macro-data were collected.

5.1.3 Method of excavation.

To excavate, the site was divided into squares based upon a 5 x 5 m grid system that was surveyed during the early years of the modern excavation. The resulting squares became the initial zones of excavation, and the location name for the intermediate proveniencing of all features and artefacts. For finer detail, the individual units of excavation are known as loci (pl.) or locus (sing.).

In D1, as with the rest of the Tel Dor excavation, a locus is a sedimentary deposit that is perceived as different from the other sedimentary deposits surrounding it. Each locus is given a unique identifying five-digit number. At the start of an excavation, the surface of a square may be assigned a single locus number. During the process of excavation the composition of the initial deposit may be seen to vary (e.g. it may be discovered that the sediments in the northern half of the locus are a different colour). At this time the first locus is closed and two new numbers are assigned to the two new regions with the different coloured soil. In this way, any time a change in the anthropogenic sediments under excavated is observed, old loci are 'closed' and new loci are 'opened'. By the same token, if many loci are being excavated in a contiguous area and are deemed to be the same material, all the old loci are closed, and a single new one is opened. This method of labelling allows for the identification of unique anthropogenic sedimentary depositional events. There are occasions when material that appears to be the same is given different locus numbers. This occurs when a physical feature (such as a wall) separates them, or when one of the areas was directly beneath an *in situ* feature (like a wall or floor), in order to preserve the sealed context of the artefactual remains within the anthropogenic sediment. When a locus is opened, it is measured, in order to maintain a record of its size, and when it is both opened and closed elevation levels are noted in order to determine the depth of the deposit.

Typically, the retrieval and collection of archaeologically significant material is limited to the collection of artefacts and ecofacts, and the architectural recording of walls and other features. All earthen sedimentary material is discarded into dumps. The pottery shards that have been collected are 'read' by a pottery specialist. This involves the identification of the period(s) represented by the pottery assemblage, and the collection of diagnostic or special pieces that should be kept for future study and/or reference. The pottery that is not kept is then discarded (this can represent as much as 98% of all shards found). Like pottery shards, all bone is collected and placed in bone bags that are specific to that locus and that day. The bone is kept for future analysis, but is not examined further during the course of the excavation season. Nondescript shell is treated in a similar manner to bone. All other artefacts, depending on their nature, are collected in small bags or boxes (e.g. charcoal, glass, metal fragments, etc.), assigned a basket number, and kept for future analysis. Special finds, such as complete vessels, figurine fragments, coins, jewellery, and tools (e.g. fishing hooks, loom weights, nails, spindle whorls, knives, etc.) are each assigned their own basket number and a three point provenience is taken. They are then kept for cleaning and future analysis.

5.1.3.1 Enhanced Method of Excavation and Analysis.

In order to collect the appropriate data and materials for this study some modifications were made to the traditional on-site excavation procedures and off-site laboratory analyses of materials. The methods of excavation applied to the three study areas of AT11, AT12/13, and AU12/13 were more systematic, with increased comprehensiveness of data recording. The previously unused earthen materials from the site were subjected to thorough collection, sorting and analysis.

5.1.3.1.1 Pottery Shards.

All pottery shards found during excavation of the site were collected. Prior to the traditional pottery reading, these shards were sorted according to their size, shape and form, counted and then collectively weighed within each category. Size was classified into three divisions based upon the maximum diameter of the shard; as indicated in Table 5.1.

Size	**Diameter**
small	less than 5 cm
medium	5 to 10 cm
large	greater than 10 cm

Table 5. 1 Size division of shards for case study.

Shards were classified according to both their shape and their form. The shape of shards was defined by two categories: regular (or relatively flat) and irregular (not flat). Seven different shard forms were recorded in this process: rims, shoulder (and neck), body shards, handles, bases, lamp fragments, and other. Lamp fragments were given a separate identification form as they could not be easily identified in any of the traditional groups. See Appendix II for a sample counting and weighing sheet.

During this classification of pottery shards, special fine wares, such as Attic Ware and East Greek Ware were separated, counted and collectively weighed for each locus. This procedure was incorporated in order to examine the proportion of these imported wares in the sedimentary deposits, and to add information to the assessment of the nature of the original deposits.

5.1.3.1.2 Bone and Shell.

All bones found in the study areas were counted and collectively weighed per daily bone bag(s) for each locus. These data were then added together to obtain totals for each locus. This method was employed to determine the quantity of bone present in each locus, as the traditional excavation methods only allowed for the recording of the presence or absence of bone.

Shells and shell fragments were collected and bagged for each locus, but unlike bone, they were weighed but not counted. This was because the shells that were bagged in this manner were all small bivalves, and it was not thought that a count of the individual shell pieces would be useful.

5.1.3.1.3 Earthen material.

The amount of earthen material that was removed during excavation was tallied based upon the number of buckets that were taken out of each locus. This was done in order to maintain a general comparative quantity of the amount of sediments in each locus. In addition to the quantification of the excavated sediments, the colour, matrix and relative density was also recorded. The actual volume of each locus was determined by a mathematical formula based upon the length, width and depth of each locus.

For the purposes of later laboratory analyses of the earthen materials, bulk sediment samples of approximately 500g were collected from various loci during the excavation. Due to transportation and financial constraints not all loci were sampled. Some loci, due to their size and the desire to have as thorough a record as possible, were sampled a number of times. The collected samples were double bagged in plastic and returned to the University of Saskatchewan.

The first step in the micro-study of anthropogenic sediments was the laying out and air drying of the samples. Once dry the sediment's colour was noted using a Munsell Colour chart. Following this, the sediment samples were sieved, and the 2 mm fraction was preserved for use in all further lab work. The sediments were analysed for five physical and chemical elements: grain size, pH, organic and inorganic carbon, and total phosphorous.

Particle size analysis of the samples was carried out by EnviroTest Laboratories, Saskatoon, Saskatchewan using the Bouyoucos Hydrometer method. The measure of each grain size was recorded as a percentage of the sample. The pH was determined for all soil samples using a 1:1 (50ml : 50g), de-ionized water to soil ratio on a Fisher Accumet pH meter, model 805 MP. The total carbon and organic carbon content was found using the LECO CR-12 induction furnace. Through incineration of 1g samples of sediment, the percentage of organic carbon and total carbon in the sample were determined. The percentage of inorganic carbon was determined by subtracting the percentage of organic carbon from total carbon. Total phosphorous tests were carried out by EnviroTest Laboratories, Saskatoon, Saskatchewan. The process involved the conversion of the phosphorous in the sediment to a soluble form by wet oxidation using a combination of nitric and perchloric acids. The total phosphorous was then extracted using inductively coupled plasma-atomic emission spectroscopy (ICP-AES).[4]

5.1.3.2 Personnel.

As with the rest of the work done in D1 during the 1997 season, field school students from the University of Saskatchewan carried out the majority of labour for the excavation in the study site. A total of ten students were involved in the excavation of these three selected areas. Five upper year students responsible for the excavation of their assigned areas were also responsible for maintaining the tally of earth buckets removed from their loci and for noting the colour and the relative density of the sediments they were excavating. Supervision and direction of the excavation as a whole was conducted by Dr. C.M Foley of the University of Saskatchewan, Peter Popkin of the University of Saskatchewan, and myself. The majority of the detailed data collection was carried out by myself, except in the case of bones, where Peter Popkin did the data collection. Every effort was made during this study to collect and record **all** materials found in the deposits studied. Unless otherwise stated, I performed the laboratory analyses of the earthen materials.

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[4] This method of total phosphorous extraction is outlined in Kuo 1996.

5.2 Statistical Procedures Applied to Excavation Contents.

The statistical procedures applied to the data gathered for this thesis were chosen to provide information on the relationship between variables across the site. For the purpose of analysis, the archaeological squares of AT11, AT12/13 and AU12/13 are considered to constitute three sets of contiguous samples. This results in each square having a variable number of samples, known as loci. Although restricted to three specific physical locations within close proximity to one another, the samples selected for this research were studied in their entirety, thus reducing the influence of sampling error. The samples can not be considered 'random' or even 'representative' in the traditional sense, but they can be considered as 'spatially defined clustered selections' to which statistical tools are applicable (Drennan 1996:87).

The elements selected for statistical analyses correspond to the data collection categories of pottery shards (by size and form), bones, Attic ware, special finds and earthen materials. All data elements were analysed using aggregated raw data, while selected data elements (e.g. shard counts) were also analysed using a standardised per cubic metre measure. The standardised measure was employed to compensate for the variable loci volumes.

The first task in gaining information of the relationship of variables across the site is to understand the basic distributional characteristics of each variable within the loci. In order to do this, the contents of each locus will be manipulated to yield measures of central tendency, variability and distribution. Specifically, data means, ranges, proportional distributions, and standard deviations will be calculated for pottery shards, bones, and other archaeological materials within each locus, and where applicable, to earthen materials.

Next, using the information gleaned from the descriptive statistics, the loci will be compared to each other so as to ascertain commonalities and differences. A series of graphic representations will be used to assist in this task. The presence, distribution, and intensity of various elements across the loci will be evaluated in relationship to their proximity to each other (physically and temporally). Loci deemed to belong to a common source and/or event will be grouped together into 'depositional units'.

The final procedures to be applied to the data will be the application of Ternary Analysis (TA) and Correspondence Analysis (CA) across depositional units. These two procedures will be employed to assist in the statistical differentiation between the diverse types of anthropogenic sediments found during excavation. TA, also called tri-plots or ternary diagrams, was chosen because it allows data elements with three distinct components to be plotted on a 3-axis plane utilising the percentage contribution of each to the whole (i.e. the three components must add to 100%) (Shennon 1997:311). As many of the data elements gathered in this study can be broken into three components, TA was viewed as an easy-to-understand method of examining the relative percentage relationship (i.e. clustering and dispersement) among the depositional units.

CA was chosen as a procedure to complement and inform the interpretation of TA findings. CA provides a multivariate method for analysis of frequency and percentage data from heterogeneous datasets (Rayment and Jorskog 1993; Phillips 1995). Additionally, CA is a single technique capable of handling and representing the relationships between different types of data (i.e. variables and depositional units) simultaneously, providing both numerical and graphical results (Greenacre 1984). It was noted further, that CA allows data from different sources to be presented on the same scale with a layering of best-fit multidimensional scales (Greenacre 1984:11). As the intent of this study is to understand "relationships", rather than investigating stability or creating predictability, CA was deemed to be the best approach among the many existing regression, correlation and factor analytical approaches for handling the multivariate and diverse datasets collected for this study.

The cumulative effect of employing the above stated statistical procedures is to facilitate an objective basis upon which to identify and examine the systemic contexts of anthropogenic sedimentary deposits. Each depositional unit will be examined in terms of it being a unique entity in and of itself, as well as an accumulation of elements that had potentially many pervious systemic contexts and were subjected to events that were formulated and occurred in antiquity.

5.3 Excavation Results.

5.3.1 Site Overview.

During the 1997 season at Tel Dor, a total volume of 13.71 m^3 was excavated in the three selected study areas. The excavation yielded the following materials: a total of 39,723 pottery shards (938.88 kg), 3,907 bones (23.60 kg), 77 special finds, 54 shell bags, 371 shards of Attic Ware (3.18 kg) and 1,531 buckets of earthen material (12,137.5 kg). [5]

[5] While every effort was made to reduce potential error at all stages of data acquisition, it was not possible to eliminate all sources. It is noted, for instance, that an element of error occurred in the process of data collection due to the vagaries of individual perceptions. As an

The three squares were partitioned into a series of loci, 26 of which were analysed for this case study. For the duration of this section, these loci will be collectively known as the "site". The 26 loci ranged in size from 0.025 to 2.856 m^3, with a median size of 0.229 m^3. The majority of the materials found in these areas dated from the Persian to the Roman Periods.

In order to facilitate the reader's understanding of the site, block diagrams have been created to provide an overview of the excavation (see Figures 5.11, 5.14, and 5.17). These stratigraphic sketches identify the history of the excavation process, and schematicize the physical relationships between all of the various loci and features encountered during excavations.[6] The block diagrams are simply reflections of the raw data in which a three dimensional situation is projected two dimensionally (Sharon 1995b:19-20). The blocks of each diagram are not expected to reflect anything other than the physical relationship between the loci. In other words, the size, shape, distance between loci are represented only in a schematic fashion. Each of the three squares is discussed below.

5.3.1.1 AT11.

Prior to the 1997 season, this entire area (refer to the top plan of the area, Figure 5.10, and the block diagram for AT11, Figure 5.11) was covered by paving stones, L5740 (some of which can be seen in Figure 5.7). At the start of the season, only the western half of the paving stones remained in place. This square was dominated by a stone sewer (L5018) that ran through its middle in an east-west direction. The anthropogenic sediments that surrounded the sewer were bounded on the north by a large ashlar foundation wall, which formed the southern extent of the *ateleo* building (W5035) and on the south by the three phases of a rubble-pier wall (W5020). The northern anthropogenic sediments were crossed at two points by small drains leading from a contemporary structure (built on top of the *ateleo* building") to the larger sewer.

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example, during excavation it was possible to miss the smallest shards (< 2 cm in size) given the quantity of artefactual material that was being removed. In order to counter this problem, random sifting (with a 1 cm mesh) was carried out to determine the level of material, if any, being missed. Through this process it was found that < 3% of small shards and none of the larger artefacts were being omitted. This figure was reduced even further (to approximately 1%) as the excavation progressed and the students became increasingly skilled at their tasks. Given the similar training that all staff and students received, as well as the large quantity of data that was collected and analysed, the level of error related to data collection was deemed to be acceptable. Analysis of the data discerned no outrageous discrepancies.

[6] This is in contrast to Harris Matrices, which connect the loci according to their sequence of deposition.

The western drain (L16409) was constructed of plaster and was built over W5035, emptying into L5018 and running for 1.1 m. The eastern drain (L16408) was constructed of cut stones, approximately 34 cm in length and was adjacent to a slight gap in the top of W5035, emptying into L5018 and running for 0.7 m. The southern anthropogenic sediments were bounded on the east by a third small drain, emptying into L5018. This drain was essentially a gap in W5020 that was lined with cut stones approximately 35 x 12 cm in size. (Figure 5.12)

Other than cleaning loci, the majority of the anthropogenic sediments in this square to the base of L5018 were subject to analysis. The only two non-cleaning loci that were not studied were L16410 and L16404, the sediments in the two small northern drains. This omission was due to the very small quantity of material that was removed from these loci, making it untenable for collection. On the northern side of the sewer (L5018) L16422, L16426, L16418, L16429, and L16423 were perceived to be part of the same sedimentary material at the time of excavation. Their distinction into separate loci was due to the presence of the small drains, and the desire to keep the sealed sediments beneath the individual drains separate. Once all these loci had been excavated to a similar level, however, they were collapsed into a single locus (L16430). At the base of the sewer's (5018) walls, this locus was closed, and L16447 was opened. On the southern side of the sewer (L5018), L16424 was excavated to the base of drain L16425, where it was closed and replaced by L16432. This locus, L16432, remained opened until the base of the drain's (L5018) walls were exposed, at which point L16432 was closed and L16448 was opened. During excavation, all of the loci to the north of L5018 were identified as belonging to the same anthropogenic sediment. Similarly, all the loci to the south of L5018 were perceived to be a part of another cohesive anthropogenic sediment. The sedimentary material within the sewer (L5018) was excavated as L16403, and was sealed by the paving stones (L5740). L16403 was noted as containing chunks of plaster fragments and a relatively large quantity of bivalve shells.

The anthropogenic sediments studied in this square were excavated to a depth of 1.5 m, with a total volume of material removed being in excess of 20 m^3. Much of this space, however, was taken up with the large ashlars and paving stones that formed the structure of the street and sewer installation, resulting in an earthen material volume of 2.9912 m^3. A total of 5,336 shards of pottery (110.585 kg), 474 (5.401 kg) bone fragments, 14 special finds, 41 pieces (0.452 kg) of Attic ware, and 340 buckets (4250 kg) of earthen material were removed during the excavation of AT11. By volume AT11 accounts for 22% of the study site, 13% of all pottery shards, 12% of bone fragments, 18% of special finds, and 14% of Attic ware collected.

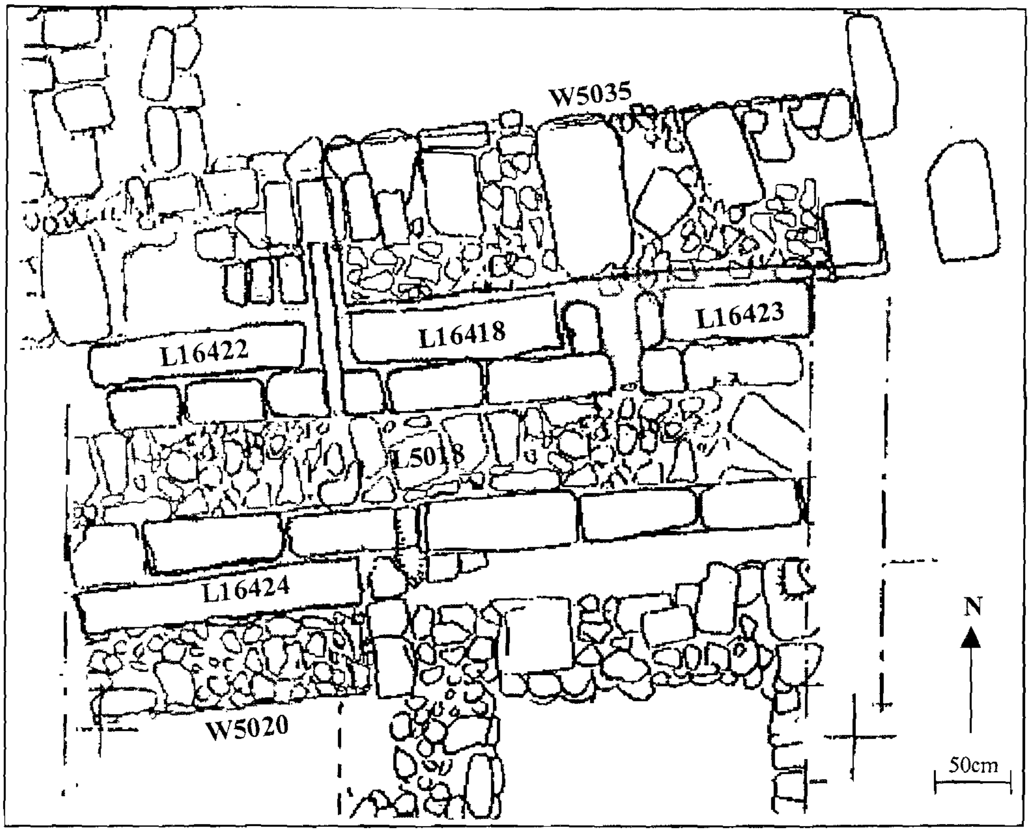


Figure 5.10 Top plan of AT11 showing the location of some walls and loci.

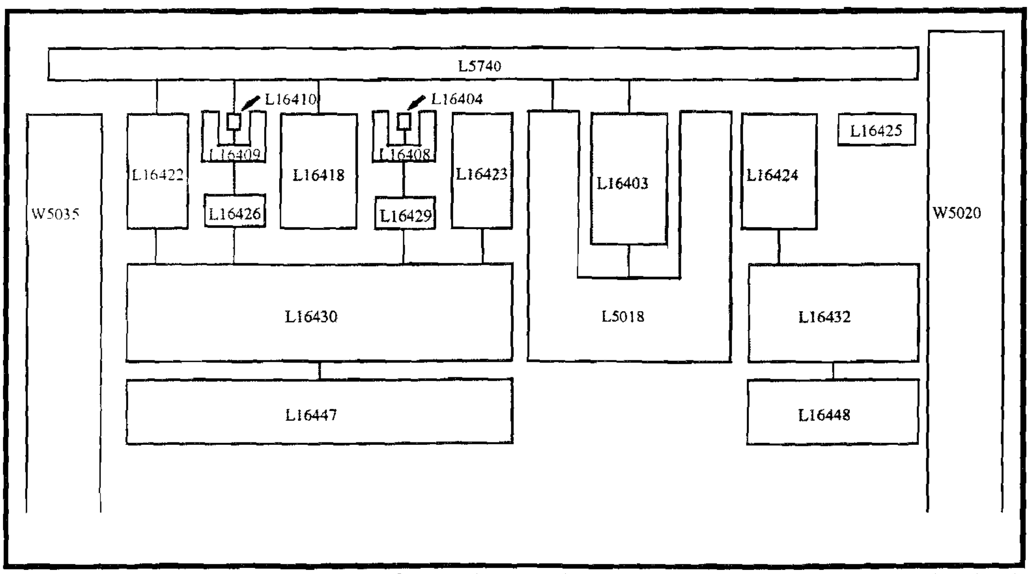


Figure 5.11 Block diagram for AT11. The shaded blocks represent the loci examined for this study.

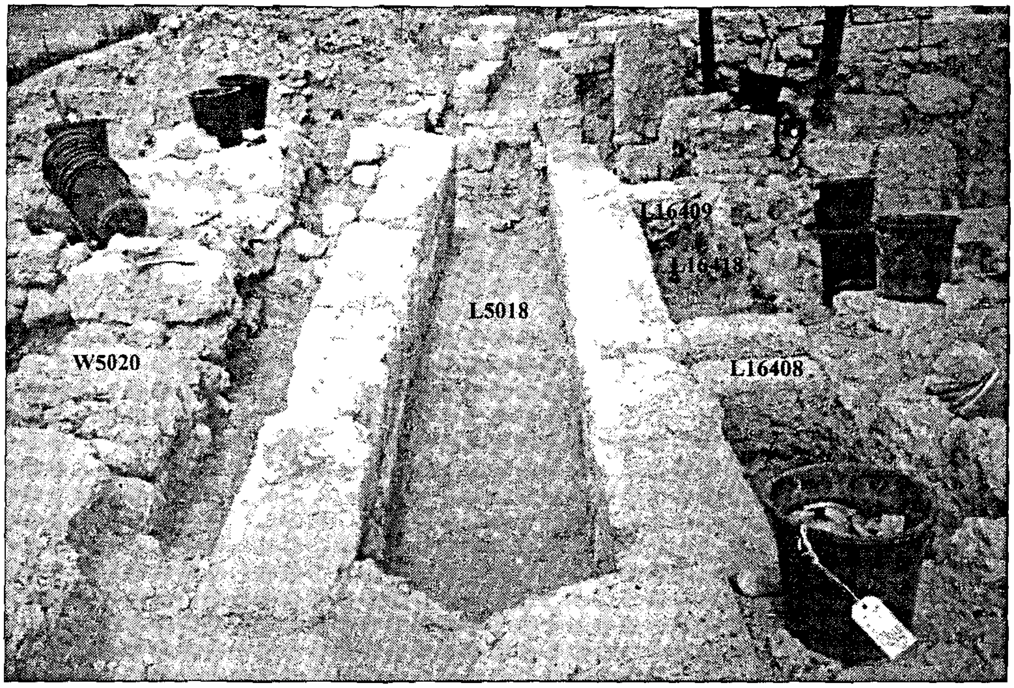


Figure 5.12 Photograph of sewer area in square AT11 during excavation, looking west.

