Dieter Vieweger
Institute of Biblical
Archaeology Wuppertal
Bergische Universität
Campus Freudenberg, FD III
Rainer-Gruenter-Straße 21
42097 Wuppertal
Germany

Dieter Vieweger

The Transition from Bronze to Iron Ages in Northern Palestine: Archaeological and Archaeometric Investigations at Tall Zar'ā

Cultural transitions have always been of particular interest to scholars. In the southern Levant, one of the most hotly debated topics is the nature of the transition from the Late Bronze Age to the Early Iron Age. That the transition involved considerable social and cultural change is uncontroversial. While to the west of the Jordan River the period is usually associated with the destruction of Late Bronze Age cities by the Sea Peoples, a lack of Egyptian territorial organisation, conflicts between Canaanite city-states or conquest by Israelite tribes, the area east of the Jordan is a different story. Scholars of this region can explore the evidence free from these presumptions, which are mainly based on written evidence.

The main archaeological questions are as follows: When did the Late Bronze Age city-state system collapse? Is there evidence for the causes of this collapse? In what form did Late Bronze Age culture continue? Which continuing and newly founded settlements can be identified in the Early Iron Age? Is it possible to identify social- or settlement-related structures that shed light on the transition from the Late Bronze Age to the Iron Age?

1. The Transition to the Iron Age in Transjordan

Previous debate and a growing body of new evidence show that the nature and chronology of Early Iron Age settlement and the development of territorial states in Iron Age II were complex processes.

In the Ammonite region, for example, there are fortified settlements that were continuously occupied from the Late Bronze Age into the Early Iron Age, such as Tall al-'Umayrī, Saḥāb and Khirbat Umm ad-Danānīr (Bienkowski 2001: 266).

One finds a different situation in the Jordan Valley. The end of the Tall Dayr 'Allā temple is attributed by the excavators to violent destruction, corresponding to the traditional scholarly view of the end of the Late Bronze Age[1]. On neighbouring Tall as-Sa'īdiyya, however, there was a transitional period between the Late Bronze Age and Early Iron Age. In stratum XII at Tall as-Sa'īdiyya an Egyptian-style palace was found; the funerary culture displays influence from both Egypt and the Sea Peoples (Tubb 1990: 26-37). The evidence at Tall al-Fukhkhār in northern Transjordan seems to suggest a seamless transition (Strange 2001: 292; cf. Bienkowski 2001: 265-6), while the evidence thus far at Tall Zar'ā (FIG. 1) is different again, pointing to a break in some aspects of material cultural and the continuation of others between the Late Bronze Age and Early Iron Age.

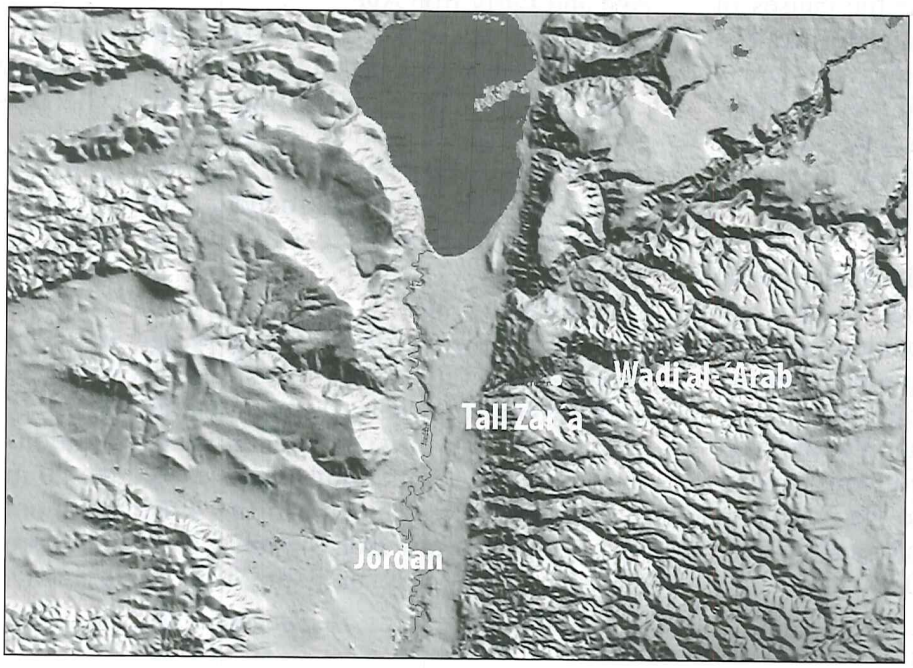
From this it can be concluded that developments in the various regions need to be investigated separately on the basis of archaeological data. This paper focuses on the geo-strategically important region of north-west Transjordan, *viz.* the area around Gadara; it starts with an introduction to the Gadara Regional Project and the excavations at Tall Zar'ā.

