THE TRANSITION FROM THE BRONZE TO THE IRON AGE IN NORTHERN PALESTINE. ARCHAEOLOGICAL AND ARCHAEOMETRIC INVESTIGATIONS ON TALL ZIRĀʻA

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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 socia and cultural changes is uncontroversial. Whilst, to the west of the Jordan River, the period is usually connected with destruction of Late Bronze Age cities by the Sea People, lack of Egyptian territorial organisation, conflicts between Canaanite city states or conquest by Israelite tribes, the area to the East of the Jordan is a different story.

Fig. 1 Tall Zirāʻa in Northern Jordan, viewing from Gadara

[*] Institute of Biblical Archaeology Wuppertal. I would like to express my deep gratitude to Manfred Bietak and the SCIEM 2000 project for inviting me to the conference about archaeology in Jordan at the Institute for Egyptology at the University Vienna in December 2010. It was a great honour for me to give this lecture on that occasion. I would also like to express cordial thanks to Wolfgang Auge, Wuppertal, for his significant contributions to this paper and especially to the Dr. Werner Jackstädt-Stiftung, Wuppertal, for their generous financial support of our project. But for this funding, our work could not have been accomplished.

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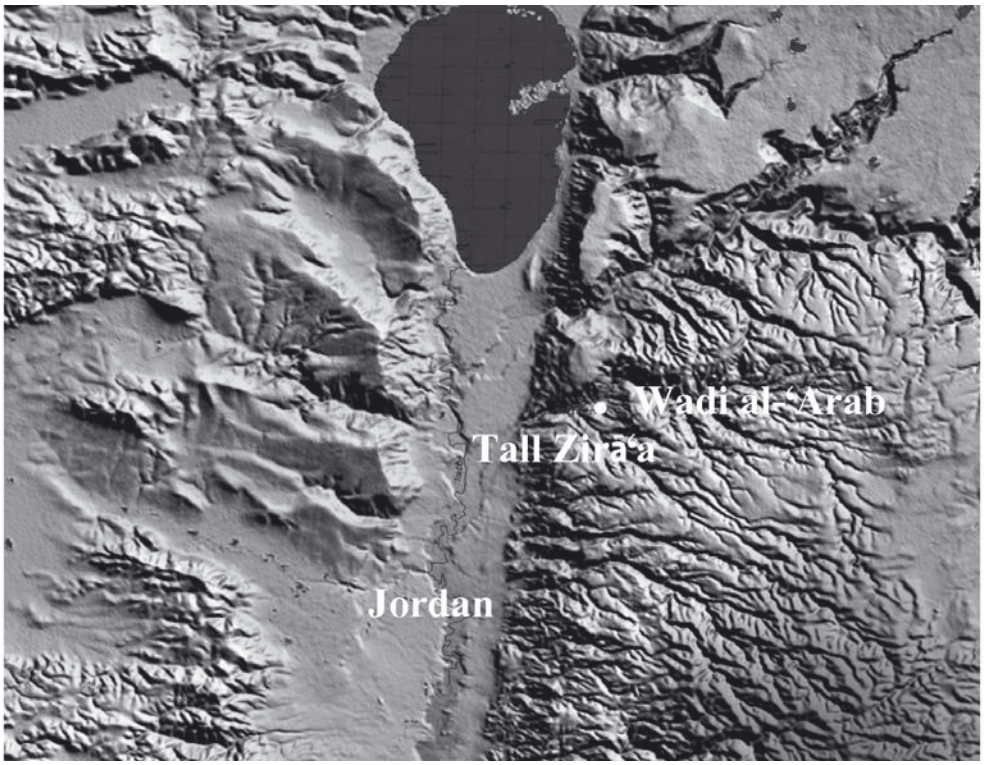

Fig. 2 Map of Northern Palestine

Scholars of this region can explore the evidence free of such presumptions and preconceptions which are based mainly on written evidence.

Ultimately, the main archaeological questions are as follows: when did the Late Bronze Age city state system collapse? Is there evidence of the causes of this event? In what form did Late Bronze Age culture continue? Which continued 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 to the Iron Ages?

1. The transition to the Iron Age in Transjordan generally

Previous discussion and the growing body of new evidence in recent years show that both the nature and the chronology of Early Iron Age settlements and the growth of territorial states in the Iron Age II were complex processes.