5.3.1.2 AT12/13.

This square (refer to the top plan of the area, Figure 5.13, and the block diagram from AT12/13, Figure 5.14) was situated within one of the 'rooms' created by the foundation walls of the 'Persian Building'. The surrounding wall to the east was W16123, to the north was W10078 and to the west was W5040. Given the large size of this room (4 x 8m), it was decided to sample the anthropogenic sediments by creating a T-shaped trench. This allowed for an analysis of the association of the anthropogenic sediments with the surrounding walls, as well as having provided a good cross section of anthropogenic sediments in the area. Prior to the 1997 excavation season, this area had been overlain by a series of foundation walls, floors and anthropogenic sediments that belonged to later phases of the site's occupation. This later material had been removed primarily in the 1993 and 1995 seasons of excavation. For the purpose of excavation the T-section was divided into two parts, the foot of the 'T' (running north-south, in the north) was separated from the cross of the 'T' (running east-west, in the south). In the centre of the 'T' a large ashlar was embedded in the sedimentary matrix. At the commencement of excavation the foot of the 'T' was divided into two loci, based on the appearance of a pit. L16412 was assigned to the pit and L16411 was assigned to the non-pit sediments. Once L16412 had bottomed out, the two loci were closed and a new single locus (L16435) was opened that covered the entire foot of the 'T'. At the time of excavation L16435

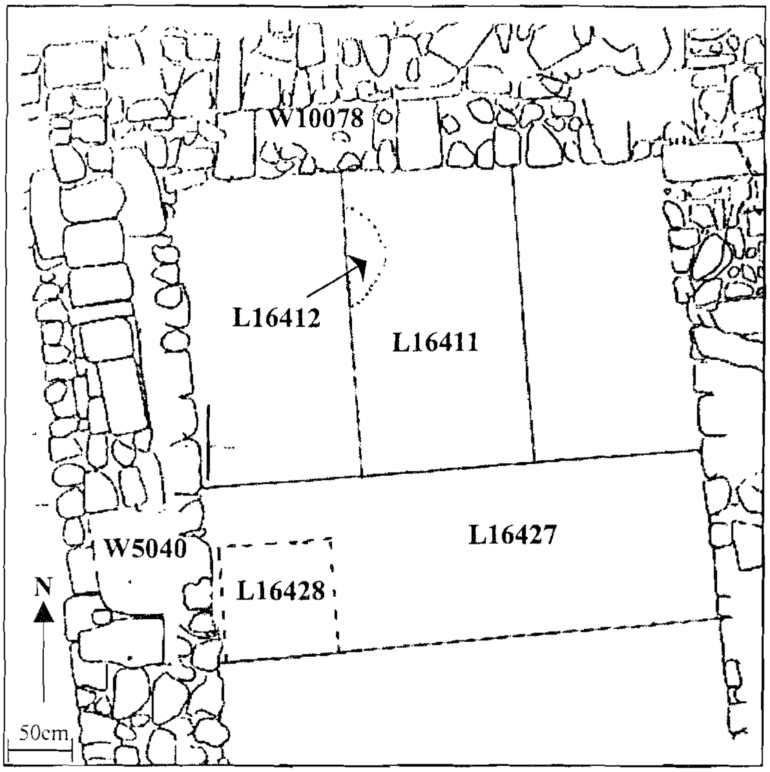


Figure 5.13 Top plan of AT12/13 showing the location of relevant walls and loci.

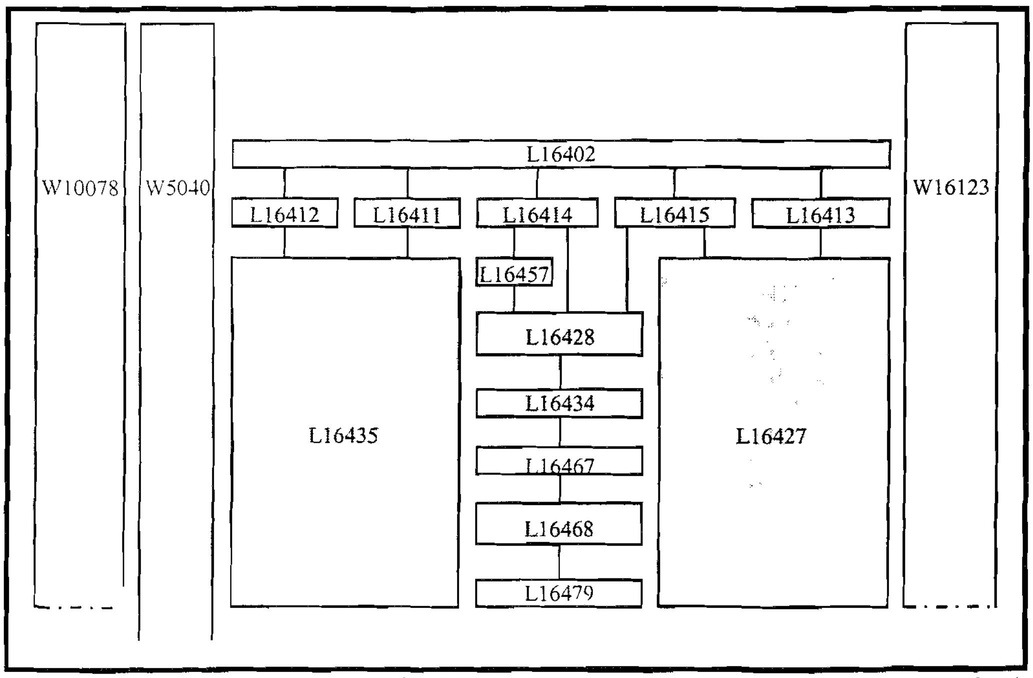


Figure 5.14 Block diagram for AT12/13. The shaded blocks represent loci examined in this study.

was seen as a continuation of L16411. To begin the excavation the cross of the 'T', it was divided into three loci, based on the appearance of a potential pit near the centre of the trench (L16414). Loci 16413 and 16415 were on either side of this feature. These areas were excavated until they reached the level of the base of L16414, where a marked difference in soil colour was revealed that spread into L16415. All of the loci were closed, and the small area that had the reddish soil was excavated as L16428, and the remainder of the cross of the 'T' was opened as L16427. This locus (L16427) was thought to be a continuation of the sediments in L16413, which in turn was believed to be the same as L16411.

During the excavation of L16428, the remains of a fragmentary kurkar surface were uncovered in the southern baulk (L16457). L16428 came down onto a 5 - 10 cm thick crushed kurkar surface with a thin sub-floor of crushed shell (cleaned and traced as L16434 and excavated as L16467). The anthropogenic sediment beneath the floor was excavated as L16468. This locus was closed when it came down onto a large concentration of rocks (L16479). The excavation of L16479 revealed no pottery, bone or shell and consisted mainly of rocks ranging from 14 - 40 cm in diameter. It was assumed during excavation that this rocky matrix served as a support for the crushed kurkar floor. The large ashlar that was centred in the 'T' was founded at the level of L16479. See Figure 5.15 for a photograph of the excavation results from this area.

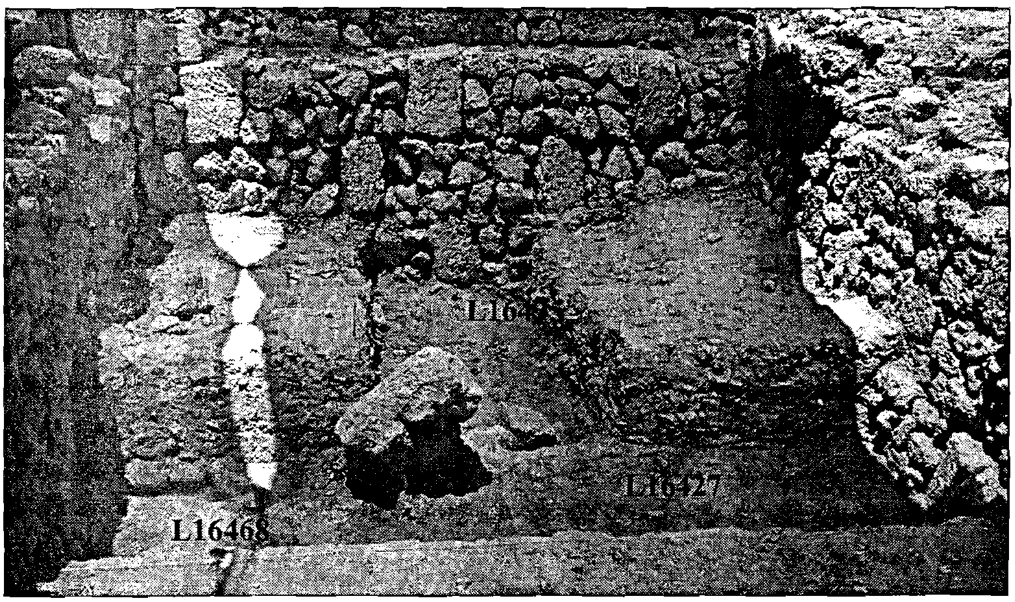


Figure 5.15 Photograph of the T-section in square AT12/13 following excavation, looking north.

For this study, the material from all loci, save the initial cleaning locus (L16402), floor make-up (L16467) and the rock platform (L16479), was collected and analysed. The T-section in AT12/13 was excavated to a depth of 0.8 m, with the total volume of sedimentary material removed being in excess of 6.7 m^3. A total of 27,324 (654.95 kg) shards of pottery, 2,857 (15.16 kg) bone fragments, 51 special finds, 168 pieces (1.42 kg) of Attic ware, and 732 buckets (9,150 kg) of earthen material were removed during the excavation of AT12/13. By volume this area accounted for 49% of the study site, over two-thirds (69%) of all pottery shards, 73% of bone fragments, 66% of special finds, and 57% of Attic ware.

5.3.1.3 AU12/13.

This square (refer to the top plan of the area, Figure 5.16, and the block diagram from AU12/13, Figure 5.17) was a baulk dividing squares AU12 and AU13, and was situated within another of the 'rooms' created by the foundation walls of the 'Persian Building'. To the east of the baulk was W5040 and to the west was W5601. Following the cleaning of the baulk, the entire area was designated L16464. This locus was closed when excavation came down to a distinct charcoal line in the baulk, which coincided with the top of wall (W10946) uncovered in the western portion of the locus. The new locus (L16475) was excavated to the top of W10855, and three new loci were opened due to the presence of a plaster mound (L16025) that rested against the baulk to its north. The three new loci were: L16503, to the east of the plaster mound; L16502, centred against the mound; and L16501, to the west of the mound. W10855 was an east-west running wall, and was almost entirely concealed within the baulk. This wall had first been discovered in 1992 during baulk trimming of this baulk. W10855 did not reach W5040 in the east, and appeared to have been cut by it. In the west, the relation of W10855 to W10946 was uncertain due to the rubbly nature of the intersect. Slightly to the south of the baulk, L16449 was excavated beneath W10946. Refer to Figure 5.18 for a final photo of AU12/13.

The baulk between AU12 and AU13 was excavated to a depth of 1.2m for this study, with a total volume of material removed for analysis being in excess of 4 m^3. A total of 7,063 shards of pottery (172.34 kg), 576 (3,040 kg) bone fragments, 12 special finds, 86 pieces (0.685 kg) of Attic ware, and 459 buckets (5737 kg) of earthen material were removed during the excavation of AT11. By volume this area accounts for 29% of the study site, 18% of pottery shards. 15% of bone fragments, 16% of special finds, and 29% of Attic ware.

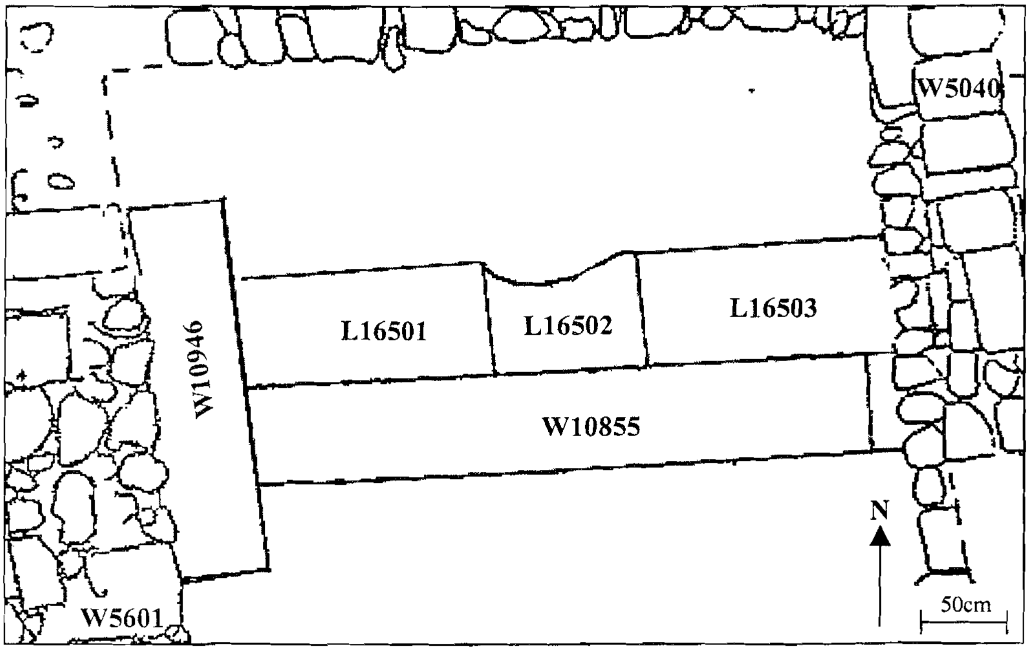


Figure 5.16 Top plan of AU12/13 showing the location of relevant walls and loci.

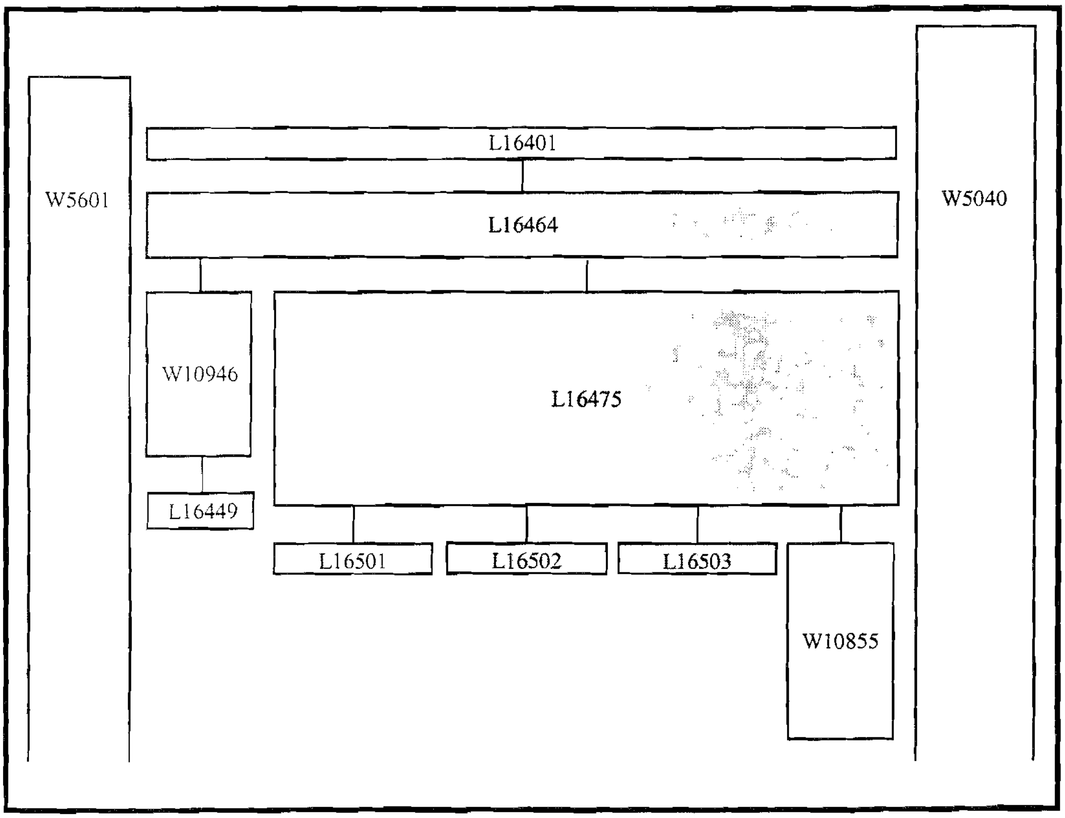


Figure 5.17 Block diagram for AU12/13. The shaded blocks represent the loci examined in this study.

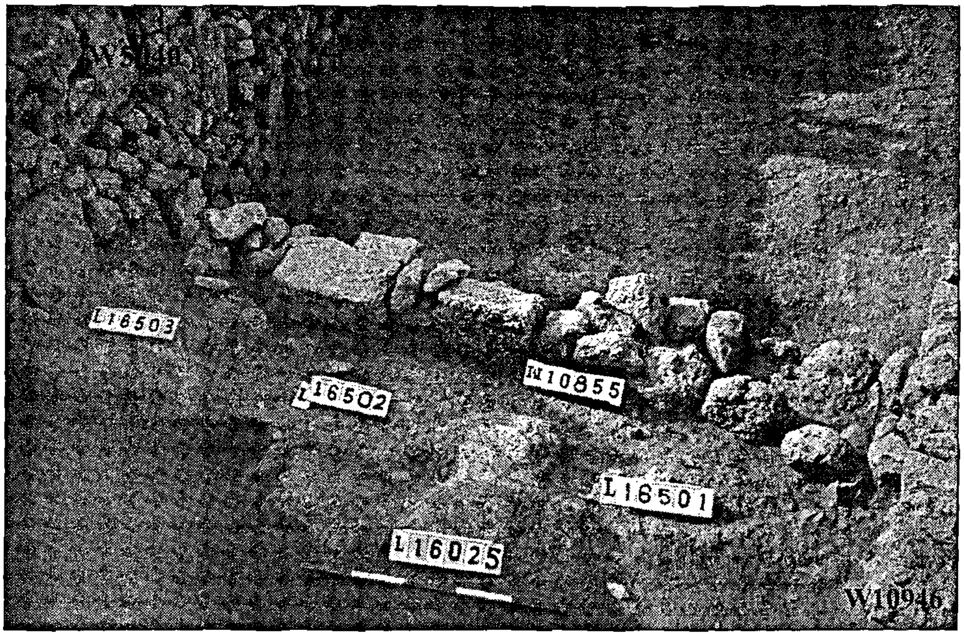


Figure 5.18 Photograph of baulk dividing squares AU12 and AU13 after excavation, looking southeast.

5.3.2 Summary of Raw Data Results.

In order to ascertain the importance and relevancy of the excavation findings, an examination of the various components (i.e. shards, bones, etc.) within and across squares was conducted. Table 5.2 (below) provides a survey of the findings by both count and weight, for each square, as well as the proportional distribution of each across the entire site. Following Table 5.2 a discussion of each component is presented. To assist interpretation, Table 5.2, lists for each square, the periods associated with the artefactual contents.

	AT11		AT12/13		AU12/13		Site Total	
	Count	Weight	Count	Weight	Count	Weight	Count	Weight
pottery shards	5,336	110.59kg	27,324	654.95kg	7,063	172.34kg	39,723	938.88kg
% of total	13%	12%	69%	69%	18%	18%	100%	100%
bone fragments	474	5.41kg	2,857	12.16kg	576	3.04kg	3,907	23.60kg
% of total	12%	23%	73%	64%	15%	13%	100%	100%
special finds	14		51		12		77	
% of total	18%		66%		16%		100%	
Attic ware	41	0.45kg	168	1.42kg	86	0.69kg	371	3.18kg
% of total	14%	18%	57%	56%	29%	27%	100%	100%
volume	2.991 m^3		6.717 m^3		4.015 m^3		13.723 m^3	
% of total	22%		49%		29%			
earth buckets	340	4,250kg	732	9,150kg	459	5,737kg	1,531	19,138kg
% of total	22%		48%		30%		100%	
Periods*	Roman, Hellenistic, Persian		Early Hellenistic, Persian, Iron Age		Early Hellenistic, Persian			

Table 5. 2 Artefactual results by area. *For a Chronological table refer to Appendix A.

5.3.2.1 Pottery Shards.

Shards were sorted by size and type, counted and weighed. Not unexpectedly, small shards accounted for the greatest count (73.5%), while medium shards accounted for the greatest weight (52.6%). Conversely, the very small proportion of large shards (1.9%) represented only one-fifth (19.4%) of the total weight. Body shards were the most prominent type of pottery across the site, representing 93.4% of the count and 81.1% of the weight. The quantities of each category by total count and total weight, as well as their respective percentage distributions, are found in Table 5.3.

		Raw Data		**% Distribution**	
		count	weight	count	weight
Size	Large	771	182.31kg	1.9%	19.4%
	Medium	9,779	492.90kg	24.6%	52.6%
	Small	29,173	262.66kg	75.5%	28.0%
	Total	39,723	937.88kg	100%	100%
Form	Rims	1,249	29.75kg	3.1%	3.2%
	Handles	857	104.72kg	2.2%	11.2%
	Bases	258	34.71kg	0.7%	3.7%
	Body	37,123	760.60kg	93.4%	81.1%
	Other	236	8.09kg	0.6%	0.8%
	Total	39,723	937.88kg	100%	100%

Table 5. 3 Pottery shards sorted by size and form.

The total count of pottery shards per locus[7] ranged from 25 in L16449, to 12,879 in L16427. By weight, the smallest amount of pottery shards was located in L16426 at 630g and the largest amount in L16427 at 253.8 kg. The smallest shards were pebble-sized (< 1 cm in diameter) and were known as 'shard gravel'. The largest shards were over 30 cm in diameter. Although the type of vessel that the shards were from was not officially recorded, the vast majority could be identified as the remains of large storage or shipping amphorae. As these storage vessels were made with particularly thick and heavy walls (approximately 2 cm in thickness at their thinnest point), their broken shards often weighed a considerable amount. Thus, by count the majority of shards in most loci were found to be small in size (< 5 cm in diameter), but by weight, the medium sized category (between 5 and 10 cm in diameter) was often considerably larger. Occasionally, the large shards (> 10 cm in diameter), although few in

[7] A complete list of total pottery shards per locus, categorised by shard size, quantified by both weight and count, can be found in Table C-1, in Appendix C.

number, could out-weigh each of the other groups. For example, in L16447, 12 large shards weighed 3.28 kg, while 37 small shards weighed only 0.45 kg. The reason for this seeming contradiction between the quantifying methods of count and weight was due to the thick and heavy nature of the pottery. Figures 5.19 to 5.21 show a representative sample of the size variation identified within the small, medium and large size categories.

With respect to shard form, throughout all the loci, the majority of shards were body shards, by both count and weight.[8] The largest weight per shard, however, was found in the handles and bases, the areas with the thickest concentration of clay. Figures 5.22 to 5.24 show a sample of some of the different shard forms.