2. Tall Zar'ā (FIG. 2)

Since 2001, the Gadara Regional Project has been investigating Tall Zar'ā ("hill of agriculture") and the surrounding wadi system. An artesian spring emerges on the *tall*, providing ideal conditions for settlement. Its first inhabitants settled the 20 m high, 5.6ha calc-sinter hill in the 4th millennium BC. From then onwards the hill was settled more or less continuously until the 19th century AD.

[1] In this area one finds Mycenaean IIIB pottery, but not IIIC; cf. Franken 1992.

1. Tall Zar'ā in northern Jordan; view from Gadara.



2. Map of northern Palestine.

As a result, cultural layers more than 16 m deep have accumulated over 5000 years of settlement. Tall Zar'ā thus offers archaeologists a unique opportunity to develop a comparative stratigraphy for northern Jordan from the Early Bronze Age to the modern period.

Tall Zar'ā occupies a key location, both topographically and geo-politically, at the point of transition between the Palestinian and Syria-Mesopotamian cultural spheres; it was influenced politically and culturally by both.

The settlement was located on a prominent hill lying on a major trade route through Wādī al-'Arab, which linked Egypt with Damascus and Mesopotamia. Finds of imported goods (e.g. pottery from Syria, Mycenae and Cyprus, bitumen from the Dead Sea, copper ore and slag, faience, raw glass) bear witness to the inhabitants' contacts with neighbouring regions(Häser and Vieweger 2008, 2010; Vieweger 2007; Vieweger and Häser 2008, 2010).

2.1. The Stratigraphic Sequence of Tall Zar'ā (FIG. 3)

The excavations in Area I aim especially to elucidate the stratigraphy of the *tall*. By the end of the spring campaign in 2010, 1750m^2 had been opened in this area. However, Area I was also chosen because it is the part of the *tall* with the most pleasant afternoon climate. It catches the Mediterranean breeze that comes up the *wadi*, thereby creating perfect conditions for workmen's kilns, so we also expected significant production activity in the area. Therefore, in addition to stratigraphy, this area can provide vital information on craft production, technical history and the transition from the Bronze Age to the Iron Age.

If we look at the architecture on the *tall*, we can see that the transition from the carefully planned and heavily fortified Late Bronze Age city to the unfortified Early Iron Age settlement was dramatic. The subsequent move back to a fortified settlement in Iron Age II can also be clearly traced. At the

3. Tall Zar'ā, Area I; excavated stratigraphy from the Late Bronze Age to Umayyad period.

same time, however, Bronze Age traditions continue on into Iron Age I, alongside new traditions that appear for the first time.

To explain this, a number of architectural features are first described, followed by archaeometric detections.

2.2. Architecture

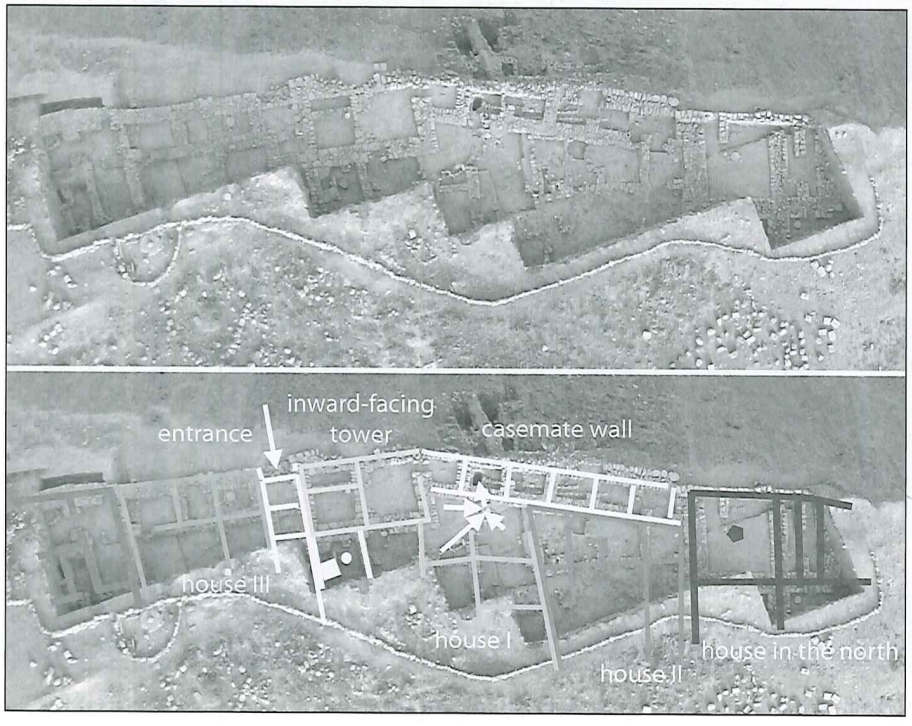
2.2.1. Late Bronze Age (FIG. 4)

The most recent Late Bronze Age layer of the 14th to 13th centuries BC has been extensively excavated (Häser and Vieweger 2007; Vieweger and Häser 2007). The most significant structure uncovered so far is a massive casemate wall that once protected the north-western side of the city. The pottery dates it to the Late Bronze Age and scientific analyses of charcoal remains confirm this. Six casemate chambers have been excavated to date. In peace they were used as storage rooms, but during times of war they could be filled with earth and stones to create an enormously thick wall that would protect the inhabitants of the city from attack. Behind the wall was a large courtyard with three covered channels. These collected rainwater which accumulated behind the city-wall into a settling basin in one of the casemate chambers, and directed it from there into a vertical chute.