In the Ammonite region, for example, there were fortified settlements that run seamlessly from the Late Bronze Age into the Early Iron Age, such as Tall al-'Umayrī, Sahāb 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 associated by the excavators with violent destruction, tying up with the traditional scholarly view of the end of the Late Bronze Age.[1] On the neighbouring Tall as-Sa'īdiyya, however, there was a transitional period from the Late Bronze Age to the Early Iron Age. An Egyptian-style palace was found in stratum XII at Tall as-Sa'īdiyya The funerary culture displays influence from both Egypt and the Sea People (Tubb 1990: 26–37). The evidence at Tall al-Fukhār in northern Transjordan seems to suggest a seamless transition (Strange 2001: 292; vgl. Bienkowski 2001: 265–256), whilst the evidence thus far as Tall

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

Zirā'a (Fig. 1) does not tie up with this, pointing as well to a break as to a transition of some cultural features in material culture between the Late Bronze Age and the Early Iron Age.

It can be concluded from all of this that developments in the various regions need to be investigated separately on the basis of the archaeological data. This paper aims to illustrate this – using the example of the geostrategically important northwestern Transjordan area – the region around Gadara, starting with an introduction to the Gadara Region Project and the excavations on Tall Zirā'a.

2. Tall Zirā'a (Fig. 2)

Since 2001 the Gadara Region Project has been investigating Tall Zirā'a ('hill of agriculture') and the surrounding wadi system. An artesian spring emerges on the Tall, offering ideal conditions for settlement. Its first inhabitants settled the 20 m-high, 5.6 ha-broad calc-sinter hill/butte in the 4th millennium BC. From then onwards, the hill was settled virtually continuously until the 19th century AD. As a result, over the 5000 years of settlement more than 16m of cultural layers accumulated. Tall Zirā'a thus offers archaeologists the unique opportunity of developing a comparative stratigraphy for northern Jordan from the early Bronze Age to the modern period.

Tall Zirā'a is located at a key- point, both topographically and geopolitically, lying – as it does – at the cross-over point between Palestine and the Syrian-Mesopotamian as well as the Egyptian cultural spheres and politically and culturally influenced by both.

The settlement site was also well chosen on a prominent hill and on a major trade route through the Wādī al-'Arab linking 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 inhabitant's contacts with neighbouring regions.[2]

2.1. The stratigraphic sequence on Tall Zirā'a (Fig. 3)

The excavations in Area I are intended in particular to elucidate the Tall's stratigraphy. By the end of the spring campaign in 2010, 1750 m^2 had been opened up in this area. However, Area I was also chosen because it is the place with the most pleasant climate in the afternoon, catching the breeze that comes from the Mediterranean up the wadi, and thus also producing the perfect conditions for workmen's kilns, which is why we were also anticipating significant production activity in the area. As a result, in addition to stratigraphy, this area can provide vital information on artisanry, technological history and the transition from the Bronze to the Iron Age.

If we take a 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 ensuing move to a fortified settlement in the Iron Age II can also be clearly traced. At the same time, however, Bronze Age traditions continue into the Iron Age I, while other new ones run parallel through this period.

To explain this – I want to show you architectural features first and then I would add archaeometric detections in a second step.

2.2. Architecture

2.2.1. The Late Bronze Age (Fig. 4)

The most recent layer of the Late Bronze Age from the 14th and 13th century BC has been extensively excavated.[3] The most significant structure uncovered so far is the massive casemate wall that once protected the city on its north-western edge. The pottery dates it to the Late Bronze Age and the ^{14}C analysis of charcoal remains confirms this. Six casemate chambers have been excavated thus far. In peacetime they were used as storage rooms. In wartime they could be filled with earth and stones to produce 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 the rainwater that accumulated behind the city wall into a settling basin in one of the casemate chambers and, from there, into the vertical chute discussed above.

To the south, the casemate wall ended in a large, inward-facing tower in two parts. It contained a temple of the long-room type with a small inner Holy of the Holiest, a main room and a court-

[2] Häser and Vieweger 2008; 2010; Vieweger 2007; Vieweger and Häser 2008; 2010.

[3] Häser and Vieweger 2007; Vieweger and Häser 2007.