During the data collection process, the shard form was also separated into two categories in order to indicate the regularity versus irregularity of their shape. Those body shards, rims and bases that were flat, were identified as 'regular', with all other shards identified as irregular.[9] Through this process, it was discovered that a similar relation of 96% regular to 4% irregular shards (by count) and 84% to 16%, by weight, was found within all loci. The difference between the count and weight ratio was due to the heaviness of the majority of irregularly shaped shards, which consisted largely of handles and irregular bases.

The order of the periods associated with each locus was conducted according to the dominant phase amongst all of the shards.[10] In other words, the period to which most of the shards belong has been listed first, followed by the next most prevalent period. The shards from AT11 were predominantly from the Hellenistic period, with a fair representation of both Roman and Persian material. The shards from both AT12/13 and AU12/13 were primarily from the Persian Period, although there were the occasional scattering of both later (Early Hellenistic) and earlier (Iron Age) shards. L16427 was noted for the find of a single shard that was dated specifically to the fourth century BCE, providing a rather late date for the *terminus post quem* of the deposit.

[8] A complete list of total pottery shards per locus, categorised by shard form, quantified by both weight and count, can be found in Table C-2, in Appendix C

[9] Refer to Tables C-3a and C-3b in Appendix C for a complete data table of shard types.

[10] Refer to Table C-4 in Appendix C for a complete data table of the periods of pottery identified in each locus.

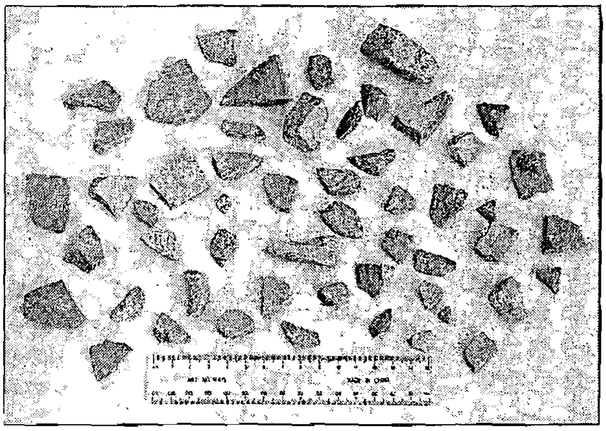
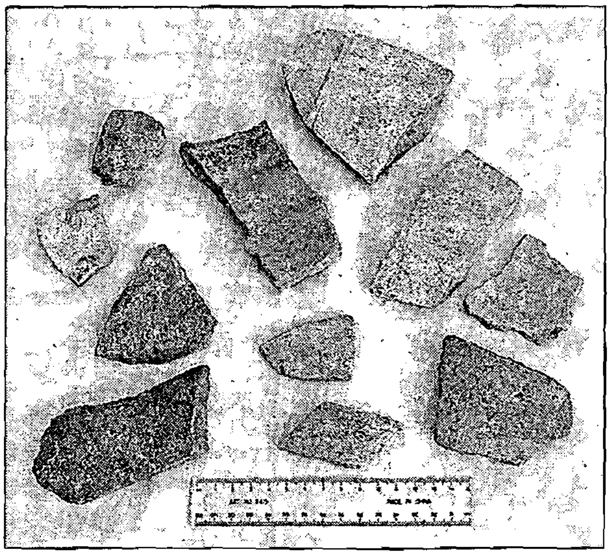


Figure 5.19 Photograph of a sample of small body shards. Small shards ranged in size from < 1 cm to 5 cm at their longest length. The scale is 15 cm in length.

Figure 5.20 Photograph of a sample of medium body shards. Medium shards ranged in size from 5 cm to 10 cm at their longest length. The scale is 15 cm in length.



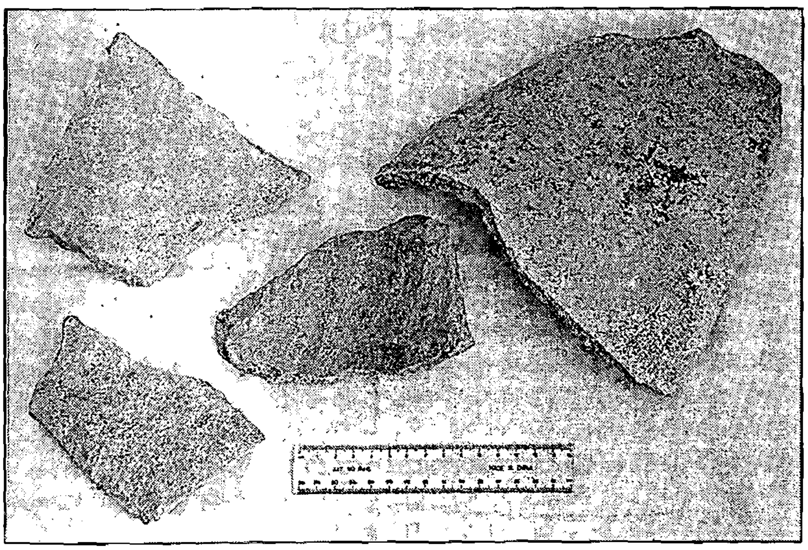


Figure 5.21 Photograph of a sample of large body shards. Large shards were those that had a longest length greater than 10 cm. The scale is 15 cm in length.

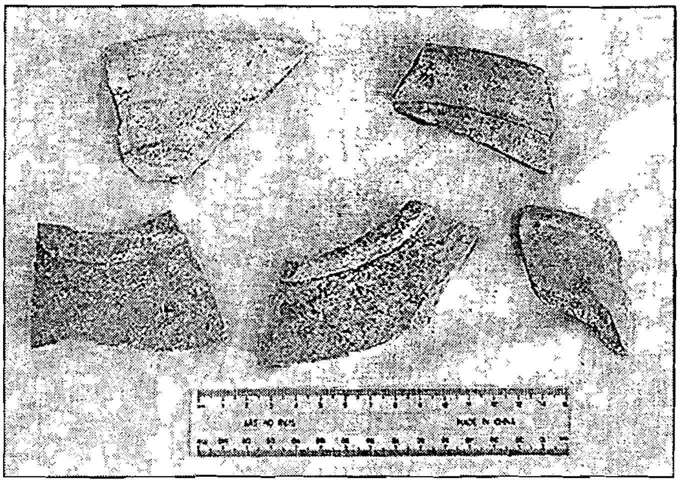
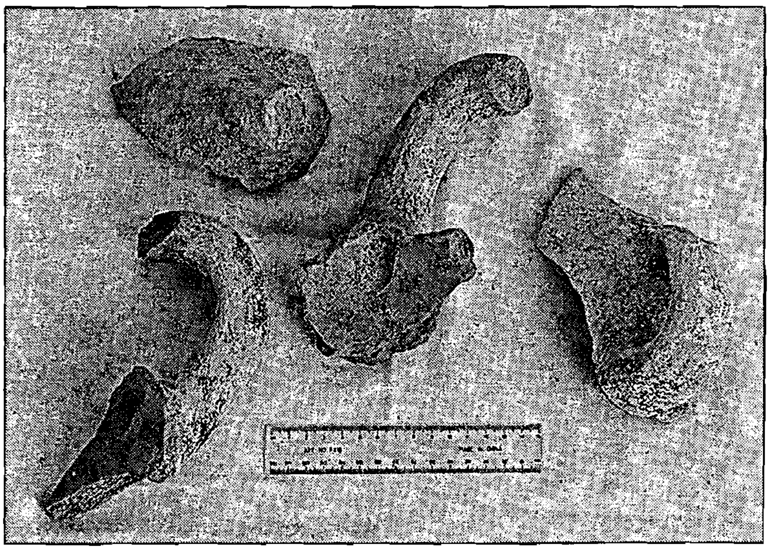


Figure 5.22 Photograph of a sample of medium rim shards. The scale is 15 cm in length.

Figure 5.23 Photograph of a selection of large handle shards. The scale is 15 cm in length.



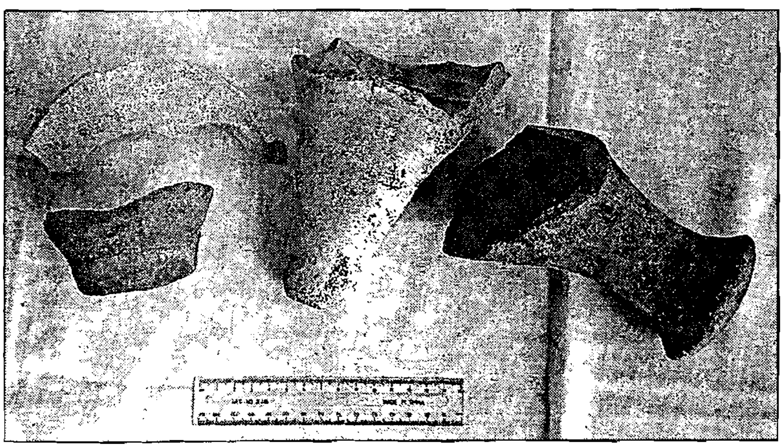


Figure 5.24 Photograph of a selection of large base shards. The scale is 15 cm in length.

5.3.4.1.1 Attic Ware.

During the sorting of the pottery shards, the quantity of Attic ware (ATC) was also recorded, by both count and weight (Figure 5.25). A total 295 pieces of Attic ware were located within 17 of the 26 loci.[11] The total weight of the Attic ware was 2.56 kg. The majority of the Attic wear was uncovered in squares AT12/13 and AU12/13, (86% by count and 82% by weight). The reduced amount of ATC material in AT11 coincides with the later phase of occupation represented in those deposits. L16427 had the most Attic shards by count and weight, however, the average weight per shard in this locus was among the lowest (8g/shard). This indicated that although ATC was well represented in L16427, it consisted mainly of very small shards. L16447, with only 6 shards, had the largest average weight per shard at 21g).

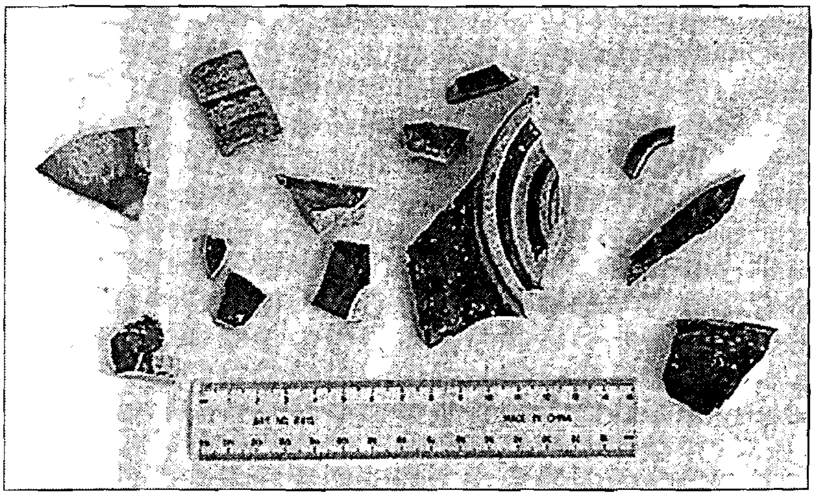


Figure 5.25 Photograph of a sample of Attic ware shards. The scale is 15 cm in length.

5.3.2.2 Bone.

All bone fragments were counted and weighed.[12] Across the site, there were 3,907 bone fragments with a total weight of 25.6 kg. The average weight per bone fragment was 6 grams. All loci, save three (L16434, L16449 and L16502), had fragments of bone in their matrix. The majority of the bones were very fragmentary, but complete bones were occasionally found (such as lower mandibles). The bones were not examined as to element nor species, but a cursory survey indicated that various bones of fish, birds, dogs, goats and sheep were present in quantity. The amount of bone by count in those loci where it was present ranged from 3 fragments in L16429 to 1,150 fragments in L16427. The quantity of bone by weight ranged from 4g in L16426 to 5,167g in L16411. The largest bone fragments were found in L16447,

[11] For a complete list of Attic Wear per locus, refer to Table C-5 in Appendix C.
[12] The data table for bone can be found in Table C-6 in Appendix C.

where they had an average weight of 37g each.

5.3.2.3 Shell.

Fragments of shell were collected and the number of shell bags for each locus was counted.[13] A total of 54 shell bags were recovered from 17 of the 26 loci. Each of the 5 loci in AU12/13 contained insufficient shell fragments to warrant a shell bag. The quantity of shell in each bag, although not individually counted, was quite variable and depended upon the amount of shell uncovered each day. As a consequence, the count of shell bags is merely an indicator of the presence of shell in that locus. The types of shell found consisted mainly of small bivalves that had a diameter of 2 - 3 cm. These bivalves are of a type consistent with local molluscs and similar shells can still be found on the surrounding beaches. Occasionally, there was also a few broken or crushed murex shells mixed in with the bivalves, most likely derived from the local murex dye installation.

5.3.2.4 Special Finds.

All special finds were individually collected, assigned separate basket numbers, identified, dated and counted.[13] Given the large area excavated for this study (13.723 m^3), relatively few special finds were uncovered, with a total of 77 found. Of the 26 loci, 11 had no special finds. The types of special finds that were uncovered included: glass fragments, bronze and iron nails, figurine fragments, and a series of eight faience beads (found in L16411).

The distributions of the types of finds across the excavated areas were in accordance with the dates assigned to the deposits during the pottery readings. The special finds from the loci in square AT11 were in agreement with the relatively late date assigned to the pottery shards during readings. Items such as stamped handles, lead and glass fragments that are associated with the later periods were not common prior to the Hellenistic period. Similarly, the special finds from the loci in squares AT12/13 and AU12/13 reflected an earlier phase noted in the pottery readings (i.e., Persian and Hellenistic). These loci had many figurine fragments, weaving tools, and bronze and iron objects.

There were 14 figurine and mask fragments found in AT12/13 and AU12/13. The figurine fragments primarily depicted horses (of the horse and rider motif) as well as human

[13] The data table for the distribution of shell and special finds across the loci can be found in Table C-7 in Appendix C.

heads, arms and legs. These figurine fragments were poorly made and displayed little evidence of religious symbolism. As a consequence, it is believed that most were likely the former pieces of small toys or other ornaments. Unlike the cultic figurine fragments found in an ash lined pit in the 1992 season of excavation in D1, the random distribution of the fragments across the 1997 loci does not indicate that this area had a cultic significance.

5.3.2.5 Earthen Material.

A total of 1,531 buckets of earth was removed from the site during excavation. Each bucket was estimated to weigh 12.5 kg, yielding a total weight of 19,189 kg of earthen material. Unlike the previous data, the analysis of the earthen material was based upon small samples drawn from selected loci. Not all loci were sampled, while some loci, due to their large size and depth, were sampled numerous times. A total of 42 samples, weighing between 250 and 500g, were extracted from 17 loci, plus an additional four samples were collected from external sources as comparative material.[14] The comparative samples were collected from a disintegrating mud brick wall dating to the Persian period (or possibly later), tabun clay, an Iron Age mudbrick (from area D2), and preserved raw potter's clay.

All of the earthen material samples were tested for colour, grain size (i.e. sand, silt and clay), carbon content and pH level. Due to cost, only a selection of the samples (i.e. 21 of the 46) could be tested for phosphorous. In the laboratory processes that identify these chemical and physical characteristics of the sediments (excluding colour and pH), very small samples (less than 1g) of the collected material are utilised. As a result, the potential for some variation and fluctuation in the results for these tests was expected.

The majority of the loci samples fell within the 10YR range on the Munsell Colour chart, and as a whole displayed little variation in colour. An interesting observation was made that the dry colour of the earth (that which was tested in the laboratory) resulted in the loss of the identifiable variation noted in the field. An example of this change can be noted in L16428. In the field this locus was identified as being distinctly different from the surrounding material due to its reddish soil colour. In the laboratory however, L16428 was found to have a brown (10YR 5/3) colour, which was very similar to the colour of the earth noted in L16427, that ranged from brown (10YR 5/3) to greyish brown (10YR 5/2), to light greyish brown (10YR 6/2).

[14] The data table for earthen material can be found in Table C-8 in Appendix C.

The average grain size for the site was 64% sand, 17% silt and 20% clay. These percentage ratios coincided very closely with the results of the degrading mud brick wall (63%, 13% and 25%). L16412, however, is notable for being quite different than the other sampled loci with a grain size distribution of 28% sand, 45% silt and 28% clay.

The averages of total carbon, organic carbon and inorganic carbon were 3.062%, 0.497% and 2.565% respectively. The range of total carbon went from a high of 5.406% in L16403 to a low of 1.807% in a sample from L16427. In all samples, the percentage of inorganic carbon exceeded that of organic carbon.. A large amount of variability was observed in the proportions of organic versus inorganic carbon, even between samples within the same locus. An example of this variability was seen in the samples from L16475, which ranged from 1.594% organic carbon to 0.065%. A explanation for this variation can be related to the presence of modern roots that extended through this locus. It is likely that small fragments of these plants could have become mixed with the earthen samples, artificially increasing the organic carbon concentration. This would also have an effect of the percentage of phosphorous, although not to the same extent.

For determination of total phosphorous content, 21 of the samples were tested. Of these 21 samples, three were from the comparative material (the mudbricky wall material, the Iron Age mudbrick, and the raw clay). The average level of phosphorous in the sampled loci was 0.473, with a range of 0.730% in L16412 to 0.300% in L16475.

The pH value across all samples was found to be slightly alkaline, ranging between 8.2 to 8.9. On average, the pH value for the entire site was calculated to be 8.4.

Throughout all of the samples, there was no relation or obvious trend in the data that related to the elevation. This lack of a relationship was found to be true for grain size, carbon content, pH and phosphorous content.

5.3.2.6 Conclusion based on the Results of Raw Data.

The division of the anthropogenic sediments into squares and loci is an artificial categorisation, as it does not reflect depositional events, but rather the excavation process. Anomalous results that may initially appear to be significant are often not systemically meaningful. For example, Table 5.2 indicates that AT12/13 represents 49% of the total volume of material excavated for the case study, yet 69% of the total pottery shards were located here. This indicates that the sedimentary material in this square was far richer in ceramics than is warranted by its volume. But because the square is an artificial designation imposed on the anthropogenic sediments, the value of this observation is nullified by the fact that AT12/13 contained a number of depositional units, all of which, or only one of which, may be responsible for the high levels of shards. The square is far too imprecise and artificial a unit to inform systemically. The locus level of analysis is also inadequate for systemic study as frequently it may only account for part of a depositional event.

In order to interpret systemic contexts accurately and systematically, data resulting from excavations must be compared and contrasted at a depositional unit level. To this end the following sub-section standardises locus-based data to a per cubic metre measure, and examines these findings to identify individual depositional units amongst and across all of the loci.

5.3.3 Identification of Depositional Units.

A depositional units (DU) is a unique sedimentary deposit that has been laid down or accumulated through a single anthropogenic (or natural) process. In the case of anthropogenic sediments, each unit represents a different systemic event and/or source. During the process of excavation, loci are often identified as a different depositional unit as they are created on the basis of differences in the sediments. Frequently, however, loci are created for purely technical reasons, and thus it is necessary to combine appropriate loci in order to identify individual depositional units.

During the excavation of the three squares, twelve depositional units were identified as being present.[15] In AT11, three units were described: a) the interior of the sewer installation, L16403; b) the sediments to the north of the sewer installation, L16418, L16422, L16423, L16426, L16429, L16430, and L16447; and c) the sediments to the south of the sewer installation, L16424, L16432, and L16448. In AT12/13, six units were defined: a) a pit, L16412; b) another pit, L16414; c) reddish coloured sediment, L16415; d) the majority of the anthropogenic sediments within the area, L16411, L16413, L16427, and L16435; e) the sediments resting on F16428, L16428 and L16434; and f) the sediment beneath F16428, L16468. In AU12/13, three units were identified: a) the material beneath W10946, L16449; b) the sediment above a charcoal line, L16464; and c) the loci below the charcoal line, L16475, L16502 and L16503. With the additional data that have been collected and manipulated for the systemic analyses of the depositional units, it is possible to check and refine the identification of

[15] Refer to sections 5.3.1.1 to 5.3.1.3 for the discussion of what loci were identified as being the 'same' as one another.

these units as understood at the time of excavation.[16]

5.3.3.1 Depositional Units in AT11.

The analysis of the extensive data that were collected on the contents and characteristics of the loci in this area indicated that the depositional units that had been identified during excavation were not accurate. It was found that rather than having one unit that consisted of all the material north of the sewer installation and another of all the material south of the sewer, these sedimentary deposits could be divided into two units based on a vertical rather than a horizontal relationship. All of the loci, north and south of the installation, which were equivalent to the base of the sewer and higher (L16418, L16422, L16423, L16424, L16426, L16429, L16430, and L16432), were found to belong to the same depositional unit, and the two loci that were lower than the base of the sewer (L16447 and L16448) to a different unit. The differentiation of the anthropogenic sediments into these depositional groupings was based largely on the shard distribution and size. L16447 and L16448 had fewer shards per m^3, with a range of 586 to 1296 shards/m^3, than the loci that overlaid them, which had a range of 1437 to 2812 shards/m^3. Proportionately, L16447 and L16448 were distinctive for their high frequency of medium shards relative to small shards (see Figure 5.26). These two loci also had much larger Attic ware shards than the other loci.

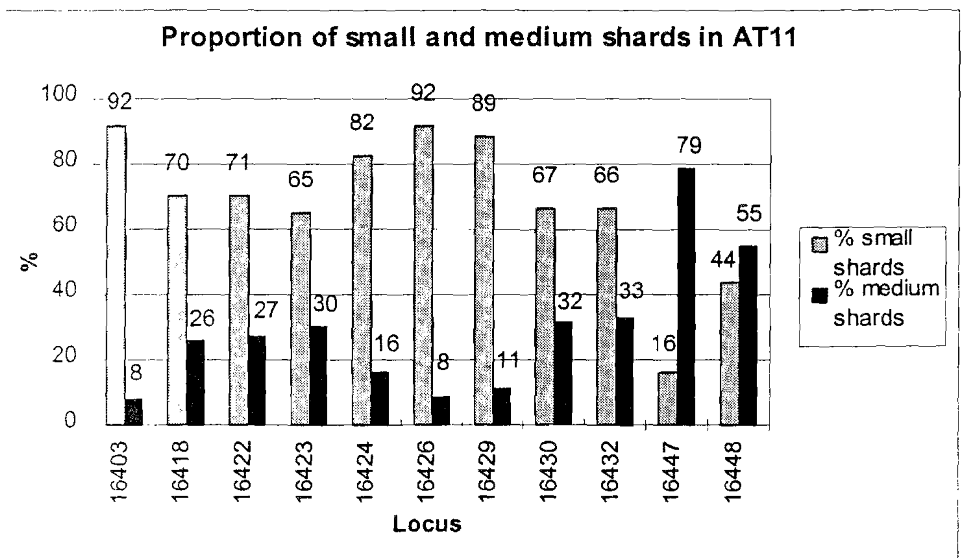


Figure 5.26 Proportion of small and medium shards in AT11.