To the south, the casemate wall ended in a large, inward-facing tower consisting of two parts. It contained a temple of 'long-room' type with a small inner sanctum, a main room and a courtyard with an elaborate altar. In the southern half we found a large room which had undergone a number of conversions, the latest of which involved the erection of a low partitioning wall in the west, creating small room just 1m wide behind it. On this wall were two large basalt column-bases which once supported wooden columns that held up the roof. The peculiar character of this small partitioned structure recalls Bronze Age 'gate sanctuaries' found elsewhere. A large stone, cut flat on the bottom and with a symmetrical 'peak' towards the top, which lay toppled beside the column-bases, may be a cultic stone owing to its similarity to such cult stones found in Palestine.

To the south of the 'gate sanctuary', we exposed a gateway 2.75m wide. This gate would have provided the most direct access for pedestrians to the lower cities to the north and west. South of the gateway we discovered one of seven bottle-shaped, stone-lined 'pits'. Late Bronze Age cities often contained such subterranean grain silos that were covered with large, (round) stone lids. These ones were 2.6 - 3.3m deep and had stamped clay floors.

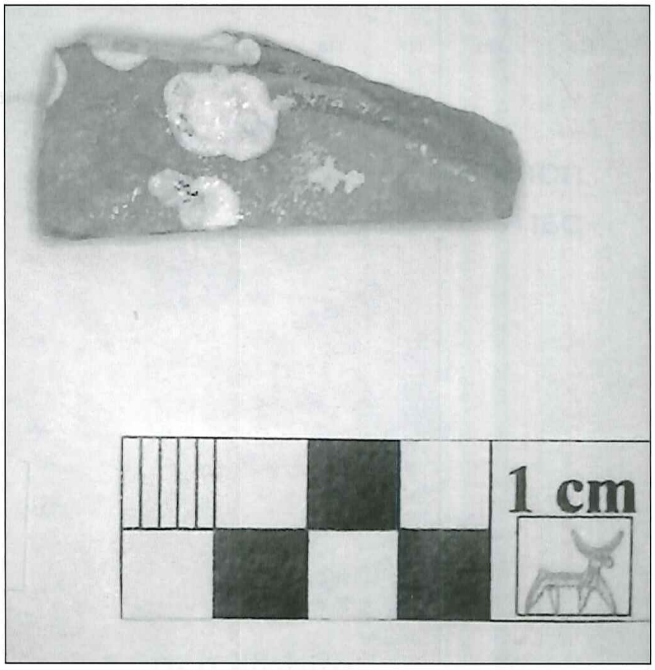
The impressive architecture in this part of the Late Bronze Age city boasted several courtyard houses. In 2008, in the northern part of the area, a room belonging to a large and particularly well-



4. Tall Zar'ā, Area I (2007); settlement of the 14th and 13th centuries BC.

built house was discovered, in which 39 cylinder seals (mostly quartz frit in Mitanni style), an intact silver pendant with the image of a female deity (FIG. 5), a scarab with inscriptions of Amenophis III and many glass beads have been found so far. We decided to investigate this house further in 2009 and plan to finish it in 2011. In 2010 we were able to excavate the large inner courtyard. It was *ca.* 150m^2 in area and carefully paved with small pebbles. Adjacent to the large roofed room, which also had a column-base, another part of the building was visible, namely a staircase consisting of two thick, parallel wall structures.

The large number of glass beads that have been found in this house complex, as well as industrial pottery, raw glass (FIG. 6) and one half-incised and one plain cylinder seal, suggest that this part of the *tall* may have been the site of a faience and glass processing workshop during the Late Bronze Age. Further excavations in 2011 are needed to clarify questions concerning the function of this complex and the activities associated with each room.



6. Raw glass find from Tall Zar'ā (2009).

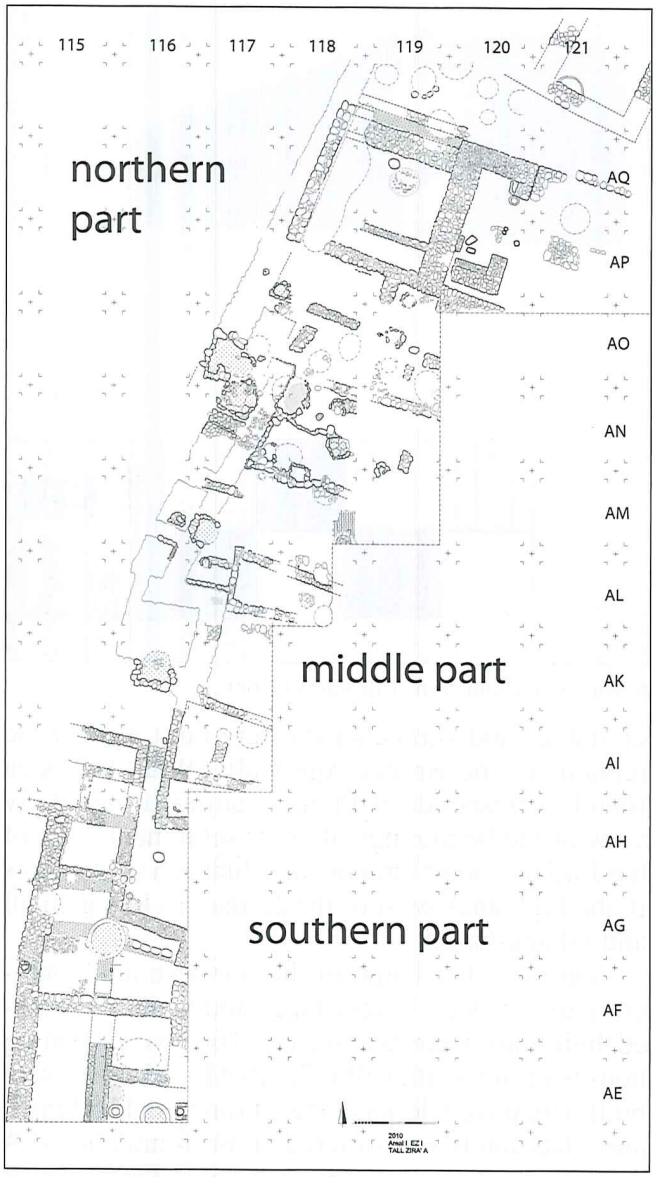
2.2.2. Iron Age I (FIG. 7)

The settlement at Tall Zar'ā appears to have experienced a dramatic cultural upheaval in the following period, *viz.* the 12th to 11th centuries BC. In place of the fortified city, there was now an open village inhabited by farmers, without even an outer wall.

The inhabitants of Tall Zar'ā in the 12th to 11th centuries BC used the Late Bronze Age ruins for their own buildings (FIG. 7; AO-AI 115-119). The remaining foundations of the Late Bronze Age city-wall were furnished with store-rooms and work-rooms for various agricultural activities. The walls of stables and simple sheds were built against the remains of the Bronze Age walls. What has been found corresponds with the traditional scholarly view of the beginnings of other settlements east of the Jordan, and of Israelite and Judaean settlements in the highlands west of the Jordan, as being small and village-based.

On the other hand, in the northern and southern parts of Area I, very large and well-constructed buildings were uncovered. The two adjoining houses in the south (FIG. 7; AI-AE 115-116) were built with paved floors at the entrance and had thick and elaborately constructed stone foundations. A door-hinge stone was found *in situ*. These court-

5. Some of the 39 cylinder seals (mostly quartz frit in Mitanni style) and the intact silver pendant with image of a female deity.



7. Iron Age I stratum of Area I (2010).

yard houses clearly illustrate the extent to which Late Bronze Age architectural style continued into the Iron Age. The courtyards contained large water containers, *ṭābūn* ovens and grinding stones. While stone-lined silos dominate the middle area (e.g. AK 116; AM 117; AN 117-118; AO 117-118), the southern buildings contained two large, plaster-lined silos (AG 115-116; AE 116). Also of particular interest is a well-preserved oven made of layers of mud, lime and pottery sherds that was found in the courtyard of one of these houses (AE 116).

The building in the north (FIG. 7; AP-AR 118-120) was uncovered in 2009. With its large courtyard (AP-AQ 118-119), long, narrow rooms to the north and south and well-preserved main room in AQ 120, it can potentially be considered an example of the so-called 'four room house', which is typical of Iron Age tradition. In the spring of 2010 we exposed an elaborate faience and glass workshop in this house, much as in Late Bronze Age times.

In summary, during the Iron Age I period, Tall Zar'ā was an agricultural settlement without fortifications, but with some larger buildings and industrial activities. Late Bronze Age traditions continued, but Iron Age traditions emerged parallel to them. Two charcoal samples from this stratum have yielded dates of 1220 - 970 cal. BC and 1270 - 1040 cal. BC respectively.