[16] For the standardised data on which these analyses were based, refer to Tables D-1 to D-4 in Appendix D.

The detailed analyses of the contents of the loci in AT11 not only allowed for the identification of two, otherwise obscured depositional units, but also allowed for the confirmation of the identification of L16403 as a unique depositional unit. The pottery shards in L16403 were smaller in all size categories based on weight per shard. It had very few bone fragments per cubic meter, and had a very different grain size composition of its earthen material than the other loci in AT11 (with relatively high silt content and low clay and sand content).

5.3.3.2 Depositional Units in AT12/13.

The analyses of locus contents in this square re-affirmed some of the traditionally determined depositional units, while re-aligning others. Depositional units identified as a) L16412, b) L16428 and L16434, and c) L16468, remained intact as a number of variables identified them as unique entities. Some of the specific variables that confirmed these depositional units included: pH, % phosphorous, shard size distribution, grain size distribution and the quantity of bone and pottery shards per cubic meter. For the remaining loci, the detailed study of their contents revealed that there was need for a re-alignment of the depositional units. It was found that L16414 did not have any distinguishing characteristics to identify it as a pit; rather it was very similar to its surrounding loci. As well, the colours that helped to identify both L16414 and L16415 at the time of excavation were found to have been part of the mottled colour matrix of both L16415 and L16411. Due to these discoveries, these four loci were grouped as a single depositional unit. It was concluded that the physical concavity that helped to initially identify L16414 as a pit was most likely because of the different depositional material that lay beneath it relative to the rest of the depositional unit.

Although L16427 and L16435 were both described during excavation as being identical to the material which overlay them, having similar colours and textures, an examination of their content suggests that this may not be case. While for many of the variables, such as grains size, soil colour, Attic ware, and average shard weight, L16427 and L16435 are comparable to L16411, L16413, L16414 and L16415, the two lower loci had considerably more pottery shards than the others. In the case of L16435, it had almost three times the quantity of shards than the locus above it (L16411), primarily in the small shard size category. Due to this particular variable, it was thought that L16427 and L16435 should be grouped together and separately from the others.

5.3.3.3 Depositional Units in AU12/13.

In the analysis of material from the loci in this square, three depositional units were identified, with two of the three being re-aligned from the original determination. L16449 was confirmed to be a unique unit based on the larger shard sizes (within the small and medium size categories, according to average weight), the lower quantity of shards per cubic meter, and the absence of Attic ware. Although L16464 and L16475 were separated by a charcoal line in the baulk, analysis of the data found them both to have similar contents in all respects. These similarities ranged from the quantity of pottery shards, the weight of the shards, grain sizes of earthen material, and their pH. In contrast, L16502 and L16503 have more than two times the number of pottery shards as L16464 and L16475, and the shards themselves were significantly larger (see Figure 5.27). Thus L16475 and L16464 were considered as a belonging to a common depositional unit, and 16502 and 16503 to another.

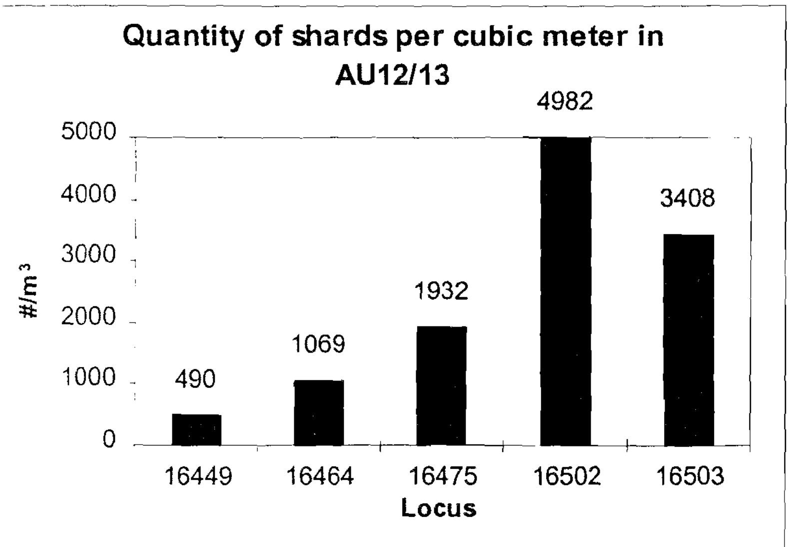


Figure 5.27 Quantity of shards in AU12/13.

5.3.3.4 Summary.

Through the above process, a total of eleven depositional units have been identified across the three excavation areas (see Table 5.4). In accordance to the frameworks presented in chapters two through four, these units are seen to represent different systemic events and/or systemic sources.

Square	Depositional Unit	Loci
AT11	A	L16403
	B	L16418, L16422, L16423, L16424, L16426, L16429, L16430, L16432
	C	L16447, L16448
AT12/13	J	L16412
	K	L16411, L16413, L16414, L16415
	L	L16427, L16435
	M	L16428, L16434
	N	L16468
AU12/13	S	L16449
	T	L16464, L16475
	U	L16502, L16503

Table 5. 4 Identification of Depositional Units for Systemic Analysis.

It should be noted at this time that although chronologically contemporary, the loci in squares AT12/13 and AU12/13 were not considered to be possible members of the same depositional units because of the physical separation (W5040 and one metre in height) between the squares. A number of similarities, however, were observed between the lower loci in AU12/13 and the upper loci in AT12/13, suggesting that they may have had similar origins.

With the identification of individual depositional units complete, it is possible to create Harris Matrices, which display the chronological sequence of depositional events (see Figures 5.28 to 5.30). In all of the cases, the separation of the blocks representing loci, walls and other features, and depositional units onto different levels indicates the physical sequences of the act of deposition, while for the purposes of archaeological interpretation they may be considered contemporaneous. The small number on the right of the affected blocks identifies this contemporaniety.

With this basic assessment and evaluation of the archaeological results complete, it is now possible to begin an examination of the systemic contexts, which caused the creation of the depositional units. The following section centres on the nature of these depositional units and the types of systemic information that they can provide about the past at Tel Dor.

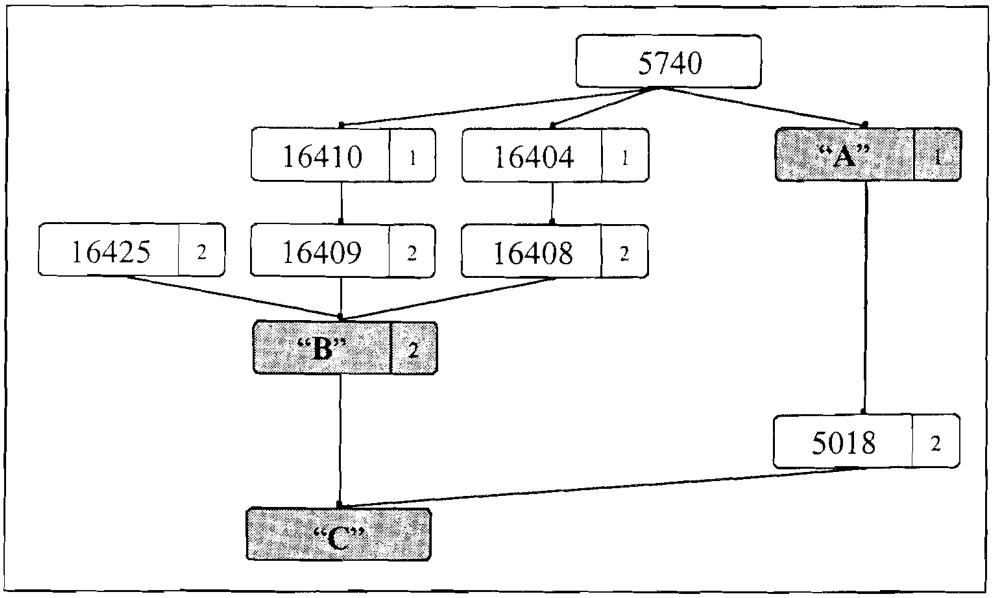


Figure 5.28 Harris Matrix for AT11. The shaded squares are the depositional units identified in the case study.

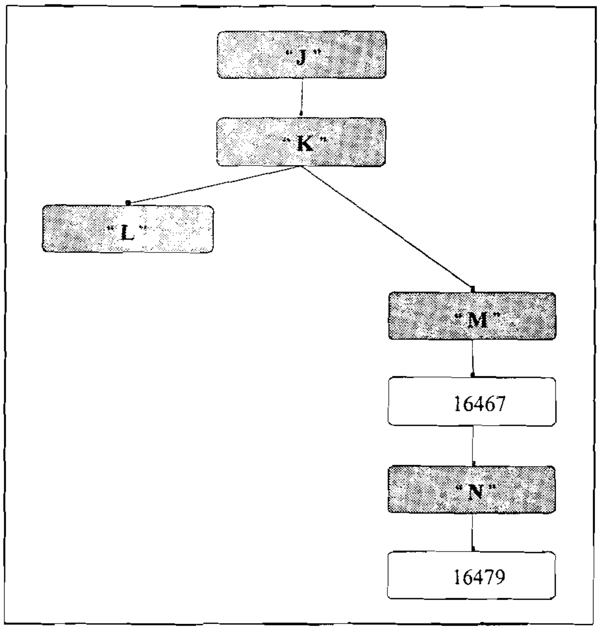


Figure 5.29 Harris Matrix for AT12/13. The shaded blocks indicate the depositional units studied.

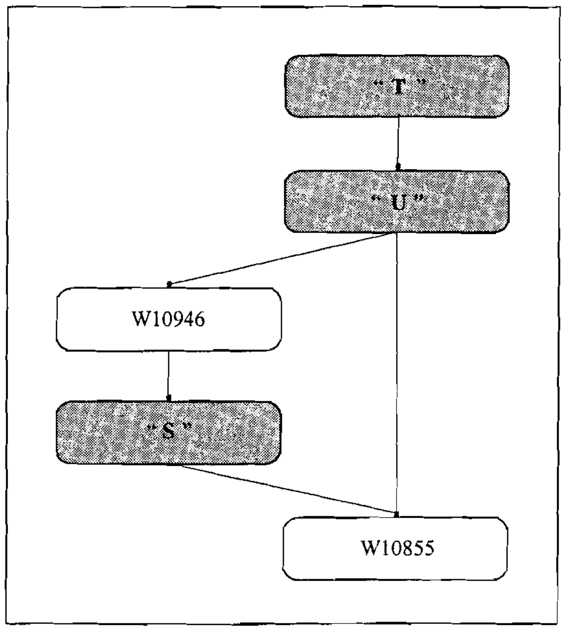


Figure 5.30 Harris Matrix for AU12/13. The shaded blocks indicate the depositional units studied.

5.4 Analysis of Depositional Units.

As with the discussion of the general excavation results, the study of the depositional units must begin with an examination of the basic characteristics of these unique deposits. Table 5.5 presents the combined data findings for a variety of variables across each depositional unit, and Figure 5.31 provides a graphic comparison across units for the average weight per shard (by size category and for Attic Ware) and bone fragment. These two data presentations reveal a number of similarities and differences across the units from which informative observations can be drawn.

Initially, it is important to note that the pH levels among the depositional units all fall within the "moderately alkaline" category identified in section 4.2.2, ranging from 8.4 to 8.8. This moderate alkalinity of the sedimentary matrix suggests that the conditions for good bone preservation are present and that the phosphorous recorded in the soil is most likely fixed in a highly insoluble state. The uniformity of the pH across the depositional units indicates that a consistency of preservation can be expected, and any observed differences between the depositional units are not due to differential preservation.

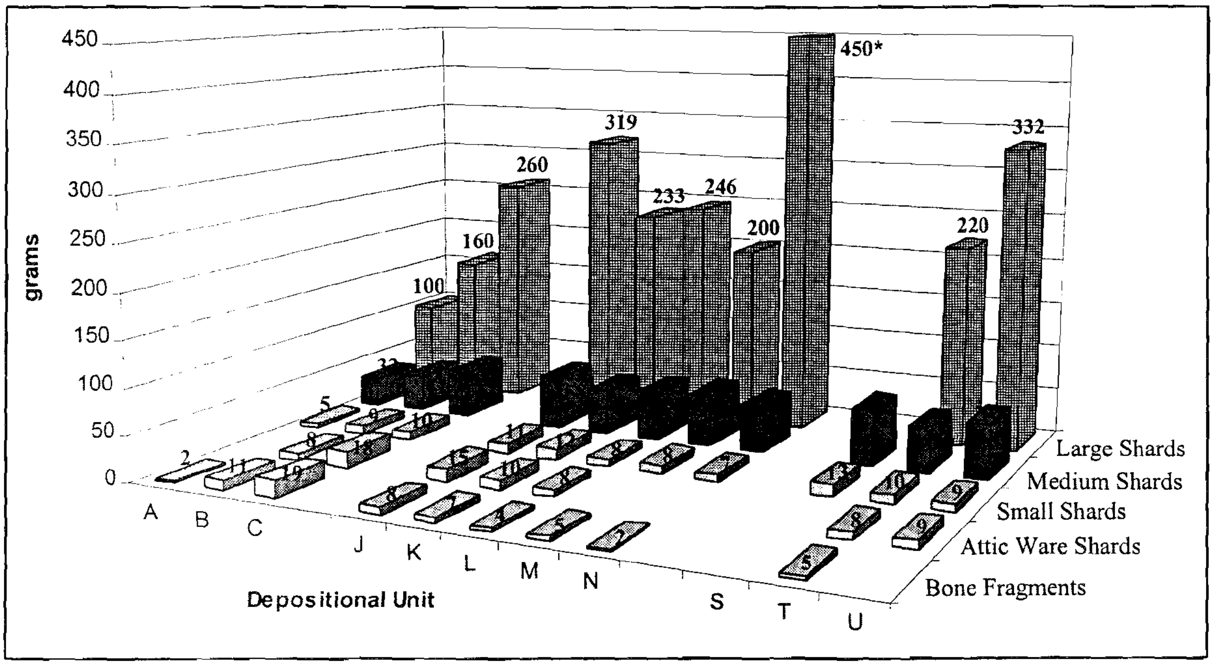


Figure 5.31 Average weight of bone fragments and small, medium and large shards for each depositional unit. *The value of 450 grams for large shards in depositional unit 'N' is due to the discovery of a single very large shard in this unit. It is possible that this large shard may have been deposited to serve the same function as the large stones of L16479, which form the foundation of F16428.

An examination of the quantity of bone fragments and different shard sizes by both weight and count across the various depositional units as well as the distribution of Attic ware yielded some very interesting comparative findings. These results, along with the data collected from the earthen material provided a very accurate means of evaluating and classifying the

			Depositional Units										
			A	B	C	J	K	L	M	N	S*	T	U
Volume		m^3	0.3605	1.9176	0.7131	0.2688	2.7734	3.4800	0.1120	0.0828	0.0510	3.7449	0.2191
Shards	*small*	#/m^3	2042	1489	309	2496	1574	4192	2955	3285	235	1189	3062
		kg/m^3	9.40	13.15	3.05	27.14	19.06	33.56	23.05	24.34	3.03	11.81	27.23
	medium	#/m^3	178	502	572	1667	874	1037	464	338	255	419	922
		kg/m^3	5.78	20.84	30.18	95.86	43.45	54.50	26.00	17.15	15.47	20.40	54.31
	large	#/m^3	8	35	28	246	89	62	36	12	0	37	32
		kg/m^3	0.83	5.59	7.30	78.40	20.65	15.39	7.16	5.44	n/a	8.17	10.61
	total	#/m^3	2228	2026	909	4409	2537	5291	3455	3635	490	1645	4016
		kg/m^3	16.02	39.59	40.53	201.40	83.16	103.45	56.21	46.92	18.50	40.37	92.15
	atc	#/m^3	0	16	15	4	17	35	0	0	0	21	32
		kg/m^3	n/a	0.252	0.201	0.015	0.463	0.946	n/a	n/a	n/a	0.166	0.297
	periods present		RM	RM, HL, PR	HL, PR	PR	EHL, PR, IA	PR, IA	PR	PR, IA	PR	EHL, PR	PR
Bone		#/m^3	119	180	119	1075	357	440	134	386	0	146	137
		kg/m^3	0.214	1.955	2.209	8.78	2.334	1.777	0.67	0.785	n/a	0.769	0.73
Earth	*pH*		8.5	8.4	n/a	8.4	8.4	8.4	8.8	8.8	n/a	8.4	n/a
	sand	%	64	69	n/a	28	66	64	68	64	n/a	63	n/a
	silt	%	20	16	n/a	45	16	16	14	16	n/a	17	n/a
	clay	%	17	16	n/a	28	20	21	19	20	n/a	21	n/a
	phosphorous	%	0.410	0.510	n/a	0.730	0.483	0.460	0.340	0.310	n/a	0.465	n/a
	org. carbon	%	0.463	0.179	n/a	0.806	0.544	0.575	0.061	0.093	n/a	0.710	n/a
	inorg. carbon	%	4.819	3.063	n/a	2.257	2.489	2.300	1.806	2.316	n/a	2.349	n/a
	total carbon	%	5.282	3.242	n/a	3.063	3.033	2.875	1.867	2.409	n/a	3.059	n/a

Table 5.5 The constituent characteristics of the depositional units. Pottery shards are identified by their size, as quantified by both count and weight per cubic metre, the quantity of attic ware (atc) by count and weight per cubic metre, and the representative periods (RM - Roman, HL - Hellenistic, EHL - Early Hellenistic, PR - Persian, IR - Iron Age). Bone is quantified by both count and weight per cubic metre. The earthen material data is provided for those depositional units from which samples were take. The measures of sand, silt and clay are proportions which cumulatively add to 100. The measures for phosphorous and carbon are proportions of the whole, but as not all chemical elements were tested, they do not add to 100. The total carbon is the sum of organic carbon and inorganic carbon.

* Depositional unit 'S' consists of a single excavation locus, where only 25 pottery shards were recovered. Because of this very small sample, the representativeness of the components of 'S', as reflective of an entire depositional unit, may be skewed.

different depositional unit.[17]

5.4.1 Classification of the Depositional Units.

At this point of the analysis, it is important to note that the accuracy and reliability of classifying depositional units is greatly influenced by the quality and quantity of data that are available. At no point can a class of deposits be identified on the basis of a single attribute or variable. It is only when many of the defining attributes are examined in combination, with the discovery of the repeated appearance of anomalies, that deposits can be properly classified. Due to the inherent randomness and variability that is associated with material that has been created by people, the process of classification is conducted in a fluid and comparative manner, rather than with a rigid pass/fail assessment.

Through the collective examination of data for the depositional units, three distinct groupings based on the similarity / dissimilarity of characteristics emerged. Depositional units 'A' and 'J' appeared to be quite distinct from the others, in fact almost exact opposites to each other. Depositional unit 'J' (du-J) was found to be characterised by the presence of relatively larger pottery shards than the others. Du-J had proportionately many more medium and large shards, and the shards within each size category tended to be heavier (thus larger) than the other depositional units. The total amount of bone fragments in du-J was more than twice that of any other depositional unit and its percentages of phosphorous and organic carbon were also found to be very high (see Table 5.5). Indeed, the level of phosphorous in du-J exceeds those of pit fills studied at Be'er Sheba, which were identified as having been used for the disposal of organic town wastes during the Persian Period (Goffer *et. al.* 1983:234). The grain size results for du-J were also very distinctive as it had less than half the proportion of sand size particles and more than twice the amount of silt. These data findings from du-J, in addition to the observations made during excavation (see section 5.3.2), display all of the traditional characteristics of pit deposits outlined in section 3.3.2. This observation, along with the

[17] A preliminary examination of the depositional units by shard forms and shape by both count and weight (found in Appendix E) revealed little differentiation between the depositional units. The correlation between all of the units was quite high, with a minimum correlation coefficient of 0.985 between units 'C' and 'S' by count and a minimum correlation coefficient of 0.909 between units 'A' and 'S' by weight. The correlation of shards by shape (regular versus irregular) across depositional units also was found to be very high. For these reasons, the classifications of shard form and shape were not considered as variables for discussing the defining characteristics of the depositional units.

apparent lack of complete or restorable pots within the matrix, lead to the identification of du-J, as a 'Pit Tertiary Anthropogenic Sediment'.

The characteristics of depositional unit 'A' (du-A) are almost a complete contrast to those of du-J. This unit has a very high proportion of small shards, and the average weights (thus sizes) of shards in the different size categories are much lower than the other depositional units. As well, du-A has a relatively small quantity of bone fragments, which are themselves very tiny. While the percentage of phosphorous for this unit is comparable to most of the other units, its very high proportion of inorganic carbon make du-A quite anomalous. These attributes coincide very closely with the description of sewer sediments discussed in section 3.3.3, and support the designation of these sediments as being 'Sewer Tertiary Anthropogenic Sediments'.

The remaining depositional units do not display any significant levels of variation among them that would warrant further distinctions into functional groupings. These units have moderate levels of organic elements and moderately sized artefact and bone fragments. Additionally, although the units display a degree of variability across their various attributes, there are no apparent patterns of consistency. These findings, along with the described associations with the other architectural features uncovered during excavation, suggest that these remaining depositional units are 'Constructional Tertiary Anthropogenic Sediments' (CTAS). The small pottery shards and bone fragments found in depositional unit 'N' (du-N), however, suggest a further sub-classification of this CTAS. The position of du-N between the uneven rocky matrix of L16479 and the plastered surface (F16428) indicated that its functional role in association with these features was to act as a leveller, and thus warrant the classification of 'Levelling Constructional Tertiary Anthropogenic Sediment' (LCTAS).

5.4.1.1 Ternary Analysis.

To explore more fully the relationships between and across the depositional units, ternary diagrams were created for four categorisations of the units (see Figure 5.32). By studying these ternary diagrams, visual patterns emerge from the data. The most obvious of these patterns is the consistent contrast between du-A and du-J. Almost always these two units tend to be positioned at opposite extremes of one another. In diagrams A and B, du-A is at the extreme small end of the data cloud and du-J at the extreme large end of the data cloud. In diagram D, du-J is separated from the others toward both organic carbon and phosphorous, while du-A is furthest from phosphorous and on the extreme edge of the data cloud toward inorganic carbon. The distinctiveness of du-J is seen best in diagram C. This diagram shows that du-A is comparable to the other depositional units with regard to grain size, but even there it is higher than the other units on the silt scale.

The remaining depositional units, which were identified as CTAS, tend to be grouped in various combinations between du-A and du-J. Similar to the observations noted in the tabular data discussed in section 5.4.1 above, the four trinomial diagrams show that the CTAS units have attributes that form no consistent pattern across component comparisons. An interesting grouping of the CTAS units, however, is observed in diagram D of Figure 5.32, where depositional units 'K', 'L', and 'T' form a distinct cluster. On close inspection of the other ternary diagrams this association continues, and is particularly apparent in diagram B. This association will be discussed further in section 5.5.1.