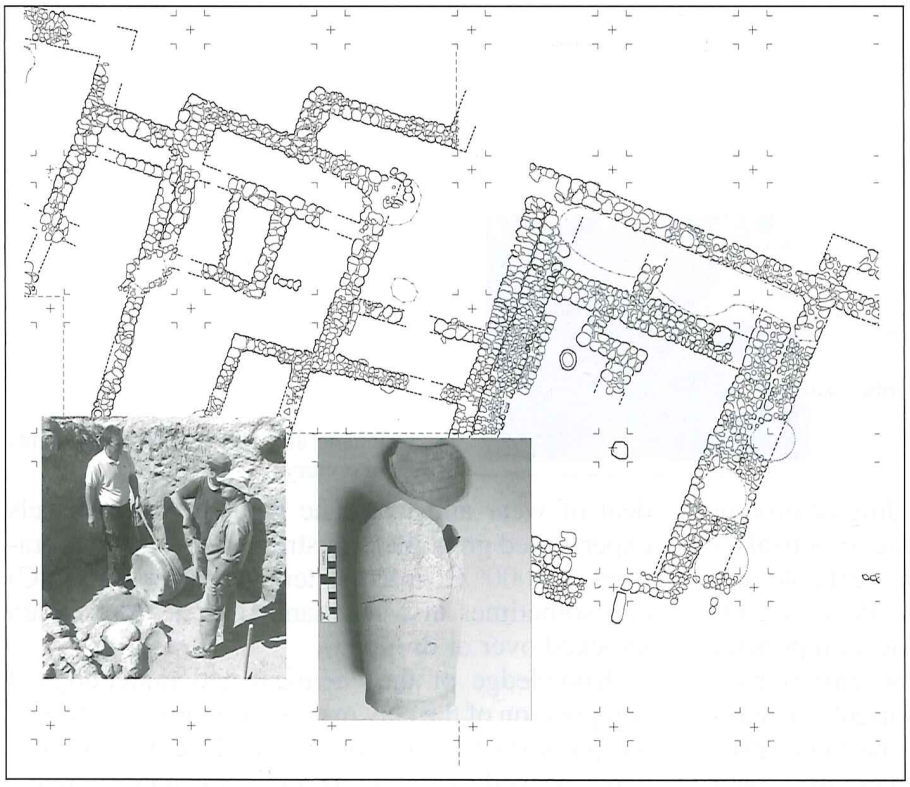
2.2.3. Iron Age II (FIG. 8)

The architecture of the Iron Age IIA - B period points to a considerably larger population on the *tall* than during the Iron Age I period. The settlement takes on an urban character and is once again protected by a town-wall, albeit this time in zigzag form and a great deal less solid than its Late Bronze Age counterpart. The settlement appears to have developed in agglomerated fashion, with houses built very closely together and domestic and administrative structures lying next to each other. House and property boundaries are signified in many cases by double walls (two walls built immediately next to each other).

On top of the Iron Age I 'four room house', a similar structure was erected in Iron Age II. In the adjacent house to the south a glass workshop was discovered.

At first sight, the transition between the sophisticated Late Bronze Age and less sophisticated Iron I settlements appears dramatic. The change from Iron Age I to the Iron Age II settlement, with its once again fortified but very characteristic agglomerative architecture, is also clear. Iron Age I clearly lies between the Late Bronze Age and Iron Age II traditions. It is truly a transitional period, characterised by both Bronze Age and Iron Age traditions. As such it reflects both continuity and change, that is to say the parallel existence of different cultures in one settlement, one neighbourhood and perhaps even within one family. It must be concluded that when change eventually occurred, it did so after years of parallel existence.

In looking at this mixture of continuity and change, with a population decrease following the destruction of the Bronze Age city and a population



8. Small part of the northern Iron Age II B stratum of Area I (2009).

increase in Iron Age II, one's attention is naturally drawn towards possible technical developments. It is the local and regional pottery industry in particular that can shed light on this issue.

2.3. Archaeometric Observations Regarding the Transition from Bronze Age to Iron Age (with Contributions by Andreas Hauptmann[2] and Wolfgang Auge[3])

A study of developments in cooking ware is particularly useful for addressing questions of technical innovation and thereby the socio-economic development of a settlement. Here, we concentrate on cooking pots.

In order to fulfil their basic function as cooking pots, materials and forms had to be found which remained thermostable (i.e. expandable) at temperatures above 1000° C and, if fuel was scarce, allowed for an efficient transfer of heat. In practice this meant thin walls and a useful surface to volume ratio.

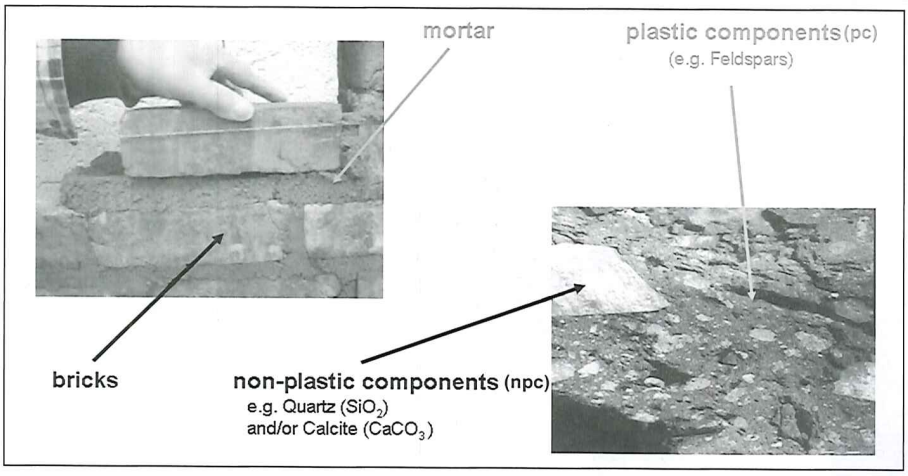
There are also other important, though not essential, considerations. These include ease of carrying and the ability to seal the vessel with a lid, i.e. weight, size, the addition of handles, shape of the rim etc. There were also aesthetic considerations, such as form, surface treatment, colour etc. All of these determined – depending on the socio-economic context – the demands the market made of manufacturers.

As a result of these demands, the rate of change (i.e. innovation) that occurred in the form and material of cooking vessels was particularly rapid in the periods under consideration. These changes are particularly clear at Tall Zar'ā, because it was continuously occupied for such a long period of time.

2.3.1. The Relationship Between Plastic and Non-Plastic Components of Cooking Vessels

Generally, pottery consists of plastic (pc) and [45]non-plastic (npc) components. The interaction between these two components can be illustrated using the example of a wall (FIG. 9)[4]. The plastic components are like mortar; it can be moulded when wet, but during the drying and firing process its form can alter, and it has no particular strength in isolation. The plastic components consist of minerals which contain aluminium and silicon (e.g. feldspars). The non-plastic components are like the bricks which give a wall its strength. The most frequent non-plastic components are calcite and / or quartz.

[2] German Mining Museum, Bochum.
[3] Biblical Archaeological Institute, Wuppertal.
[4] Obviously, in a wall the ratio of pc to npc is quite different to pottery, as is the chemical and mineralogical composition.



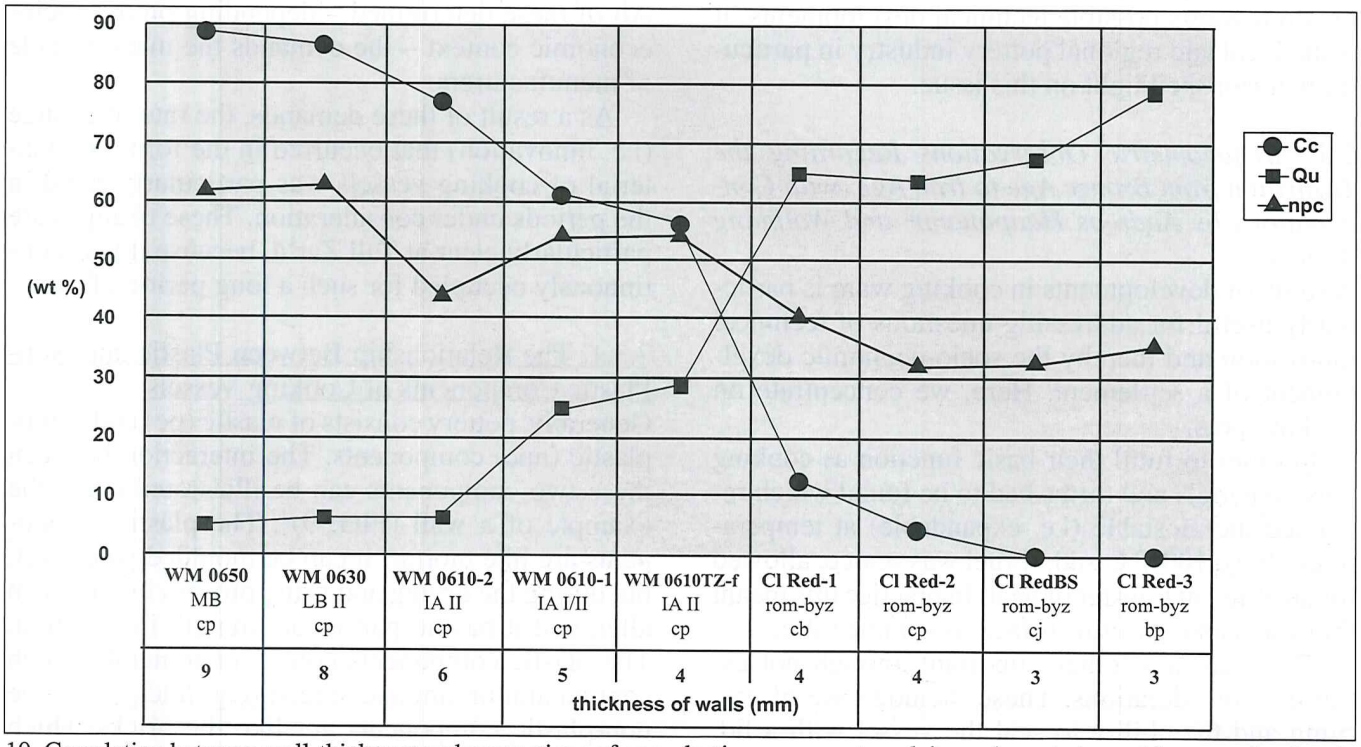
9. Plastic and non-plastic components in pottery.