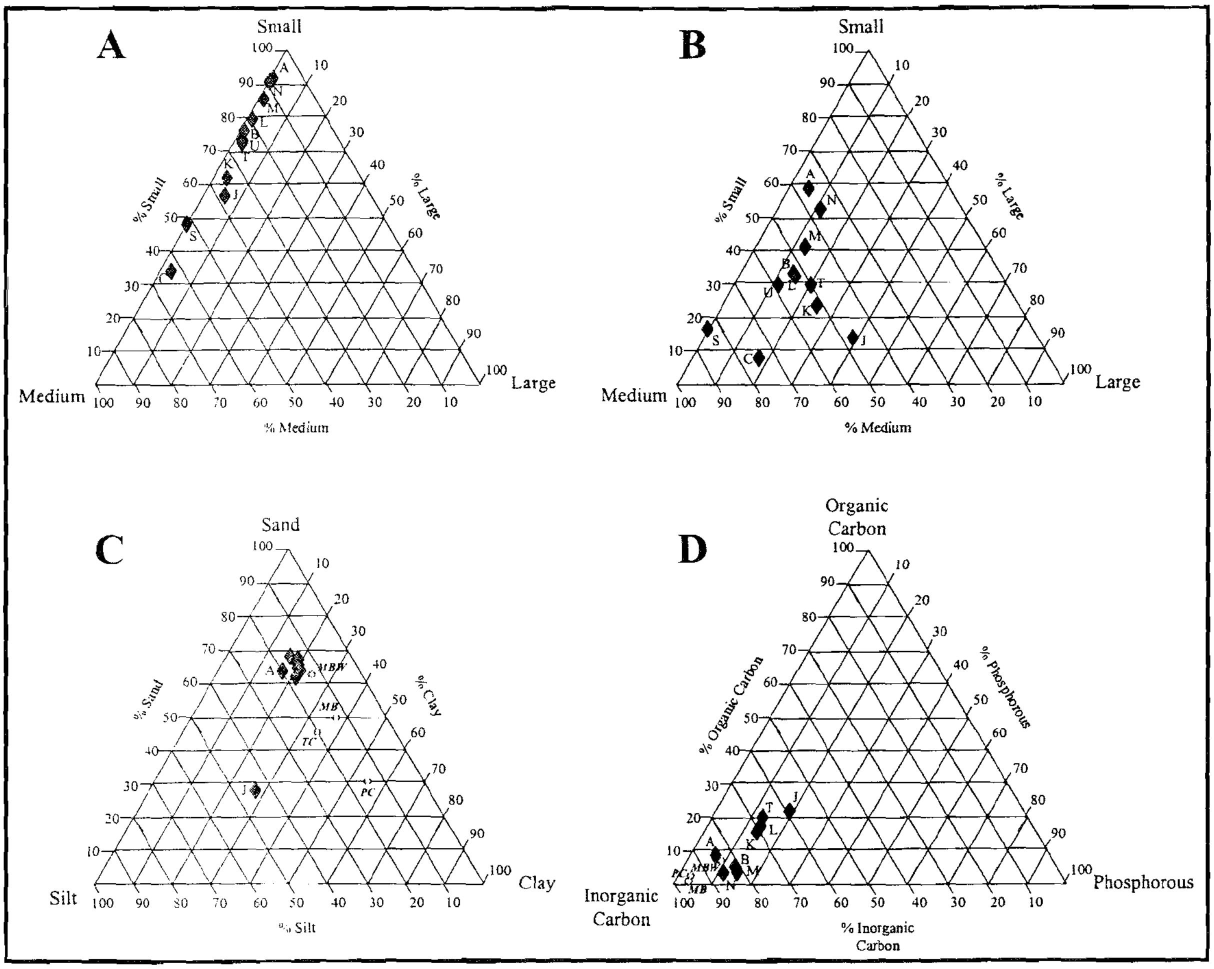


Figure 5.32 Trinomial Diagrams of the distribution of shard sizes by count (A) and weight (B), and of the distribution of grain size (C) and chemical composition (D) of the earthen component of the anthropogenic sediments. In diagrams C and D, the data for the comparative material is included – Potter's Clay (*PC*), Tabun Clay (*TC*), Iron Age Mudbrick (*MB*), and degraded Persian-Hellenistic Mudbrick-like material (*MBW*). The chemical data in diagram D represents the proportion of the combined total content of organic carbon, inorganic carbon and phosphorous found in the tested samples, and does not imply that these were the only three elements to be identified in the sediments.

5.4.1.2 Correspondence Analysis.

In order to explore further the relationships and disparities between the depositional units, correspondence analysis (CA) was applied to a variety of unit attributes. As CA facilitates an examination of many variables at the same time, it was deemed an important investigative tool to enhance the understanding gleaned from the previously described tabular and ternary analyses, as well as to add another approach to the comparative process. A number of CA's were conducted, with the most informative findings being revealed for weight of bone and pottery shards by size (Figure 5.33), grain size and chemical analysis (Figure 5.34), and count of pottery shards by form (Figure 5.35).[18] It is important to note that in all three displays, the multi-dimensional relationships that are presented on 2-dimensional planes, each account for over 90% completeness along their respective two axes. Indeed, in Figure 5.34, the cumulative inertia of the two axes is 98.1% with the primary axis accounting for 93.2% of the total inertia. This finding is important for interpreting the diagrams, as the higher the profile completeness and the percentage of any one axis, the greater the validity of the data elements' positioning.

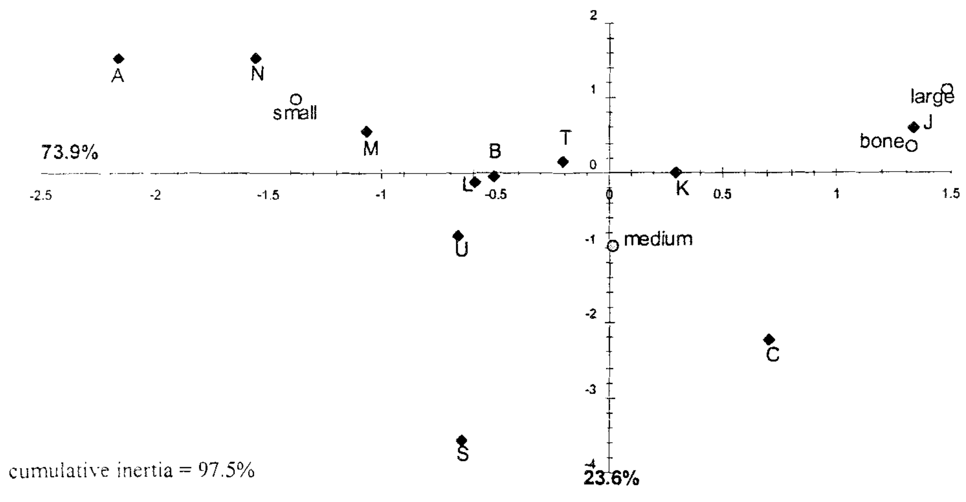


Figure 5.33 Correspondence analysis of depositional units and bone and pottery shards quantified by weight.

In Figure 5.33, the association of shard size and bone categories by depositional units displays a similar pattern to that identified in the ternary analysis. The sewer and pit sediments (du-A and du-J respectively) are found to be at opposite ends of the depositional unit's profile

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[18] The contingency tables for these correspondence analyses can be found in Appendix F.

along the first component, while all the remaining sediments fall somewhere between these two extremes. The grouping of depositional units 'K', 'L' and 'T' is also observed in this analysis, with the inclusion of du-B into the mix. The attribute profile of the shard sizes is very similar to the depositional unit's profile and shows again the strong correlation of du-A with small shards and du-J with large shards. The addition of bone data to the profile indicates the close correlation between the presence of large shards and the presence of bone fragments in anthropogenic sediments. This finding concurs with the expectations outlined in chapter three, where large fragments of pottery shards and bones were seen as being reflective of a short-lived, intentional discard of domestic refuse.

The parabolic configuration of the points in this two-dimensional representation Figure 5.33 indicates a high association between the two discrete variables (i.e. depositional units and weight per cubic metre of shard sizes and bone). This pattern indicates that there is a diagonal band of association between the rows and columns of the data table for these variables (Greenacre 1984:257-258). This relationship between depositional units and quantity of bone fragments and different shard sizes supports the interpretation that there is a level of variation within the different anthropogenic sediments that can be best described in relation to itself, and not via methods that set rigid and discreet criteria for analysis.

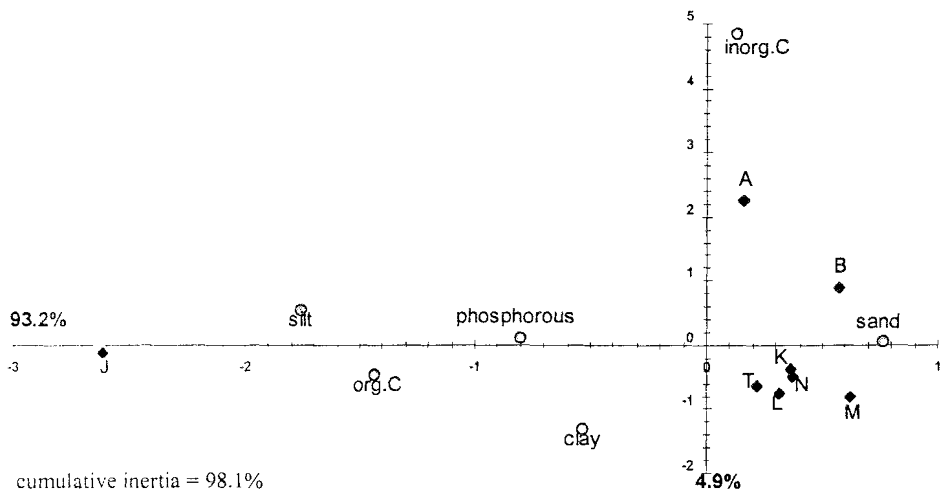

Figure 5.34 Correspondence analysis of depositional units and grain size and chemical analysis.

The correspondence analysis of earthen material by depositional units in Figure 5.34, shows that the unit relationships observed above continue. Within the depositional unit profile, du-A and du-J remain unique, while the other units tend to cluster between them. The association between the organic components (organic carbon and phosphorous) with the smaller grain sizes is an interesting finding. The correspondence between these profiles enhances the interpretation of the relationships between the physical and chemical properties of the earthen material and the depositional units. The correspondence between the depositional units identified as CTAS with sand and the lack of strong correspondence with a specific chemical component reflects their 'moderate' or 'average' nature. The association of inorganic carbon and du-A with the second component indicates the level of distinctiveness of these variables within their respective profiles, and provides a much clearer connection between these two points than that found through ternary analysis.

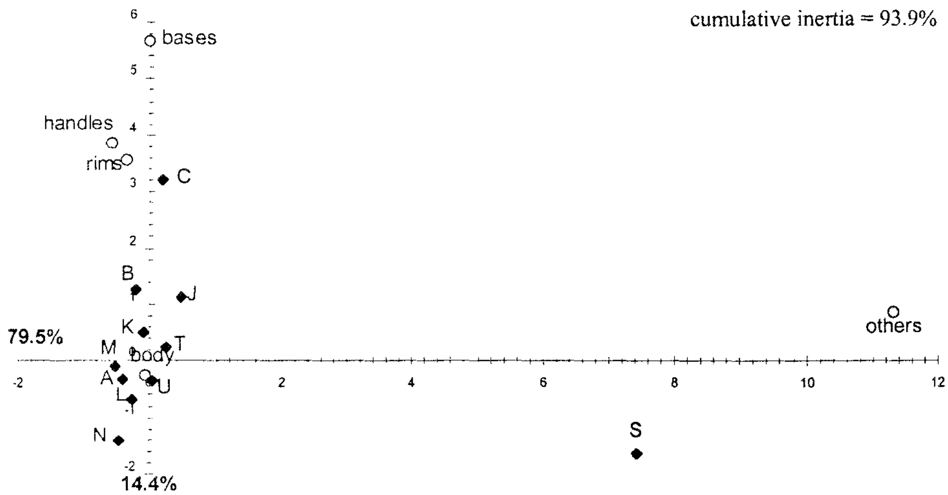

Figure 5.35 Correspondence analysis of depositional units and shard form quantified by count.

To this point little has been said about the nature of shard form as related to the analysis of depositional units. As explained at the beginning of section 5.4, there were no apparent data to indicate differential disposal across units of broken shards on the basis of their form. In order to explore this phenomenon further, a CA was run against the data. Figure 5.35 provides a visual display of the findings. Unlike the relationships revealed in Figures 5.33 and 5.34, this CA display showed a concentrated clustering of points around the centroid of the primary axis with a few outliers. This finding confirms the uniformity among depositional units according to this attribute, and reflects the exceptional number of these types of body shards found during excavation. The only exceptions to this clustering phenomenon are for du-S (in the depositional profile) and 'other' for the shard form profile. As noted in Table 5.5, the sample of material from du-S was thought to have been anomalous because of its small volume. The supposition is confirmed by its outlier status in this CA.

5.4.1.3 Summary.

The different types of analyses applied to the depositional units in this section have revealed a number of informative associations that can now be used to facilitate a discussion of the systemic contexts of the anthropogenic sediments. It was concluded and confirmed that the contents and characteristics of du-A conform with those of Sewer Tertiary Anthropogenic Sediments (STAS), du-J with those of Pit Tertiary Anthropogenic Sediments (PTAS), and all other depositional units with those of Constructional Tertiary Anthropogenic Sediments (CTAS).

5.5 Systemic Interpretations of the Depositional Units.

By combining the information gained through the detailed analysis of anthropogenic sediments with the physical manifestation of the deposits in their archaeological context, it is possible to acquire knowledge about various systemic processes. The two main systemic contexts that the detailed analyses and the excavation results clarify are: 1) the systemic processes that resulted in the deposits as found during excavation (to be known as systemic context I); and 2) the nature of the activities that took place in the immediate vicinity of the sedimentary deposit, prior to and/or at the time of deposition (known as the systemic context II). On the basis of the information collected in the 1997 field season at Tel Dor, the following sections discuss the interpretations that can be put forth about the selected D1 area of the ancient city of Dor.

5.5.1 Systemic Context I.

At least five different phases of construction and/or use are represented in the units studied from D1. The sediments from AT11, that is those associated with the sewer feature, represent two separate events, and the remaining depositional units from AT12/13 and AU12/13 represent at least three other events.

In AT11 the systemic processes associated with the deposition of depositional units 'A', 'B', and 'C' are straightforward. The manner of construction of the sewer system involved two distinctly different anthropogenic sediments. The first of these, du-C, was laid down to form a strong base on which the sewer (L5018) could be built. Once this deposit was laid, the construction of the stone walls and base of the sewer was undertaken. This was followed by the deposition of the second anthropogenic sediment, du-B, which originated from a different source than that of du-C. The distinction between these two deposits was identified on the basis of differences in shard and bone sizes and the quantity of artefact material. The source material for du-B was later in origin due to the presence of Roman shards in its matrix. Based on the periods identified in the anthropogenic sediments associated with the construction of the sewer (see Table 5.5), its date of construction seems to have been early in the Roman period. The process of the construction of this feature did not involve the creation of any kind of foundation trench and thus conforms to the standing foundation construction process. Building of this feature appears to have been associated with the reconstruction of the southern wall of the *ateleo* building (W5035), which occurred during the Roman period as well.[19] This association may well explain the source of the anthropogenic sediments of du-B. The similarities between du-B and some of the depositional units inside the foundation walls of the *ateleo* building (specifically depositional units 'K', 'L', and 'T') are striking (refer to Table 5.5 and Figures 5.33 through 5.35). This similarity might be explained by suggesting that some of the sediments dug up when W5035 was undergoing renovation became incorporated into the foundation of the sewer L5018.

The material recovered from inside the sewer, du-A, suggests that this feature was not only built in the Roman period, but that it also went into disuse in this period as well. The deposition of du-A was the result of sediments that continued to accumulate while the sewer was in use. As it became clogged with debris that dated exclusively from the Roman period, it can be assumed that its use and ultimate abandonment must have occurred in this period. In order to further explore the nature of this abandonment, however, it would be necessary to study the anthropogenic sediments associated with the Roman occupation, such as in square AS12/13 where the remains of a Roman structure associated with small drains leading into sewer L5018 were uncovered.

In squares AT12/13 and AU12/13, the anthropogenic sediments studied collectively provide interesting insight into the processes associated with the development of this area. As first mentioned in section 5.4.1.1, depositional units 'K', 'L', and 'T' show a remarkable degree of similarity across all attribute features, suggesting that they may be samples of a single, large depositional event. This conclusion ties the systemic events that occurred in these two rooms of the *ateleo* building together, even though they are physically separated by a large wall (W5040). The positioning of these deposits as part of the foundation structure of the *ateleo* building's

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[19] The identification of the reconstruction of W5035 during the Roman period was made during the 1996 field season.

foundation walls indicates that they were deposited during the construction process. Other observations about the features in these squares also have yielded useful information about the events that led to the construction of the foundation walls for the *ateleo* building. The first of these is that W16123 and W10078 were found to have been constructed on material that closely resembled the anthropogenic sediments of du-K, du-L and du-T. The second interesting observation about these features is the fact that W5040 appears to be older than the other foundation walls. In the 1992 field season, this wall was found to be in association with features that were identified as belonging to the Early Persian period or Late Iron Age.[20] As well, during the 1997 excavations the bottom of this wall was not reached, which suggests that its depth is far greater than that of the other foundation walls. The final observation about the nature of the foundation walls is that there is no foundation trench associated with any of them. From these details a systemic scenario can be inferred about the construction process of *ateleo* building. To begin, a structure (or structures) of some sort existed on that spot that included W5040. The majority of this area was dismantled and/or cleared in the first part of the Early Hellenistic period[21], with some earlier materials being left behind (such as: du-N, du-M, du-U and du-S, L10836, F10853, W10946, W10855, and F16428). This area was levelled with a layer of constructional tertiary anthropogenic sediment upon which walls W16123 and W10078 (minimally) were built. The construction of these foundation walls was done in a similar style to W5040, which suggests that there was not a long period of time between the two construction events. In this process, one of the large ashlars was abandoned in the centre of the 'room' (located in AT12/13). The resulting space between the standing foundation walls was then filled in to the floor level of the building with a similar constructional tertiary anthropogenic sediment as that used in the initial levelling process. Following these events, it would then have been possible to complete the construction of the superstructure of the building.

At some point, soon after the construction of the building, a pit was dug (du-J) into the constructional fill that supported the foundation walls. This pit was filled with refuse, which although appearing to contain an identically dated assemblage of artefacts to that found in the constructional tertiary anthropogenic sediment into which it was dug, the anthropogenic sediment found within the pit must have originated from a different source. The nature and

[20] These features from square AU12, included a tabun (L10836) and a floor (F10853).

[21] This date was identified due to the presence of Early Hellenistic shards in the artefact assemblage du-K and du-T.

timing of the systemic event associated with the pit is unclear. Although the pottery assemblage in the deposit contained exclusively Persian shards, because it cut into anthropogenic sediments that were deposited no earlier than the Early Hellenistic, it could not have been created earlier than the Hellenistic Period. For further elucidation of these systemic events affiliated with the creation of the pit, the excavation data from the 1992, 1993 and 1995 seasons would have to be analysed, as it was in these seasons that the material (walls, floors, etc.) that overlaid du-K was removed.

It is not possible to directly relate the other depositional units identified in these two squares to one another or to specific systemic events. In AU12/13, du-S predates all other studied deposits in the square because of its position beneath a wall (W10946), which itself, pre-dates the deposition of du-T and du-U. Similarly, du-U is in association with a feature (the plaster mound, L16025), which pre-dates du-T. Consequently, both du-S and du-U predate the construction of the foundation for the *ateleo* structure, and are related instead to earlier systemic processes. The date of the pottery assemblages in these deposits indicates that this area was under development and in use as late as the Persian period, prior to the large construction project that took place in the Early Hellenistic period.

Similarly, in AT12/13 du-M and du-N pre-date the construction of the foundational substructure of the *ateleo* building. The presence of F16428 is similar to that of F16431 in square AU12, and the association of its underlying substructure (L16479) to W5040[22], indicates that these materials were part of the residual debris from the clearing of the area prior to construction that was left in place. Although du-N is believed to have been a levelling fill, the exact functional nature of this area is difficult to ascertain without expanded excavation at this level. These deposits are thought to date to the Early Persian period.[23]

In summary, the anthropogenic sediments within AT11 were found to represent two systemic events/processes, the construction of the sewer in the Early Roman period (du-B and du-C), and the abandonment of the area, also in to Roman period (du-A). The anthropogenic sediments from AT12/13 and AU12/13 revealed at least three systemic events/processes: 1) the activities associated with area prior to the construction of the *ateleo* building, dating to the early Persian period (du-M, du-N, du-S and du-U); 2) the construction of the foundation walls for the *ateleo* structure in the Early Hellenistic period (du-K, du-L and du-T); and 3) the creation of a

[22] This association is similar to the association of F10853 in square AU12 to W5040.

[23] These data were arrived at by the lack of Attic ware in the shard assemblages and the higher concentration of Iron Age shards.

refuse pit (du-J) also in the Early Hellenistic.

5.5.2 Systemic Context II.

Tertiary anthropogenic sediments are the accumulated result of various bits of intentionally and unintentionally deposited debris and rubbish. As a consequence these deposits can reflect the nature of the activities that caused their creation. In this way they record the economic, social and domestic activities of the local community within the larger city, prior to being buried, usually as constructional deposits.

The most striking feature of the CTAS from the four chronological phases represented in this study is their similarity. This homogeneity is reflected in the nature of the sedimentary matrix and the grain size of the earthen materials, as well as in the continuity of shard types. The consistency of particle size across the nine depositional units identified as CTAS suggests a consistency of building material throughout all of the chronological phases represented by the deposits. This supports the notion that the CTAS is the degradation of mudbricks which create the majority of the earthen material on tel sites. It is noted that the material studied from Tel Dor may not display a direct relationship between the grain sizes of CTAS and that of the comparative constructional material (as seen in Figure 3.32C), as might be expected, but it is important to recall that CTAS has undergone an extensive process of degradation and mixing that unaltered constructional materials have not. Figure 3.32C shows that the CTAS cluster is most closely related to the degraded Persian-Hellenistic mudbricky material (MBW), followed by the sample from an Iron Age mudbrick (MB), with the tabun and potter's clay samples being quite different. The disparity in grain sizes between the clays and the CTAS indicates that these two sedimentary sources did not contribute significantly to the formation of depositional units. The reason that the CTAS deposits are distinctive from the MBW and MB samples can be attributed to the natural and cultural processes that occurred during degradation, such as the addition of airborne sands blown in from the nearby beaches, and the not inconsequential addition of sediments unintentionally brought to the site by animals and on the clothing and footwear of people from outside the city. These two occurrences would cause an increase in the sand content of these deposits. The MBW is more closely aligned to the CTAS because it has undergone some of the processes of degradation, but not enough to have resulted in total decay. The MB sample has not undergone any degradation, and thus has not incorporated extraneous sedimentary elements from the natural environment. The degree of uniformity within the proportion of grain sizes of the CTAS provides a strong indication that the creation processes associated with their development remained consistent for over four hundred years.