One of the potters' skills was finding or mixing clays that had the right ratio of plastic to non-plastic components, so that it was both workable and durable. They also had to make sure the clay contained different types of non-plastic component, i.e. calcite and quartz, in the right concentrations[5].

These skills were especially important for making cooking vessels, which had to be very resilient (Vilders 1991/2: 69-81). They were used on a daily basis and as such were subjected to a great deal of wear and tear. The walls of such vessels experienced great thermal stress (fire-side temperatures > 1000° C; internal temperatures < 100° C) and sometimes also mechanical stress (e.g. when knocked over or dropped).

Knowledge of the chemical and mineralogical composition of the clay makes it possible to estimate the proportion of non-plastic (and plastic) components, as well as the quartz and / or calcite content.

FIG. 10 shows how cooking wares developed



10. Correlation between wall-thickness and proportions of non-plastic components, calcite and quartz in cooking vessels of various eras (npc = non-plastic components; Cc = calcite; Qu = quartz; cp = cooking pot; cb = cooking bowl; cj = cooking jar; bp = baking plate; HM hand-made; WM = wheel-made).

[5] In addition, potters intentionally add other materials (temper) to the clay, to decrease plasticity, reduce shrinkage during drying, increase strength of the fired pottery etc. The temper can be quartz, crushed rock (e.g. calcite), organic material (e.g. straw) etc.

during the Middle / Late Bronze Ages (MB/LB) by means of a reduction in the proportion of non-plastic components (npc / triangles) from > 60% to 30 - 40%, at which level it remained until the Roman - Byzantine (ROM-BYZ) period. Until Iron Age I - II, the calcite content (circles) remained at a high level (> 55%) and the quartz content (rectangles) remained at a low level (< 30%).

It seems that in all cooking wares of these periods, a high calcite content was considered a guarantor of sound thermal properties and became, in effect, a signature characteristic of cooking vessels[6].

Cooking wares WM 0610-1 / WM 0610-2, as well as cooking pot type WM 0610TZ-f which was first discovered on the *tall*, appear to indicate a paradigm shift. The proportion of non-plastic components was reduced to > 45%, while the quartz content increased to nearly 30% at the expense of calcite.

A more significant paradigm shift occurred during the Roman period. Some Roman classic red (Cl Red 1) cooking vessels still have a relatively high non-plastic component content (*ca.* 40%), but their quartz content is already high (65%) and calcite content accordingly low (< 15%). However, it can generally be said that in most Roman classic red (Cl Red 2 and 3) and classic red black-slipped (Cl Red BS) cooking wares, the proportion of non-plastic components was *ca.* 30 - 40%, whereas that of quartz increased to *ca.* < 80% at the expense of calcite, which was sometimes absent altogether.

With decreasing proportions of calcite and non-plastic components, coupled with increasing proportions of quartz, vessel-walls became thinner. WM 0610TZ-f already achieved a wall-thickness comparable to that of Roman - Byzantine wares[7]. With thinner walls (and optimised composition), cooking vessels became lighter and thermal properties improved. Analyses of many firing and re-firing experiments show that pottery with high calcite contents (WM 0610TZ-f / WM 0610 / WM 0630 / WM 0650; MB, LB, IA) was fired at temperatures of 550 - 700° C[8], while pottery with high quartz contents such as Roman classic red and classic red black-slipped (Cl Red and Cl Red BS; Roman - Byzantine) was fired at temperatures of up to 900° C, sometimes even more than 1000° C.

In sum, it seems that over time, better and more easily worked clays, as well as improved processing techniques, enhanced potters' creativity enormously. This is not only demonstrated by the reduced thickness of vessel-walls, but also by an increase in the number of types / shapes, from two during the Early Bronze Age (HM Buff) to 23 during Iron Age I - II (WM 0610-1 / WM 0610-2, including WM 0610TZ-f).

Amazingly, the number of Roman - Byzantine cooking vessel types is lower than that of Iron Age I - II, even though the Romans seem to have had knowledge of optimal clay composition and access to adequate (especially firing) technology. The reason for this may lies in the fact that Roman processing of common wares was already mechanised and standardised, perhaps even 'industrialised' by the late Roman era. Therefore individual creativity, as expressed in the production of numerous different types by small local workshops, was no longer needed (Homès-Fredericq and Franken 1986: 227-8).

The development of these Roman cooking vessels cannot be seen in the context of regional 'evolution' of Palestinian cooking wares, as their origins lay in Europe (specifically Italy) and more or less 'standardised' processing methods were exported to all parts of the Roman Empire. This is why imports from all parts of the Near East can be found (Schneider 2000: 525-536).

This type of 'Roman' development of cooking vessels could not take place at Tall Zar'ā or in the surrounding area during the Iron Age or later because:

1- Local clays have high calcite and relatively low quartz contents;
2- High firing temperatures (> 900° C) were necessary, but could not be achieved in the kilns which were commonly used during the Iron Age.