The results from the analyses of the entire sedimentary matrix of the constructional tertiary anthropogenic sediments indicate that not only had the materials of construction remained the same over this period, but so had the style. There was no differential presence of quantities of stone chips in the sediments to indicate any extensive or increased use of stone in the construction of the superstructure of buildings. Instead, we see a further continuity of the use of mudbrick for superstructure wall construction. As well, there was no major differentiation between depositional units on the basis of regularly versus irregularly shaped shards. Indeed, the proportions for these two shard shapes were very consistent for all types of anthropogenic sediments (sewer, pit and construction). Thus, the presence of pottery shards in these tertiary deposits was not the result of having been an element of the architectural superstructure, and that this lack of application in the construction styles did not change over time either.

The types of shards (cooking pots, plates, etc.) found in the pottery assemblages of the depositional units did not change over the course of time. Throughout all the depositional units, the shards of storage jars and amphora were the primary components of the pottery assemblages, with a small percentage of domestic shards (such as Attic ware) present. In this case, the continuity of shard types is indicative not of the continuity of building methods and materials, but rather of the economic subsistence of the neighbourhood from the Early Persian to the Roman Periods. The preponderance of shards was from shipping and storage containers, with a general lack of domestic materials. Thse data suggest that the area around D1 was an industrial/commercial activity centre through these periods.

Figure 3.32D shows that all the depositional units had enhanced levels of organic carbon and phosphorous relative to comparative samples of constructional materials (i.e.: degraded mudbricky material, Iron Age mudbrick and potter's clay). This discovery is not unexpected given that the completely degraded and mixed tertiary anthropogenic sediments would have been subject to more extensive human activities and handling than the raw construction materials brought in from off site. Unlike the conclusions reached by Davidson (1973), it is proposed here that higher levels of organic elements, particularly phosphorous, are not the result of an increased intensity of occupation, but rather a reflection of the nature of the types of material that had been deposited. Those sediments that had received deposits rich in organic matter, such as faeces or urine from animals and domestic food refuse would be more likely to have higher phosphorous and organic carbon levels than others. This hypothesis would explain why the pit (du-J) had much higher phosphorous levels than the sewer sediments (du-A), and would indicate that this difference was not due to a demographic shift between the Hellenistic and Roman periods.

The regularity of the distribution of shard forms across depositional units indicates that systemic scavenging among refuse for certain shard forms, or a pre-selective process of shard discard, did not occur in this area. The reasons for this lack of selective processes may be due to the industrial nature of the area. The level of provisional discard and individual scavenging would tend to be limited in these contexts, unlike in domestic situations where scavenging and provisional discard would be more prevalent.

All of these data support the hypothesis that although there were architectural shifts in this area from the Early Persian to the Late Roman Periods, as reflected in the different construction phases that caused the deposition of the CTAS, the systemic activities that took place did not change substantially. The area of ancient Dor now known as D1 maintained its industrial/commercial identity throughout these periods. The variations that exist between CTAS deposits are not reflective of changes or differences in the economic activities of the area, but rather of the vagaries of undirected refuse accumulation associated with what was discarded intentionally or accidentally at any one time or place.

5.6 Conclusion to Case Study.

The study of anthropogenic sediments in this case study has revealed that the frameworks described in chapters two to four are useful tools that assist with the clarification of the types of deposits present, and enhance the archaeological interpretation of a tel site. Close examination of a limited set of anthropogenic sediments from the 1997 excavation of area D1 at Tel Dor has revealed important discoveries about a number of systemic processes related to the occupation of this part of the ancient city from the Persian through Roman Periods. Of primary interest, information was obtained about both the date and extent of the construction event associated with the *ateleo* building in AU12/13 and AT12/13, the elucidation of the time frame of the sewer system in AT11, and the types of activities that occurred, as well as the nature of building material employed in this entire area from the Early Persian to the Mid- to Late Roman Periods.

The identification of 'K', 'L' and 'T' as having been derived from the same source material and serving the same functional role for different parts of the same building provided the data from which it could be concluded that these anthropogenic sedimentary deposits were laid simultaneously. With this realisation, it became possible to make a number of inferences about the activities that occurred in this area during the Early Hellenistic Period, when the *ateleo* building was constructed. The data indicate that the erection of the *ateleo* building occurred as a single construction event, and that this construction event must have constituted a major architectural re-development of the area. The presence of the standing foundations along with the identification of previous occupation layers suggests that the actual floor level of this structure was at a substantially higher elevation than the previous structures in the area.

Although not representative of a major architectural redevelopment, the construction of a sewer and associated drains in the Roman Period does provide interesting information on the activities of peoples of Dor at that time. To begin, the sewer in D1 was identified as having been built and supported with the use of two different constructional tertiary anthropogenic sediments. The systemic reasons for the use of two distinct constructional fills for this process cannot be explained fully at this time, without further investigation into these and the surrounding sediments, both horizontally and vertically. Two possibilities that could explain this difference are: 1) that the underlying CTAS has specific properties that were found to be beneficial as foundational material; and 2) that the sewer was constructed on pre-existing CTAS (like standing foundations for walls), and once built, the space surrounding the sewer was filled in with a different CTAS (like foundation trenches for walls).

All aspects of the construction, use and ultimate abandonment of the sewer system occurred in the Roman Period. This finding is interesting, as the Roman Period was a critical time in the demographic decline of the city. As mentioned in section 5.1.1, Dor was thought to have succumbed to the economic success of Caesarea sometime during the Roman Period. The results from these data suggest that Dor's decline was not immediate and indeed, that the city engaged in major public works and development at this time. The time frame, however, for the ultimate discontinued use of this feature cannot be refined any further through analysis of the current data beyond a broad identification of the Roman Period. A more intense analysis of the anthropogenic sediments from other, nearby, deposits from the Roman Period would be required to address these issues further. It would be interesting, for example, to conduct a closer inspection of the micro-stratigraphy of the sediments within the sewer to determine distinctions between the anthropogenic sedimentary deposits that formed along the bottom of the sewer during its use, and the sediments that formed as the drain became clogged when it was no longer being maintained.

Regardless of the changes in the architectural and demographic landscapes that occurred in what is now D1 of Tel Dor beginning in the Early to Mid- Persian Period and lasting until the Mid- to Late Roman Periods, the functional activities of this area of the ancient city do not appear to have been altered greatly. The anthropogenic sediments examined from these phases of occupation displayed a remarkable continuity in the kinds of artefacts that were discarded and allowed to accumulate. Throughout these time periods the same types and proportions of pottery shards, which were mainly amphora with a smaller representation of shards from domestic vessels and wares such as Attic ware, and other artefacts[24] were present throughout the cultural deposits. It can be reasonably inferred from this lack of interruption in artefact types that there was a continuity of activities that created the debris. In the case of the functional area that is now D1, these activities were most likely to be light industry and commercial pursuits involved with the storage, sale, etc. of trade goods that are transported in large storage vessels.

The systemic consistencies uncovered in the depositional units also extend to the methods and materials of construction. As explained in section 3.2.2, the majority of the earthen element of anthropogenic sediments is derived from constructional materials, predominantly mudbricks. From the earliest deposits to the latest, the most striking feature is the consistency of grain size.[25] This discovery clearly reveals the continuity of the systemic use of materials for over four hundred years at this site.

This case study, although small in scope, has exemplified how the study of anthropogenic sediments can provide "added value" to the analysis and interpretation of a number of systemic processes and contexts of a Near Eastern tel. Although this study did not address all aspects of the theoretical and archaeological frameworks presented in chapters 2 through 4, it has shown the richness in information that can be gleaned from such an approach to site excavation. Clearly, the larger the area studied and the more intense the deposit analyses, the greater the knowledge to be obtained.

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[24] Some of the artefacts other than pottery shards found in the depositional units from the Early to Mid- Persian and the Early Hellenistic include: amorphous bronze and iron fragments, small fragments of metal tools, worked bone, fragments of figurines, loom weights and spindle whorls, etc. For a complete list of special finds from the excavated anthropogenic sediments see Table C-7 Appendix C.

[25] The exception to this consistency is du-J. It is, however, anomalous due to its specialised systemic context. Unlike constructional anthropogenic sediments and sewer anthropogenic sediments, the sediments found in pits are not generated by the general wear and tear, or intentional destruction, of structures. As a result, their earthen component would be less likely to reflect the nature of constructional resources.

CHAPTER SIX

6. Conclusion.

The purpose of this thesis was to demonstrate the potential for deposits of anthropogenic sediments to inform archaeologists about systemic processes. In order to accomplish this end, theoretical and archaeological frameworks were developed to exemplify how sedimentary deposits can provide information at a variety of systemic levels, and a case study was conducted at a tel in Israel to test the utility of such an approach to archaeological excavation. The major hypotheses examined throughout the course of this study were: (1) sedimentary deposits can be studied like 'regular' artefacts; and (2) anthropogenic deposits can be studied and understood both in terms of their specific depositional context and as the archaeological context for the variety of individual artefacts that form the deposit's component elements.

Early in the process of researching the topic of anthropogenic sediments, it became apparent that no consistent terminology was employed to discuss this material. Of particular concern was the realisation that there was a multitude of interchangeable terms that were used to describe all types of archaeological sediments, with little indication of what exactly was being described. Some of the more frequently employed expressions, which could be used to describe anything from destruction debris or constructional fill to a trash middens, included: 'refuse', 'earth'. 'soil', 'occupation debris', 'occupational deposits', 'collapse debris', 'anthropogenic soils, 'anthropogenic sediments', archaeosediments', 'archaeological deposits', as well as 'fill'. Without the development of a consistent, clear, and informative terminological system, it became emmently clear that this study could not proceed.[1] In response to this need, a trinomial nomenclature was developed that provided this terminological framework. The

[1] One might wonder what the state of ceramic studies, or the analysis of other archaeological elements would be today if an equally inconsistent terminology had been applied to artefacts and features such as pottery vessels and walls, over the last thirty years.

hierarchical classification scheme that was created provided a precise and inclusive system of labelling archaeological sediments. As exemplified in Figure 2.2 (on page 28) the approach organised archaeological sediments into three levels: deposit type (process of sedimentation - cultural or natural), deposit formation (level of transformation - primary, secondary or tertiary), and deposit mode (systemic context of the deposit - e.g. constructional, geochemical, disposal, etc.). In this way, each archaeological sedimentary deposit would have a single, non-interchangeable term that described its level of transformation and the cultural factors that resulted in its deposition. This hierarchical approach enhances greatly the archaeologist's ability to describe anthropogenic sediments in terms of both their archaeological and systemic contexts. Sedimentary deposits, as identified at any one or more of the levels, could now be place within a context for determining interpretative significance. As noted in Chapter 2, the terminology that is used to describe features and objects has an intense impact on the way in which we perceive those same features and objects. As a result, this clear and specific nomenclature developed for archaeological sediments makes us better able to understand these features. Used consistently across archaeological literature, this trinomial nomenclature would permit comparisons of similar materials from different sites, which given the current state of archaeological sediment terminology is impossible.

With an informative terminology established, the next step in the process of elucidating the levels of systemic information contained within anthropogenic sediments was to examine their formation processes. Through an analysis of the primary elements of Near Eastern archaeological sites (e.g. walls, foundations, roofs, floors, artefacts and ecofacts, and their constituent elements: stone, mudbrick, plaster, clay, etc.), and a re-evaluation of the processes of city and town development, it was possible to observe the level of systemic information contained within anthropogenic sediments. Rather than viewing the creation of tel sites as the result of a Construction/Destruction cycle, with the ancient city growing as the consequence of massive destruction events followed by large scale construction, a more localised, 'continual renewal' process was proposed. In order to shed some light on this dynamic phenomenon of continual renewal, the 'Construction Cycle' was formulated (Figure 3.7, page 48). This cycle articulated the systemic processes on-going in an ancient community, which resulted in the ultimate development of an archaeological site. The creation of the 'Construction Cycle' focused attention toward the unceasing activity and renewal that caused the incorporation of sediments into the site. By developing a framework through which the formation processes of sites were more clearly defined, the systemic contexts of different types of anthropogenic sediments became apparent.

Once an understanding of the formation processes that led to the creation of anthropogenic sedimentary deposits was achieved, the final step in being able to study this material was to develop a comprehensive research design. Chapter 4 examined the significance of a variety of key analyses and observations that could be conducted/recorded on/about artefacts and earthen material that composed anthropogenic sediments. Through this investigation it became apparent that different analyses could provide distinct levels of information. The quantification of pottery shards and the simple chemical properties of the earthen material were found to assist in identifying the character of anthropogenic sediments. In turn, this information proved to be useful in the differentiation or, conversely, the amalgamation of different deposits. The identification of the form and size of pottery shards, as well as particle size analysis of the earthen element of the anthropogenic sediment provided information about the nature of formation processes that led to the deposit's creation. Finally, information about the systemic function of the sediment was derived from the identification of pottery shard types and forms, the faunal assemblage, and various chemical analyses of the earthen fraction (such as phosphorous and organic residues). Due to these various levels of information contained within the different tests and observations of anthropogenic sediments, this chapter highlighted the necessity to develop a comprehensive research design when planning a study of these deposits. As represented in Figure 4.2 (on page 90) the costs, both in money and time, tend to increase as we move from tests that help characterise a deposit to tests that assist with the identification of functionality. However, in order to ensure a broadly based data set upon completion of an excavation, which permits the study of a variety of research topics, aspects of all the different levels of tests and observations should be made.

Through the development of a precise terminology, a formation process atlas (which identified the relationship between archaeological deposits and ancient systemic activities) and a method for creating a comprehensive research design, anthropogenic sediments, as archaeological features, came into focus. In many respects it was only upon the completion of these three steps that anthropogenic sediments could begin to be studied (as outlined in Figure 6.1).

The final step of this thesis was to conduct a small case study, which applied the principles developed in chapters two through four. To this end, parts of three squares from the site of Tel Dor in Israel were analysed systematically as to their content and chemical make-up.

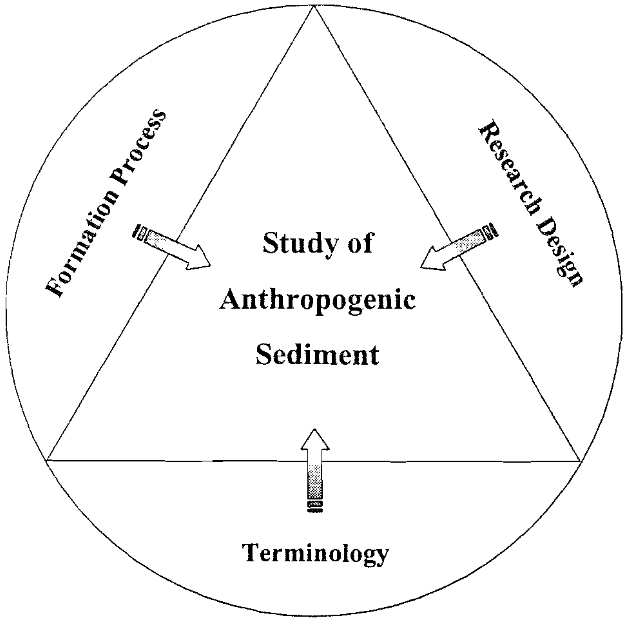

Figure 6.1 Schematic of the relationship between the supporting frameworks of Terminology, Formation Process, and Research Design to the study of Anthropogenic Sediments. Without these three 'retaining walls', the systemic information contained within anthropogenic sediments 'slides away' and is lost.

An analysis of the resultant data yielded a number of extremely interesting findings. Much of the information obtained from this case study provided corroboration for earlier interpretations about the occupation of the area from the Persian period onward. However, the analysis of the anthropogenic sediments from area D1 at Tel Dor yielded a number of interesting details that had not been identified previously, about the occupational history of this small part of the ancient city. The results from this study provided a more accurate chronology as related to the construction of the *ateleo* structure, which then created a new perception of the chronology of the Persian and Hellenistic periods in this area. Interesting information also was obtained about the nature of the Roman occupation of this locale. The focus on anthropogenic sediments in this study answered questions that heretofore had never been investigated. Some of these revelations included: the complete continuity of construction materials and methods from the Persian to Roman periods; the systemic activities in this part of the city prior to the construction of the *ateleo* building in the early part of the Hellenistic period; the method of sewer construction in the Roman period, with the use of two different 'fills' for its support; and the development of a more comprehensive chronological sequence of depositional events (based on the identification of 'depositional units', which informed the development of the Harris matrices). It has to be noted that it was only through the use of the 'additional' data collected from anthropogenic sediments that these enhancements to understanding the site came to light.

In conclusion, the research in this thesis has identified a number of issues related to our ability as archaeologists to understand the sites we excavate. Material, which in the past we have cavalierly discarded as an uninformative remnant of the excavation process, has been shown to contain a significant amount of cultural information. This thesis has shown that anthropogenic sediments are important sources of systemic data.

As mentioned at the beginning of this chapter, the recognition that deposits of anthropogenic sediments contain similar types of information as 'regular' artefacts, and thus should be similarly emphasised during the analysis of excavational material was substantiated in this study. The parallels between the range of cultural information derived from a shard of pottery (as a typical example of an artefact) and from an anthropogenic sedimentary deposit were found to be quite convincing. Table 6.1 identifies a number of archaeological questions that are frequently asked, and the way in which both traditional artefacts and anthropogenic sediments can address the various issues, exemplifying the parallel between these 'units' of archaeological information. This finding is significant as it offers archaeology another vehicle through which to enhance the understanding and interpretation of sites.

One of the most useful aspects of anthropogenic sedimentary deposits is that they can be studied on two different levels, as unique entities with their own systemic 'story' (as outlined in Table 6.1), and as the context for the artefacts and other materials that serve as the deposit's component elements. This thesis showed that as deposits are understood and studied as individual entities, explanations can be deduced about the formation processes (c-transforms) associated with the deposition of the anthropogenic sediment's constituent elements. Further, with this background understanding of the context of the *artefactes mobiles*, the process of untangling the c-transforms associated with their deposition, as postulated in the theoretical approach adopted in this thesis (refer to Section 2.1), is possible. Thus, the systemic information contained within individual artefacts in anthropogenic sediments can no longer be considered to be irrelevant. What had often been regarded as a 'hopelessly mixed' context (refer to Section 1.1) has now achieved a level of clarity. Indeed, the study of deposits can assign renewed meaning to a traditional source of information, which in these contexts, previously had been lost.

The case study from Tel Dor and the frameworks proposed in this thesis have provided extensive evidence that it is no longer appropriate to think that the study of pottery shards or other artefacts (particularly as related to function) can only be conducted on artefacts found in 'primary' contexts. It has been shown that statements like: "To ask the function of… the town

Archaeological Questions	Examples of information that can be obtained from:	
	Pottery Shards	**Anthropogenic Deposits**
Locally Exploited Natural Resources	• physical and chemical properties of the pottery fabric can indicate where clays for pottery manufacture were collected.	• physical and chemical properties of the earthen element of the deposit can indicate the source for mudbrick materials and stone quarries.
Materials and Methods of Construction	• types of temper employed. • technology (kilns, hand or wheel manufacture, etc.).	• mudbrick or stone construction. • fired or sun-dried mudbricks. • types of temper employed.
Systemic Function Associated with the Find	• vessel form or shape (best suited for storage of liquids, access to dry goods, etc.). • wear marks and sooting (exposed to fires for cooking, etc.). • decoration (e.g. attic fishplates)	• deposit context (e.g. pit, along a foundation wall, etc.). • the nature of the deposit's constituent components (e.g. lack of artefacts, only small artefacts, etc.).
Systemic Activities of the Find	• in *in situ* → the assemblage of vessel types informs on the types of activities that occurred in that space.	• the functions of the range of artefacts and other component elements inform upon the range of systemic activities that occurred in the deposit's catchement area.
Subsistence of the Past Population	• extraction of residues (lipids, proteins, etc.) from fabric.	• species identification of disarticulated bones. • extraction of residues (lipids, proteins, etc.) from earthen material.
Date of the Find*	• identifiable through the design, style, decoration, shape, etc. of shard/vessel.	• the most recent attributable date of the artefact assemblage in the deposit provides and approximate date of deposition. • the range of dates identified for the component elements provide an approximate span of when the deposit acted as a repository for debris.
Chronological Seriation	• changes in vessel shapes, design, etc.	• changes in the nature/types of component elements.

Table 6.1 Parallels between the archaeological information derived from typical artefacts (e.g. pottery shards) and anthropogenic sediments.
* This is exclusive of scientific dating methods, which also could be applied to both artefacts and anthropogenic sediments.

dump [and its component artefacts] is either trivial or meaningless" (Orton *et. al.* 1993:28) are very short-sighted. Such assertions assume much that is erroneous, from the idea that all non-primary contexts are "town dumps", to the suggestion that functionality of ceramics is only important if they are in *in situ* contexts, and finally that 'dump' assemblages and their artefactual elements are meaningless. This traditional perception of the role and function of anthropogenic sediments is far too general and exclusionary. Although other archaeologists have recognised that anthropogenic sedimentary deposits do contain culturally important information about how people lived in the past (Dever 1980:46 and Rosen 1986:117), it is necessary to move beyond this conceptualisation and determine how to derive "meaning" from these sediments. This thesis has demonstrated how to obtain information from archaeological sediments, by understanding: (1) the formation processes that led to the creation of the assemblage of artefacts, ecofacts and earthen materials that make up sedimentary deposits (Section 3.2); (2) the final systemic contexts of sedimentary deposits (Section 3.3); and (3) the archaeological and systemic significance of the elements within the deposits (Chapter 4).

Although the study of anthropogenic sediments conducted in this thesis has been a preliminary investigation, the findings show quite clearly that systemic information associated with individual artefacts in anthropogenic sediments can no longer be considered as irrelevant. Evidence has been found that supports the notion that the study of these deposits should be viewed as providing valuable information to help the understanding and interpretation of systemic processes. In order to achieve the full potential that anthropogenic sediment studies promise, however, more research in a variety of areas is required. For example, a more refined perception of the manner in which the sediments were manipulated and created in ancient cities, towns and fortresses could be examined by studying larger areas of a site with an examination of anthropogenic sediments in a broader horizontal scale. Additionally, continued work and research on sedimentary deposits from a variety of contexts and sites could refine and expand the catalogue of both anthropogenic and natural archaeological sedimentary deposit types, beyond that found in Section 3.3.

As discussed in Section 1.1, my primary interest in archaeology is to understand the day to day realities of people's lives in previous societies. I believe that the theoretical and archaeological frameworks and functional processes that have been put forth in this thesis, when implemented to their fullest extent, can enhance significantly our comprehension of the systemic reality offered through the excavation of archaeological sites.

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APPENDIX A – CHRONOLOGICAL TABLE

Bronze Age	**3300 - 1200 BCE**	***Early***	***3300 - 2000 BCE***
		Middle	***2000 - 1550 BCE***
		Late	***1550 - 1200 BCE***
Iron Age	**1200 - 586 BCE**	***I***	***1200 - 1000 BCE***
		II	***1000 - 586 BCE***
Persian Period	**586 - 332 BCE**	***Neo-Babylonian***	***586 - 539 BCE***
		Early	***539 - 400 BCE***
		Late	***400 - 332 BCE***
Hellenistic Period	**332 - 63 BCE**	***Early***	***332 - 200 BCE***
		Late	***200 - 63 BCE***
Roman Period	**63 BCE - 325 CE**	***Early***	***63 BCE - 135 CE***
		Late	***135 - 325 CE***

Table A-1 Chronological table adapted from Zorn *et. al.* n.d. and Rast 1992.

APPENDIX B – EXCAVATION FORMS

This section provides copies of some of the forms that were used to record the data gathered during excavation. Figures B-1 and B-2 were created specifically for this research project, Figure B-3 is the traditional record that is done for each locus created/identified during excavation, and Figure B-4 displays the method of recording artefactual finds. The latter two of these forms would be the only written sources for information that describe the nature of a locus and its contents, if standard excavation procedures were followed.

Figure B-1 Example of a Shard Form. Each basket of pottery that was collected from the study area was counted, with each category collectively weighed. In order to identify to totals for each locus, all of the data from its pottery baskets was added together.

Figure B-2 Example of the Locus Information Form. The upper year student that was responsible for the excavation unit was required to fill in this form in order to provide the basic gross data for each locus.

Figure B-3 Example of a Locus Card. These forms are the final written record maintained by the excavation about each locus. This card contains all of the detailed information about the process of excavation and about the locus itself, including its relation to surrounding loci. A small schematic diagram is usually included in the description of each locus at the bottom of the page.

Figure B-4 Example of a Basket List Sheet. These forms note the data recorded for all artefactual material uncovered during excavation.

24/7/97

Date: 25/07/97 Levels: Soil Sample # :

locus #	16464			COUNT	WEIGHT
basket # 167250	regular shapes	body shards	small (<5cm)	79	900
			medium	48	1300
			large (>10cm)	1	125
		bases	small (<5cm)	1	10
			medium	1	50
			large (>10cm)		
		other – inc: necks, rims, tiles	small (<5cm)	9	75
			medium	1	25
			large (>10cm)		
	irregular shapes	lamp fragments	small (<5cm)		
			medium	1	5
			large (>10cm)		
		rims	small (<5cm)		
			medium		
			large (>10cm)		
		attached handles	small (<5cm)		
			medium	2	250
			large (>10cm)		
		unattached handles	small (<5cm)	1	25
			medium	1	50
			large (>10cm)		
		bases – inc: V-bases, etc...	small (<5cm)		
			medium		
			large (>10cm)		
		shoulders, necks, etc...	small (<5cm)		
			medium		
			large (>10cm)		
		other	small (<5cm)		
			medium		
			large (>10cm)		
	attic wear			3	20
	non-attic wear			142	2795

Figure B-1 Example of a Shard Form.

FILL LOCUS INFORMATION for DI 1996

Locus number: L16411
Locus type: F-11-SA

Square(s): AT13

Date opened: 08/07/97
Date closed: 18/07/97

Opening high: 13.74 C
Closing high: 13.27 N

Opening low: 13.71 S
Closing low: 13.22 S

Strat. value: U

Length: 2.8 m
Width: 1.5 m

sherds:
pottery baskets:

whole vessels:
Types of vessels:

other special finds:
Types of finds:

Pottery basket #'s:
Periods of pottery:

buckets soil: 159
Was soil kept?: yes

Soil colour: light to dark brown

Soil packedness: hard in the south soft in the north

Soil matrix: compact soil, w/rocks, potsherds, bone, shell and some charcoal

Loci above: L16402

Loci below: L16435

Comments:

Written by: David Reines

Figure B-2 Example of the Locus Information Form.

L16403	Dor 1997	Fld D1	Sq AT11	fill

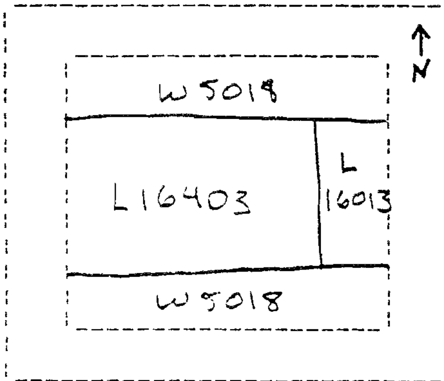
Open 04/07/97	High 15.19 NW	Low 15.19 NW	Seals
Close 04/07/97	High 14.71 NW	Low 14.64 C	Seal by 5740
Floor Type	High	Low	
Length 1.4	Width .5	Vol .4	Loci 5740
Value s	Remove	Drawn?	Above
Photo # 1		Photo # 2	Loci 5018
Written by ZWS		Checked by CMF	Below

Unit	Phase	Stage	Strat	PoM

Summary:

Opened: To determine what, if anything, was located in the remaining unexcavated part of the sewer drain installation W5018.
Limits (N): W5018
(S)W5018
(E)L16013
(W)AU/AT grid line
Closed: Remainder of drain was excavated and no further excavation could be performed in this locus.
Matrix: Chuncks of plaster, most likely from collapse in earlier years, and a fine greyish-brown soil. Numerous pottery fragments and an extremely large quantity of bivalve shells were found. There were also bits of glass and bone.
Relations: This locus was sealed by the paving stones of the Roman road L5740. Contained within the sewer drain W5018.

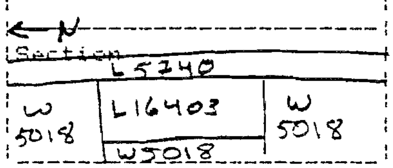
Value:



Photo

Photo

Section



Section

Figure B-3 Example of a Locus Card.

Locus Basket List L 16475

Bask. No.	Sq.	Beg. Ele.	Clo. Ele.	St Df	Lc St	Ob	Ma	R	C	P1	P2	P3	Comments Comments
167354	AU12	14.55	14.17	sa		sh	cr	0	u	pr			12th pottery open LMP's
167355	AU12	14.55	14.17	sa		tw	ib		u				worked bone, 6.5cm. exact location unknown.
167362	AU12	14.28	13.86	sa		sh	cr	2	u	pr			pottery ATC, 2 open LMPs, small cooking pot pieces found also in BN167363
167363	AU12	14.28	13.86	sa		sh	cr	2	u	pr			2nd pottery ATC, small cooking pot pieces also found in BN167362.
167364	AU12	14.28	13.86	sa		sh	cr	2	u	pr			3rd pottery open LMP
167368	AU12	14.28	13.86	sa		ma	bn		u				bone
167371	AU12	14.28	13.86	sa		tw	ib		u				worked bone, 4.4cm. Exact location unknown.
167372	AU12	14.28	13.86	sa		sh	cr	0	u	pr			4th pottery ATC
167373	AU12	14.28	13.86	sa		sh	cr	2	u	pr			5th pottery ATC, open LMP
167374	AU12	14.28	13.86	sa		sh	cr	2	u	pr			6th pottery ATC
167383	AU12	14.01	14.01	sa		sc	cr		u				persian figurine, 8cmx6cm. Man with a beard and a hat. 47cm W of W5040b, 2.52m S of W10078.
167389	AU12	14.14	13.79	sa		sh	cr	2	u	pr			pottery ATC open LMP
167390	AU12	14.14	13.79	sa		sh	cr	0	u	pr			2nd pottery ATC

Figure B-4 Example of a Basket List Sheet.

APPENDIX C -- RAW DATA

The following tables provide the raw data collected during excavation for each of the loci examined in this study. It was through the study, and manipulation of this material that all quantitative results were obtained. More detailed data (data from individual basket lists, etc.) is available by contacting the author.

square	locus	volume (m^3)	total count	count			total weight (g)	weight (g)			average weight (g)/shard	average weight (g)/shard		
				small	medium	large		small	medium	large		small	medium	large
AT11	16403	0.361	803	736	64	3	5775	3390	2085	300	7	5	33	100
	16418	0.218	271	191	70	10	4710	1500	2060	1150	17	8	29	115
	16422	0.240	584	412	158	14	13275	4110	6144	3021	23	10	39	216
	16423	0.161	231	150	70	11	5315	1390	2575	1350	23	9	37	123
	16424	0.468	1316	1085	216	15	18295	8055	8165	2075	14	7	38	138
	16426	0.026	61	56	5	0	630	455	175	0	10	8	35	
	16429	0.026	62	55	7	0	730	490	240	0	12	9	34	
	16430	0.608	1009	673	321	15	23815	6480	14885	2450	24	10	46	163
	16432	0.171	351	233	116	2	9140	2740	5725	675	26	12	49	338
	16447	0.389	228	37	179	12	14047	454	10309	3283	62	12	58	274
	16448	0.324	420	183	229	8	14853	1722	11210	1921	35	9	49	240
AT12/13	16411	2.016	4907	2859	1880	168	169172	36372	93399	39401	34	13	50	235
	16412	0.269	1185	671	448	66	54133	7296	25763	21074	46	11	58	319
	16413	0.466	1527	1098	388	41	39240	11735	19330	8175	26	11	50	199
	16414	0.077	141	108	27	6	3235	885	1150	1200	23	8	43	200
	16415	0.215	460	301	128	31	18975	3860	6615	8500	41	13	52	274
	16427	2.856	12879	10044	2682	153	253834	84364	135112	34358	20	8	50	225
	16428	0.054	173	153	18	2	2385	1035	950	400	14	7	53	200
	16434	0.058	214	178	34	2	3911	1547	1962	402	18	9	58	201
	16435	0.624	5537	4544	928	65	106185	32425	54558	19202	19	7	59	295
	16468	0.083	301	272	28	1	3885	2015	1420	450	13	7	51	450
AU12/13	16449	0.051	25	12	13	0	954	154	789	0	38	13	61	
	16464	1.247	1333	964	347	22	31571	9416	16031	6124	24	10	46	278
	16475	2.498	4825	3487	1221	117	119625	34805	60345	24475	25	10	49	209
	16502	0.085	422	324	95	3	9100	2775	5225	1100	22	9	55	367
	16503	0.134	458	347	107	4	11090	3190	6675	1225	24	9	62	306
total		13.723	39723	29173	9779	771	937880	262660	492898	182312	24	9	50	236

Table C-1 Complete list of pottery shards per locus, categorised by size and quantified by both count and weight. Included in this table is the average weight per shard size for each locus.

square	locus	volume (m^3)	total count	count					total weight (g)	weight (g)					average weight g/shard	average weight g/shard				
				rim	handle	base	body	other		rim	handle	base	body	other		rim	handle	base	body	other
AT11	16403	0.361	803	14	26	4	758	1	5775	150	1205	85	4325	10	7	11	46	21	6	10
	16418	0.218	271	11	5	4	246	5	4710	310	525	235	3600	40	17	28	105	59	15	8
	16422	0.240	584	38	8	4	534	0	13275	829	691	40	11715	0	23	22	86	10	22	
	16423	0.161	231	8	9	3	211	0	5315	180	750	110	4275	0	23	23	83	37	20	
	16424	0.468	1316	44	28	7	1232	5	18295	665	1660	705	15200	65	14	15	59	101	12	13
	16426	0.026	61	1	2	0	58	0	630	5	125	0	500	0	10	5	63		9	
	16429	0.026	62	4	4	1	53	0	730	50	60	20	600	0	12	13	15	20	11	
	16430	0.608	1009	55	38	10	898	8	23815	1360	2880	380	18975	220	24	25	76	38	21	28
	16432	0.171	351	21	13	3	312	2	9140	500	1425	350	6850	15	26	24	110	117	22	8
	16447	0.389	228	6	15	3	200	4	14047	340	2831	585	10082	208	62	57	189	195	50	52
	16448	0.324	420	29	15	6	366	4	14853	866	2276	273	11070	367	35	30	152	46	30	92
AT12/13	16411	2.016	4907	156	148	44	4529	30	169172	5725	19741	8409	134342	955	34	37	133	191	30	32
	16412	0.269	1185	38	36	15	1078	18	54133	1853	7606	5857	37891	927	46	49	211	390	35	52
	16413	0.466	1527	48	26	12	1430	11	39240	1515	3720	1070	32650	285	26	32	143	89	23	26
	16414	0.077	141	4	1	1	133	2	3235	50	5	10	3150	20	23	13	5	10	24	10
	16415	0.215	460	18	12	7	421	2	18975	580	1590	2540	14200	65	41	32	133	363	34	33
	16427	2.856	12879	383	222	70	12159	45	253834	7669	27748	7591	209620	1206	20	20	125	108	17	27
	16428	0.054	173	2	1	2	168	0	2385	5	275	30	2075	0	14	3	275	15	12	
	16434	0.058	214	6	12	0	196	0	3911	165	458	0	3288	0	18	28	38		17	
	16435	0.624	5537	97	93	20	5307	20	106185	1986	12646	3592	87267	694	19	20	136	180	16	35
	16468	0.083	301	6	4	1	290	0	3885	45	665	25	3150	0	13	8	166	25	11	
AU12/13	16449	0.051	25	0	0	0	22	3	954	0	0	0	760	183	38				35	61
	16464	1.247	1333	69	26	11	1225	2	31571	896	2906	246	27468	55	24	13	112	22	22	28
	16475	2.498	4825	165	99	24	4469	68	119625	3565	9935	1815	101725	2585	25	22	100	76	23	38
	16502	0.085	422	11	6	3	400	2	9100	110	745	280	7875	90	22	10	124	93	20	45
	16503	0.134	458	15	8	3	427	5	11090	335	2250	460	7950	95	24	22	281	153	19	19
total		13.723	39723	1249	857	258	37123	236	937880	29753	104718	34709	760603	8086	24	24	122	135	20	34

Table C-2 The complete list of all pottery shards, categorised by form and quantified by both count and weight. The average weight per shard form for each locus is included also.

square	locus	volume (m^3)	total #	total weight (g)	Regular (Flat) Shards # rims	# body shards	# bases	total regular shards (#)	rims (g)	body shards (g)	bases (g)	total regular shards (g)
AT11	16403	0.361	803	5775	14	758	1	773	150	4325	25	4500
	16418	0.218	271	4710	1	246	0	247	25	3600		3625
	16422	0.240	584	13275	16	534	2	552	156	11715	16	11887
	16423	0.161	231	5315	7	211	0	218	175	4275		4450
	16424	0.468	1316	18295	37	1232	2	1271	480	15200	50	15730
	16426	0.026	61	630	1	58	0	59	5	500		505
	16429	0.026	62	730	4	53	1	58	50	600	20	670
	16430	0.608	1009	23815	50	898	6	954	1025	18975	105	20105
	16432	0.171	351	9140	21	312	3	336	500	6850	350	7700
	16447	0.389	228	14047	6	200	2	208	340	10082	86	10508
	16448	0.324	420	14853	27	366	6	399	770	11070	273	12114
AT12/13	16411	2.016	4907	169172	140	4529	12	4681	5050	134342	226	139618
	16412	0.269	1185	54133	32	1078	2	1112	1678	37891	21	39590
	16413	0.466	1527	39240	40	1430	7	1477	1290	32650	220	34160
	16414	0.077	141	3235	2	133	0	135	25	3150		3175
	16415	0.215	460	18975	9	421	0	430	400	14200		14600
	16427	2.856	12878	253834	362	12159	42	12563	6347	209620	938	216906
	16428	0.054	173	2385	2	168	1	171	5	2075	25	2105
	16434	0.058	214	3911	6	196	0	202	165	3288		3453
	16468	0.083	301	3885	6	290	1	297	45	3150	25	3220
AU12/13	16449	0.051	25	954	0	22	0	22		760		760
	16464	1.247	1333	31571	69	1225	9	1303	896	27468	201	28565
	16475	2.498	4825	119625	161	4469	16	4646	3360	101725	615	105700
	16502	0.085	422	9100	11	400	2	413	110	7875	30	8015
	16503	0.134	458	11090	15	427	2	444	335	7950	60	8345
total		13.099	34185	831695	1039	31815	117	32971	23382	673336	3288	700006

Table C-3a The complete list of all 'Regular' pottery shards in each locus, quantified by both count and weight.

square	locus	Irregular Shards									
		# rims	# handles	# bases	# others	total # irregular	rims (g)	handles (g)	bases (g)	others (g)	total irregular shards (g)
AT11	16403	0	26	3	1	30		1205	60	10	1275
	16418	10	5	4	5	24	285	525	235	40	1085
	16422	22	8	2	0	32	673	691	24		1388
	16423	1	9	3	0	13	5	750	110		865
	16424	7	28	5	5	45	185	1660	655	65	2565
	16426	0	2	0	0	2		125			125
	16429	0	4	0	0	4		60			60
	16430	5	38	4	8	55	335	2880	275	220	3710
	16432	0	13	0	2	15		1425		15	1440
	16447	0	15	1	4	20		2831	499	208	3539
	16448	2	15	0	4	21	97	2276		367	2740
AT12/13	16411	16	148	32	30	226	675	19741	8183	955	29554
	16412	6	36	13	18	73	175	7606	5835	927	14543
	16413	8	26	5	11	50	225	3720	850	285	5080
	16414	2	1	1	2	6	25	5	10	20	60
	16415	9	12	7	2	30	180	1590	2540	65	4375
	16427	21	222	28	45	315	1322	27748	6652	1206	36928
	16428	0	1	1	0	2		275	5		280
	16434	0	12	0	0	12		458			458
	16468	0	4	0	0	4		665			665
AU12/13	16449	0	0	0	3	3				183	194
	16464	0	26	2	2	30		2906	45	55	3006
	16475	4	99	8	68	179	205	9935	1200	2585	13925
	16502	0	6	1	2	9		745	250	90	1085
	16503	0	8	1	5	14		2250	400	95	2745
total		113	764	121	217	1214	4386	92071	27829	7392	131689

Table C-3b The complete list of all pottery shards in each locus, categorised by type and quantified by both count and weight.

Square	Locus	Period
AT11	16403	Roman
	16418	Hellenistic, Roman
	16422	Hellenistic, Persian
	16423	Hellenistic
	16424	Hellenistic, Late Hellenistic, Roman, Late Roman, Persian
	16426	Roman, Hellenistic, Persian
	16429	Hellenistic
	16430	Hellenistic, Persian, Roman
	16432	Persian, Hellenistic,Early Hellenistic
	16447	Persian
	16448	Persian, Hellenistic, Early Hellenistic
AT12/13	16411	Persian, Iron Age
	16412	Persian
	16413	Persian, Iron Age
	16414	Persian, Early Hellenistic
	16415	Persian
	16427	Persian, Iron Age
	16428	Persian
	16434	Persian
	16435	Persian
	16468	Persian, Iron Age
AU12/13	16449	Persian
	16464	Persian, Early Hellenistic
	16475	Persian
	16502	Persian
	16503	Persian

Table C-4 Periods represented in the pottery assemblage for each locus. The first period in each is the predominant in the locus.

square	locus	volume (m^3)	total count	total weight (g)	average g/atc shard
AT11	16403	0.361	0		
	16418	0.218	0		
	16422	0.240	6	41	7
	16423	0.161	0		
	16424	0.468	8	86	11
	16426	0.026	0		
	16429	0.026	0		
	16430	0.608	15	120	8
	16432	0.171	1	5	5
	16447	0.389	6	126	21
	16448	0.324	5	75	15
AT12/13	16411	2.016	23	229	10
	16412	0.269	1	15	15
	16413	0.466	17	190	11
	16414	0.077	1	10	10
	16415	0.215	5	35	7
	16427	2.856	107	819	8
	16428	0.054	0		
	16434	0.058	0		
	16435	0.624	14	127	9
	16468	0.083	0		
AU12/13	16449	0.051	0		
	16464	1.247	20	186	9
	16475	2.498	59	435	7
	16502	0.085	2	5	3
	16503	0.134	5	60	12
total		13.723	295	2563	9

Table C-5 Count and weight of total Attic Ware shards per locus. The average weight of Attic Ware shards is provided as well.

square	locus	volume (m³)	total count	total weight (g)	average g/bone fragment
AT11	16403	0.361	43	77	2
	16418	0.218	18	215	12
	16422	0.240	21	250	12
	16423	0.161	16	90	6
	16424	0.468	150	1520	10
	16426	0.026	4	4	1
	16429	0.026	3	20	7
	16430	0.608	105	1475	14
	16432	0.171	29	175	6
	16447	0.389	22	820	37
	16448	0.324	63	755	12
AT12/13	16411	2.016	699	5167	7
	16412	0.269	289	2360	8
	16413	0.466	255	1150	5
	16414	0.077	16	50	3
	16415	0.215	20	105	5
	16427	2.856	1150	4990	4
	16428	0.054	15	75	5
	16434	0.058	0	0	
	16435	0.624	381	1195	3
	16468	0.083	32	65	2
AU12/13	16449	0.051	0	0	
	16464	1.247	92	740	8
	16475	2.498	454	2140	5
	16502	0.085	0	0	
	16503	0.134	30	160	5
total		13.723	3907	23598	6

Table C-6 Count and total weight of all bone fragments per locus.

Square	Locus	Volume (m³)	Total # Shell Bags	Special Finds	Total # Special Finds
AT11	16403	0.361	1	1 ceramic stopper, 1 glass bag, 1 glass juglet rim	3
	16418	0.218	1	1 stamped handle	1
	16422	0.240	1		0
	16423	0.161	1	1 glass fragment, 1 lead fragment	2
	16424	0.468	7	1 bronze fibula, 1 stamped handle, 1 stone weight	3
	16426	0.026	1		0
	16429	0.026	0		0
	16430	0.608	2	1 bronze nail, 1 iron nail	2
	16432	0.171	1	1 bronze hook, 1 iron bag	2
	16447	0.389	0		0
	16448	0.324	2	1 figurine fragment	1
AT12/13	16411	2.016	10	1 bronze nail, 1 bronze ring, 8 faience beads, 5 figurine fragments, 1 loom weight fragment, 1 slingstone	17
	16412	0.269	2		0
	16413	0.466	4	1 bronze nail, 2 figurine fragments	3
	16414	0.077	0	1 iron tool	1
	16415	0.215	1	1 bronze nail, 1 figurine fragment, 1 mask fragment	3
	16427	2.856	11	2 alabaster fragments, 1 bone bead, 1 bone needle, 1 bone frag - worked, 2 bronze bags, 1 bronze coin, 2 bronze tools, 1 faience fragment, 1 game piece (ceramic), 4 iron bags, 1 iron tool, 1 mask fragment, 1 spindle whorl	19
	16428	0.054	1		0
	16434	0.058	0		0
	16435	0.624	4	1 bronze bag, 2 bronze coins, 1 figurine fragment, 1 iron bag, 2 slingstones, 1 spindle whorl	8
	16468	0.083	4		0
AU12/13	16449	0.051	0		0
	16464	1.247	0		0
	16475	2.498	0	1 bronze bag, 1 bronze pin, 2 bones - worked, 1 iron bag, 1 iron hoop, 2 figurine fragments, 1 mask fragment, 1 spindle whorl, 1 stone - worked	11
	16502	0.085	0		0
	16503	0.134	0	1 figurine fragment	1
total		13.723	54		77

Table C-7 Shell count by bag and the quantity of special finds by count and type.