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[6] According to common theory, calcite, included in the form of smaller or larger crystals (temper), has an optimal thermal expansion coefficient - like many other inclusions (Rice 1987: 228-230). A similar effect is apparently caused by mica, which is present in most of the examined cooking pots from the *tall* in the form of the mineral illite.

[7] According to statistical analyses of cooking ware wall-thickness on samples from the *tall*, the values in FIG. 16 are most frequent (Gauss distribution). It is therefore clear that thicker and thinner walls also existed. The second most frequent thickness of WM 0610TZ-f is 3 mm, whereas Roman cooking vessels are sometimes thinner.

[8] Rice 1987: 98; calcite ($CaCO_3$) breaks down at temperatures in excess of 700° C, forming CO_2 and CaO (lime). As lime is hygroscopic, it absorbs H_2O to form 'quicklime' [$Ca(OH)_2$]. This process is accompanied by expansion, with the result that the surrounding clay body can crack if the lime particles are particularly large ('lime popping').

In this area, much more continuity than change can be observed between the Late Bronze Age and Iron Age. Late Bronze Age cooking ware type TZ 630 (FIG. 10) was the subject of further development in the Early Iron Age. A new group, 610, appeared at the end of the Late Bronze Age and was likewise developed further in the Iron Age (FIG. 10), no doubt owing to its advantages in terms of weight, thickness and thermal stability. For this reason it rose to predominance and became the main cooking ware type during Iron Age II.

We thus have on the *tall* a high degree of continuity in pottery making, both in production methods and kiln technology.

2.3.2. Chemical Analysis

Even though Late Bronze Age and Iron Age cooking pots were made in the same tradition and using the same techniques, we can see from their colour and quality that there are also significant differences between them. Chemical analysis of locally produced pots has examined this issue FIG. 11. With regard to the essential oxide components of potter's clay (SiO_2 [red], Al_2O_3 [yellow], Fe_2O_3 [green] and the ratio of CaO to Fe_2O_3 [blue]), the following observations can be made:

Cooking ware types from the Middle Bronze Age (our type 650), from the Late Bronze Age (our type 630) and from the Iron Age (our type 610) were all important steps in the general development of cooking pots, which had the aim of making them more robust, lighter and harder. The different types overlap each other chronologically, but many eventually disappeared to make way for more 'modern' types, such as 630 and 610, during Iron Age I.

This chronological development from the Late Bronze Age to the Iron Age saw:SiO_2 content increase considerably at the expense of CaO;

Fe_2O_3 and Al_2O_3 contents also increase dramatically.

During Iron Age I both types of cooking pot were produced in parallel, until the new wheel-made 610 ware became dominant and eventually ubiquitous during Iron Age II.

3. Conclusion (FIG. 12)

Continuity and at the same time new beginnings - this is how we can characterise the Early Iron Age at Tall Zar'ā. We have some dramatic changes, but no sharp breaks or completely new beginnings. New elements appear – both in architecture and pottery – and then become more common and eventually predominant. The older traditions continue in use for a time, but then disappear at the beginning of Iron Age II. This combination of continuity and discontinuity is what we have observed for Iron Age I at Tall Zar'ā. Perhaps it is typical for the region, but the situation in other regions of Palestine may have been entirely different.

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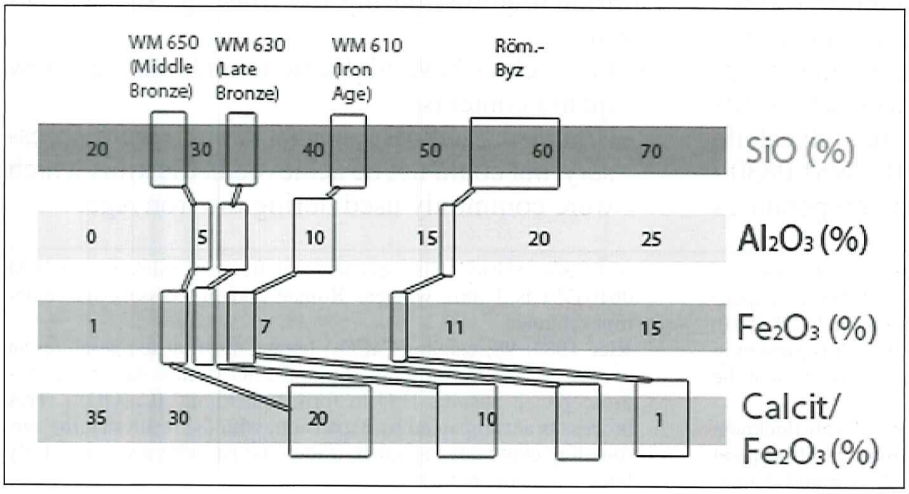

11. Chemical analysis of cooking pots.

12. Aerial view of Area I (2010).

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