Square	Locus	Elevation (m)	Colour	% Sand	% Silt	% Clay	% Carbon	% orgC	% inorgC	% Phosphorous	pH
AT11	16403	15.06	10 YR 6/3	65	20	15	5.406	0.492	4.914	0.410	8.5
		14.72	10 YR 6/2	63	20	18	5.157	0.433	4.724		8.4
	16418	14.84	10 YR 6/2	65	18	18	4.029	0.312	3.717	0.520	8.3
	16422	14.86	10 YR 5/3	68	13	20	2.487	0.064	2.423		8.4
	16423	14.70	10 YR 6/3	70	15	15	3.200	0.116	3.084	0.530	8.5
	16424	14.99	10 YR 6/2	70	18	13	3.858	0.440	3.418		8.2
		14.73	10 YR 5/2	70	15	15	2.774	0.090	2.684	0.560	8.4
	16430	14.57	10 YR 5/3	70	13	18	3.238	0.084	3.154		8.7
		14.69	10 YR 5/3	68	18	15	3.107	0.149	2.958	0.430	8.6
AT12/13	16411	13.67	10 YR 6/2	70	15	15	3.466	0.098	3.368		8.3
		13.48	10 YR 6/2	55	18	28	2.951	0.614	2.337		8.4
		13.45	10 YR 5/2	68	13	20	2.970	0.662	2.308	0.460	8.5
		13.24	10 YR 4/2	63	13	18	2.925	0.734	2.191	0.470	8.5
		13.27	10 YR 5/2	73	15	30	3.123	0.717	2.406		8.3
	16412	13.52	10 YR 6/2	28	45	28	3.063	0.806	2.257	0.730	8.4
	16413	13.71	10 YR 4/2	65	20	15	3.639	0.875	2.764		8.2
	16415	13.65	10 YR 5/3	70	15	15	2.159	0.109	2.050		8.4
	16427	13.49	10 YR 5/2	65	18	18	3.432	0.858	2.574	0.520	8.3
		13.49	10 YR 5/2	65	15	20	3.494	0.733	2.761		8.3
		13.42	10 YR 5/3	65	15	20	3.569	0.727	2.842		8.3
		13.37	10 YR 5/2	63	15	23	2.956	0.649	2.307		8.3
		13.34	10 YR 5/3	73	10	18	1.807	0.104	1.703		8.8
		13.21	10 YR 5/2	68	18	15	3.229	0.599	2.630		8.3
		13.24	10 YR 6/2	68	18	15	3.033	1.081	1.952		8.4
		13.07	10 YR 5/2	65	13	23	2.293	0.222	2.071		8.3
		13.11	10 YR 6/2	70	13	18	1.925	0.057	1.868	0.330	8.4
		13.12	10 YR 5/4	60	18	23	2.263	0.050	2.213		8.5
	16428	13.47	10 YR 5/3	73	13	15	1.903	0.064	1.839		8.9
	16434	13.39	10 YR 5/3	63	15	23	1.830	0.058	1.772	0.340	8.7
	16435	13.04	10 YR 5/2	45	15	40	3.246	1.104	2.142	0.590	8.4
		13.05	10 YR 5/2	60	18	23	3.254	0.717	2.537	0.460	8.5
	16468	13 29	10 YR 5/4	70	13	15	2.768	0.064	2.704	0.310	8.8
		13.25	10 YR 5/3	58	18	25	2.050	0.122	1.928		8.7
AU12/13	16464	14.46	10 YR 5/2	55	20	25	3.737	0.692	3.045	0.460	8.4
		14 70	10 YR 6/2	58	18	25	3.364	0.646	2.718		8.2
		14 50	10 YR 5/3	60	18	23	2.932	0.525	2.407		8.3
	16475	13.86	10 YR 5/3	68	13	20	2.712	1.165	1.547	0.470	8.7
		13.79	10 YR 6/3	80	13	8	2.400	0.065	2.335	0.300	8.7
		13.79	10 YR 5/3	68	13	20	2.746	0.769	1.977		8.7
		14 22	10 YR 5/3	60	18	23	3.076	0.538	2.538		8.2
		14.17	10 YR 5/2	55	23	23	3.207	0.870	2.337		8.2
		14.14	10 YR 4/3	60	18	23	3.828	1.594	2.234	0.630	8.2
average				64	17	20	3.062	0.497	2.565	0.473	8.4
comparative material	mudbricky material		7.5 YR 4/6	63	13	25	1.609	0.119	1.490	0.160	8.5
	tabun clay		7.5 YR 6/6	45	20	35	3.752	0.042	3.710		8.6
	mudbrick		10 YR 4/3	50	13	38	0.820	0.001	0.819	0.035	8.8
	potter's clay		2.5 Y 7/2	30	15	55	0.773	0.017	0.756	0.030	8.9

Table C-8 Earthen material analysis by sample.

APPENDIX D – STANDARDISED DATA

The following tables provide the standardised data for each locus. Data related to pottery shards and bone fragments has been calculated to reflect a per cubic meter standard. As there were, in some instances, more than one sample of earthen material per locus, data related to the earthen material has been averaged to obtain an overall reading for each locus. This data was used to identify "depositional units".

Square	Locus	Volume m^3	Earth	Shards by Size			Shards by Form					Bone
			# Buckets /m^3	# Small /m^3	# Medium /m^3	# Large /m^3	# Rims /m^3	# Handles/ m^3	# Body /m^3	# Bases /m^3	# Other Shapes/m^3	# Fragments /m^3
AT11	16403	0.3605	130	2042	178	8	39	72	2103	11	3	119
	16418	0.2184	85	875	321	46	50	23	1126	18	23	82
	16422	0.2400	94	1717	658	58	158	33	2225	17	0	88
	16423	0.1608	100	933	435	68	50	56	1312	19	0	100
	16424	0.4680	98	2318	462	32	94	60	2632	15	11	321
	16426	0.0264	152	2121	189	0	38	76	2197	0	0	152
	16429	0.0255	118	2157	275	0	157	157	2078	39	0	118
	16430	0.6075	109	1108	528	25	91	63	1478	16	13	173
	16432	0.1710	105	1363	678	12	123	76	1825	18	12	170
	16447	0.3891	131	95	460	31	15	39	514	8	10	57
	16448	0.3240	148	565	707	25	90	46	1130	19	12	194
AT12/13	16412	0.2688	126	2496	1667	246	77	73	2247	22	15	1075
	16411	2.0160	79	1418	933	83	141	134	4010	56	67	347
	16413	0.4658	88	2357	833	88	103	56	3070	26	24	547
	16414	0.0765	72	1412	353	78	52	13	1739	13	26	209
	16415	0.2151	107	1399	595	144	84	56	1957	33	9	93
	16427	2.8560	126	3517	939	54	134	78	4257	25	16	403
	16435	0.6240	120	7282	1487	104	37	18	3088	37	0	611
	16428	0.0544	239	2813	331	37	104	208	3403	0	0	276
	16434	0.0576	174	3090	590	35	155	149	8505	32	32	0
	16468	0.0828	145	3285	338	12	72	48	3502	12	0	386
AU12/13	16449	0.051	98	235	255	0	0	0	431	0	59	0
	16464	1.2474	74	773	278	18	55	21	982	9	2	74
	16475	2.4975	139	1396	489	47	66	40	1789	10	27	182
	16502	0.0847	94	3825	1122	35	130	71	4723	35	24	0
	16503	0.1344	45	2582	796	30	112	60	3177	22	37	223
Average for Site			97	2126	713	56	91	62	2705	19	17	285

Table D-1 Standardised data for the quantity (by count) of earth buckets, pottery shards categorised by size and form, and bone fragments.

Square	Locus	Volume m^3	Shards by Size Small Kg/m^3	Medium Kg/m^3	Large Kg/m^3	Shards by Form Rims Kg/m^3	Handles Kg/m^3	Body Kg/m^3	Bases Kg/m^3	Other Shapes Kg/m^3	Bone Fragments Kg/m^3
AT11	16403	0.361	9.404	5.784	0.832	0.416	3.343	11.997	0.236	0.028	0.214
	16418	0.218	6.868	9.432	5.266	1.419	2.404	16.484	1.076	0.183	0.984
	16422	0.240	17.125	25.600	12.589	3.453	2.881	48.814	0.166		1.042
	16423	0.161	8.644	16.014	8.396	1.119	4.664	26.586	0.684		0.560
	16424	0.468	17.212	17.447	4.434	1.421	3.547	32.479	1.506	0.139	3.248
	16426	0.026	17.235	6.629		0.189	4.735	18.939			0.152
	16429	0.026	19.216	9.412		1.961	2.353	23.529	0.784		0.784
	16430	0.608	10.667	24.502	4.033	2.239	4.741	31.235	0.626	0.362	2.428
	16432	0.171	16.023	33.480	3.947	2.924	8.333	40.058	2.047	0.088	1.023
	16447	0.389	1.168	26.495	8.438	0.873	7.277	25.911	1.504	0.536	2.107
	16448	0.324	5.315	34.598	5.930	2.674	7.024	34.168	0.844	1.134	2.330
AT12/13	16412	0.269	27.142	95.846	78.401	2.840	9.792	66.638	4.171	0.474	8.780
	16411	2.016	18.042	46.329	19.544	6.894	28.294	140.962	21.789	3.449	2.563
	16413	0.466	25.193	41.498	17.550	3.252	7.986	70.094	2.297	0.612	2.469
	16414	0.077	11.569	15.033	15.686	0.654	0.065	41.176	0.131	0.261	0.654
	16415	0.215	17.945	30.753	39.517	2.696	7.392	66.016	11.808	0.302	0.488
	16427	2.856	29.539	47.308	12.030	2.685	9.716	73.396	2.658	0.422	1.747
	16435	0.624	51.963	87.433	30.772	3.182	5.055	38.143	0.551		1.915
	16428	0.054	19.026	17.463	7.353	0.092	7.946	57.079			1.379
	16434	0.058	26.853	34.068	6.971	2.867	20.266	139.850	5.757	1.112	
	16468	0.083	24.336	17.150	5.435	0.543	8.031	38.043	0.302	0.000	0.785
AU12/13	16449	0.051	3.029	15.467				14.903		3.594	
	16464	1.247	7.548	12.852	4.910	0.718	2.329	22.020	0.197	0.044	0.593
	16475	2.498	13.936	24.162	9.800	1.427	3.978	40.731	0.727	1.035	0.857
	16502	0.085	32.763	61.688	12.987	1.299	8.796	92.975	3.306	1.063	
	16503	0.134	23.735	49.665	9.115	2.493	16.741	59.152	3.423	0.707	1.190
Average for Site			19.140	35.920	13.285	2.168	7.631	55.425	2.529	0.589	1.720

Table D-2 Standardised data for the quantity (by weight – Kilograms) of pottery shards categorised by size and form, and bone fragments.

Square	Locus	Shards by Size (g)			Shards by Form (g)					Bone (g)
		Small	Medium	Large	Rims	Handles	Body	Bases	Other	Fragments
AT11	16403	5	33	100	11	46	6	21	10	2
	16418	8	29	115	28	105	15	59	8	12
	16422	10	39	216	22	86	22	10		12
	16423	9	37	123	23	83	20	37		6
	16424	7	38	138	15	59	12	101	13	10
	16426	8	35		5	63	9			1
	16429	9	34		13	15	11	20		7
	16430	10	46	163	25	76	21	38	28	14
	16432	12	49	338	24	110	22	117	8	6
	16447	12	58	274	57	189	50	195	52	37
	16448	9	49	240	30	152	30	46	92	12
AT12/13	16412	11	58	319	37	133	30	191	32	8
	16411	13	50	235	49	211	35	390	52	7
	16413	11	50	199	32	143	23	89	26	5
	16414	8	43	200	13	5	24	10	10	3
	16415	13	52	274	32	133	34	363	33	5
	16427	8	50	225	20	125	17	108	27	4
	16435	7	59	295	3	275	12	15		3
	16428	7	53	200	28	38	17			5
	16434	9	58	201	20	136	16	180	35	
	16468	7	51	450	8	166	11	25		2
AU12/13	16449	13	61				35		61	
	16464	10	46	278	13	112	22	22	28	8
	16475	10	49	209	22	100	23	76	38	5
	16502	9	55	367	10	124	20	93	45	
	16503	9	62	306	22	281	19	153	19	5
Average across the Site		9	50	238	22	119	21	103	32	8

Table D-3 Average weight per shard (in grams) categorised by size and form and average weight per bone fragment uncovered in each locus.

Square	Locus	% Sand	% Silt	% Clay	% Carbon	% orgC	% inorgC	% Phosphorous	pH
AT11	16403	64	20	17	5.282	0.463	4.819	0.410	8.5
	16418	65	18	18	4.029	0.312	3.717	0.520	8.3
	16422	68	13	20	2.487	0.064	2.423		8.4
	16423	70	15	15	3.200	0.116	3.084	0.530	8.5
	16424	70	17	14	3.316	0.265	3.051	0.560	8.3
	16430	69	16	17	3.173	0.117	3.056	0.430	8.7
AT12/13	16412	28	45	28	3.063	0.806	2.257	0.730	8.4
	16411	66	15	22	3.087	0.565	2.522	0.465	8.4
	16413	65	20	15	3.639	0.875	2.764		8.2
	16415	70	15	15	2.159	0.109	2.050		8.4
	16427	66	15	19	2.800	0.508	2.292	0.425	8.4
	16435	53	17	32	3.250	0.911	2.340	0.525	8.5
	16428	73	13	15	1.903	0.064	1.839		8.9
	16434	63	15	23	1.830	0.058	1.772	0.340	8.7
	16468	64	16	20	2.409	0.093	2.316	0.310	8.8
AU12/13	16464	58	19	24	3.344	0.621	2.723	0.460	8.3
	16475	65	16	20	2.995	0.834	2.161	0.467	8.5
Average for Site		63	18	20	3.057	0.399	2.658	0.475	8.5

Table D-4 Averaged earthen material data for those loci from which samples were collected. The abbreviations, 'orgC' refers to organic Carbon, and 'inorgC' to inorganic Carbon.

APPENDIX E – DEPOSITIONAL UNIT DATA FOR SHARD FORMS AND SHAPE

An examination of the depositional units by shard forms and shape by both count and weight revealed very little that differentiated the units. As a result of this finding, the classification of shard forms and shape were not considered as variables for discussing the defining characteristics of the depositional units carried out in Section 5.4. Because these results were not used in the body of the thesis, they were not presented. However, in order to provide a complete set of data, this information is presented here.

Depositional Units	Rims		Handles		Body		Bases		Others		Total		Rims		Handles		Body		Bases		Others		Total	
	$\#/m^3$	%	$\#/m^3$	%	$\#/m^3$	%	$\#/m^3$	%	$\#/m^3$	%	$\#/m^3$	%	Kg/m^3	%	Kg/m^3	%	Kg/m^3	%	Kg/m^3	%	Kg/m^3	%	Kg/m^3	%
A	39	1.7	72	3.2	2103	94.4	11	0.5	3	0.1	2227	100	0.42	2.6	3.34	20.9	12.00	74.9	0.24	1.5	0.03	0.2	16.0	100
B	95	4.7	56	2.8	1848	91.2	17	0.8	10	0.5	2026	100	2.03	5.1	4.23	10.7	32.18	81.3	0.96	2.4	0.18	0.4	39.6	100
C	49	5.4	42	4.6	794	87.3	13	1.4	11	1.2	909	100	1.69	4.2	7.16	17.7	29.66	73.2	1.20	3.0	0.81	2.0	40.5	100
J	141	3.2	134	3.0	4010	91.0	56	1.3	67	1.5	4408	100	6.89	3.4	28.29	14.0	140.96	70.0	21.79	10.8	3.45	1.7	201.4	100
K	81	3.2	67	2.7	2348	92.6	23	0.9	16	0.6	2537	100	2.84	3.4	9.03	10.9	66.47	79.9	4.34	5.2	0.48	0.6	83.2	100
L	138	2.6	91	1.7	5019	94.8	26	0.5	19	0.4	5292	100	2.77	2.7	11.61	11.2	85.31	82.5	3.21	3.1	0.55	0.5	103.5	100
M	71	2.1	116	3.4	3250	94.1	18	0.5	0	0	3455	100	1.52	2.7	6.54	11.6	47.88	85.2	0.27	0.5		0	56.2	100
N	72	2.0	48	1.3	3502	96.3	12	0.3	0	0	3635	100	0.54	1.2	8.03	17.1	38.04	81.1	0.30	0.6		0	46.9	100
S	0	0	0	0	431	88.0	0	0	59	12.0	490	100		0		0	14.90	80.6		0	3.59	19.4	18.5	100
T	62	3.8	33	2.0	1520	92.5	9	0.6	19	1.1	1644	100	1.19	3.0	3.43	8.5	34.50	85.4	0.55	1.4	0.70	1.7	40.4	100
U	119	3.0	64	1.6	3775	94.0	27	0.7	32	0.8	4016	100	2.03	2.2	13.67	14.8	72.23	78.4	3.38	3.7	0.84	0.9	92.1	100

Table E-1 Standardised shard forms, by both count and weight, for the depositional units. The shaded areas indicate the percentage of the total pottery assemblage each form represents in that depositional unit.

Depositional Unit	By Count				By Weight			
	Regular Shards #/m^3	Irregular Shards #/m^3	% Regular Shards	% Irregular Shards	Regular Shards Kg/m^3	Irregular Shards Kg/m^3	% Regular Shards	% Irregular Shards
A	2144	83	96.3	3.7	12.48	3.54	77.9	22.1
B	1927	99	95.1	4.9	33.73	5.86	85.2	14.8
C	851	57	93.7	6.3	31.72	8.81	78.3	21.7
J	4137	272	93.8	6.2	147.29	54.10	73.1	26.9
K	2424	112	95.6	4.4	69.07	14.09	83.1	16.9
L	5165	126	97.6	2.4	88.05	15.40	85.1	14.9
M	3330	125	96.4	3.6	49.62	6.59	88.3	11.7
N	3587	48	98.7	1.3	38.89	8.03	82.9	17.1
S	431	59	88.0	12.0	14.90	3.81	79.6	20.4
T	1589	56	96.6	3.4	35.85	4.52	88.8	11.2
U	3911	105	97.4	2.6	74.67	17.48	81.0	19.0

Table E-2 Standardised shard shapes, by both count and weight, for the depositional units. Depositional unit 'S' may appear to be anomalous relative to the other units, however, this unit consists of a single excavation locus, where only 25 pottery shards were recovered. Because of this very small sample, the representativeness of the components of 'S', as reflective of an entire depositional unit, may be skewed.

APPENDIX F – CONTINGENCY TABLES FOR CORRESPONDENCE ANALYSIS

Component	Iterations	Norm	Eigenvalue	% Intertia	Cummulative
1	9	0.041	0.107021	73.9	73.9
2	7	0.002	0.034119	23.6	97.5

* = Intertia Outliers

Types

Name	Qlt	Mass	Inr	Comp 1	Cor	Ctr	Comp 2	Cor	Ctr
Small	1000	257	422	-452	859	490	183	140	251
Medium	999	506	115	5	1	0	-181	998	487
Large	996	210	405	485	845	462	205	151	258
Bone	609	27	59	435	597	47	63	13	3

Average Type QLT: 901

Units

Name	Qlt	Mass	Inr	Comp 1	Cor	Ctr	Comp 2	Cor	Ctr
A	995	21	86	-707	859	100	282	136	50
B	482	55	22	-168	480	14	-11	2	0
C	932	56	94	231	222	28	-414	710	283
J	1000	277	388*	437	942	495	108	58	95
K	956	113	7	95	956	10	-1	0	0
L	993	139	37	-194	978	49	-24	15	2
M	997	75	69	-350	925	86	98	72	21
N	996	63	148	-510	760	152	284	236	148
S	986	24	83	-212	92	10	-662	894	313
T	828	54	2	-68	730	2	25	98	1
U	946	122	64	-217	627	54	-155	319	86

Average Unit QLT: 919

Table F-1 Contingency table for correspondence analysis diagram of depositional units and bone and pottery shards quantified by weight, seen in Figure 5.33.

Component	Iterations	Norm	Eigenvalue	% Intertia	Cummulative
1	5	0.000	0.072918	93.2	93.2
2	12	0.018	0.003862	4.9	98.1

* = Intertia Outliers

Types

Name	Qlt	Mass	Inr	Comp 1	Cor	Ctr	Comp 2	Cor	Ctr
Sand	999	580	320*	207	999	343	3	0	2
Silt	998	191	554*	-474	993	590	33	5	54
Clay	974	194	70	-144	737	55	-82	237	337
% P	712	4	4	-215	711	3	7	1	0
% inorgC	936	26	32	36	13	0	302	923	606
% orgC	392	4	20	-388	390	8	-29	2	1

Average Type QLT: 835

Units

Name	Qlt	Mass	Inr	Comp 1	Cor	Ctr	Comp 2	Cor	Ctr
A	972	128	36	43	85	3	139	887	642
B	923	125	47	154	813	41	56	109	103
J	1000	125	798*	-705	1000	856	-8	0	2
K	931	125	18	99	878	17	-24	53	19
L	884	125	17	86	684	13	-46	200	70
M	930	124	52	168	853	48	-51	77	82
N	841	123	21	100	766	17	-31	75	31
T	679	125	12	60	469	6	-40	210	52

Average Unit QLT: 895

Table F-2 Contingency table for correspondence analysis diagram of depositional units and grain size and chemical analysis, seen in Figure 5.34.

Component	Iterations	Norm	Eigenvalue	% Intertia	Cummulative
1	9	0.081	0.030855	79.5	79.5
2	14	0.023	0.005587	14.4	93.9

* = Intertia Outliers

Types

Name	Qlt	Mass	Inr	Comp 1	Cor	Ctr	Comp 2	Cor	Ctr
Bases	803	7	40	-2	0	0	424	803	222
Handles	677	24	85	-102	74	8	290	603	354
Rims	681	28	80	-64	38	4	266	643	357
Body	998	934	12	-12	278	4	-19	721	61
Others	1000	8	783*	1990	999	984	64	1	6

Average Type QLT: 832

Units

Name	Qlt	Mass	Inr	Comp 1	Cor	Ctr	Comp 2	Cor	Ctr
A	450	73	25	-73	407	13	-24	43	7
B	693	66	25	-39	102	3	93	591	103
C	987	30	45	32	17	1	239	970	305
J	905	144	57	82	435	31	85	470	185
K	944	83	4	-18	180	1	37	763	20
L	913	173	23	-45	393	11	-52	519	82
M	566	113	42	-90	563	30	-7	3	1
N	986	119	54	-80	360	24	-105	626	235
S	999	16	709*	1305	990	882	-121	9	42
T	360	54	8	43	311	3	17	49	3
U	307	131	9	7	18	0	-27	289	18

Average Unit QLT: 737

Table F -3 Contingency table for correspondence analysis diagram of depositional units and shard form quantified by count, seen in Figure 5.35.