Fig. 3 Tall Zirā'a, area I (excavated stratigraphy from the Omayyad period to the Late Bronze Age)

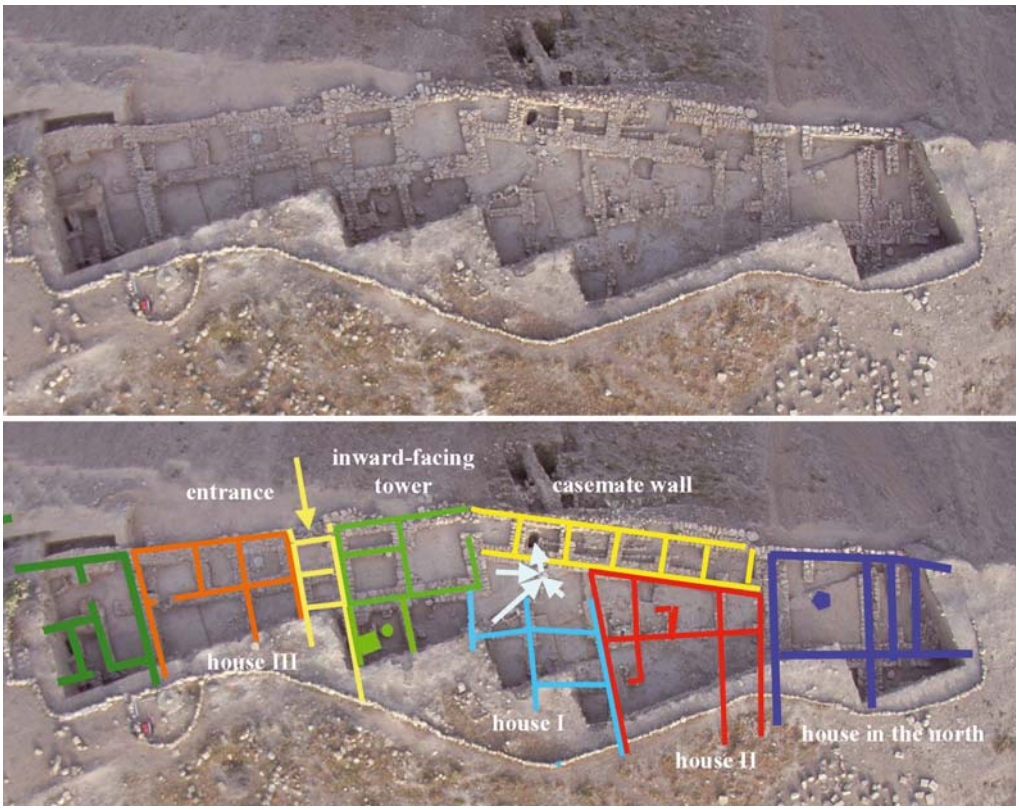

Fig. 4 Tall Zirā'a, Area I (2007) with the settlement of the 14th and 13th century B.C.

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

yard with an elaborate altar. In the southern half we found a large room which had seen a number of conversions, the latest of which involved a low partition wall in the west, creating behind it a small room only 1 m wide. This wall was supported by two large basalt column bases which once supported wooden columns to hold up the roof. The peculiar character of this small partitioned structure calls to mind the 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 due to its similarity to such cult stones found in Palestine.

To the south of the 'gate sanctuary', we turned up a gate opening, 2.75 m wide. This gate would have provided the most direct access for pedestrians to the lower-lying cities to the north and west.

To the south of the gateway we uncovered one of seven bottle-shaped, stone-lined 'pits'. The late Bronze Age cities contained such subterranean grain silos that were covered with large, (round) stone lids. They were 2.6–3.3 m deep and had stamped clay floors.

The impressive architecture of the late Bronze Age city state in this area boasted several courtyard houses. In 2008, in the northern part of the area, a room – which was part of a large and particularly well-built house – was discovered and it is there that 23 of 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 the inscriptions of Amenophis III and many glass beads have been so far found. We decided to investigate this house further in 2009, and we plan to finish in 2011. In 2010 we were able to excavate the large inner courtyard. It was ca. 150 m^2 in size and carefully paved with small pebbles. Adjacent to the large roofed room with a column base, another part of the building can be seen: a staircase consisting of two thick, parallel wall structures.

The large number of glass beads that have been found in this house complex, industrial pottery, raw glass (Fig. 6) and one half incised and one

Fig. 6 Raw glass find from Tall Zirā'a (2009)

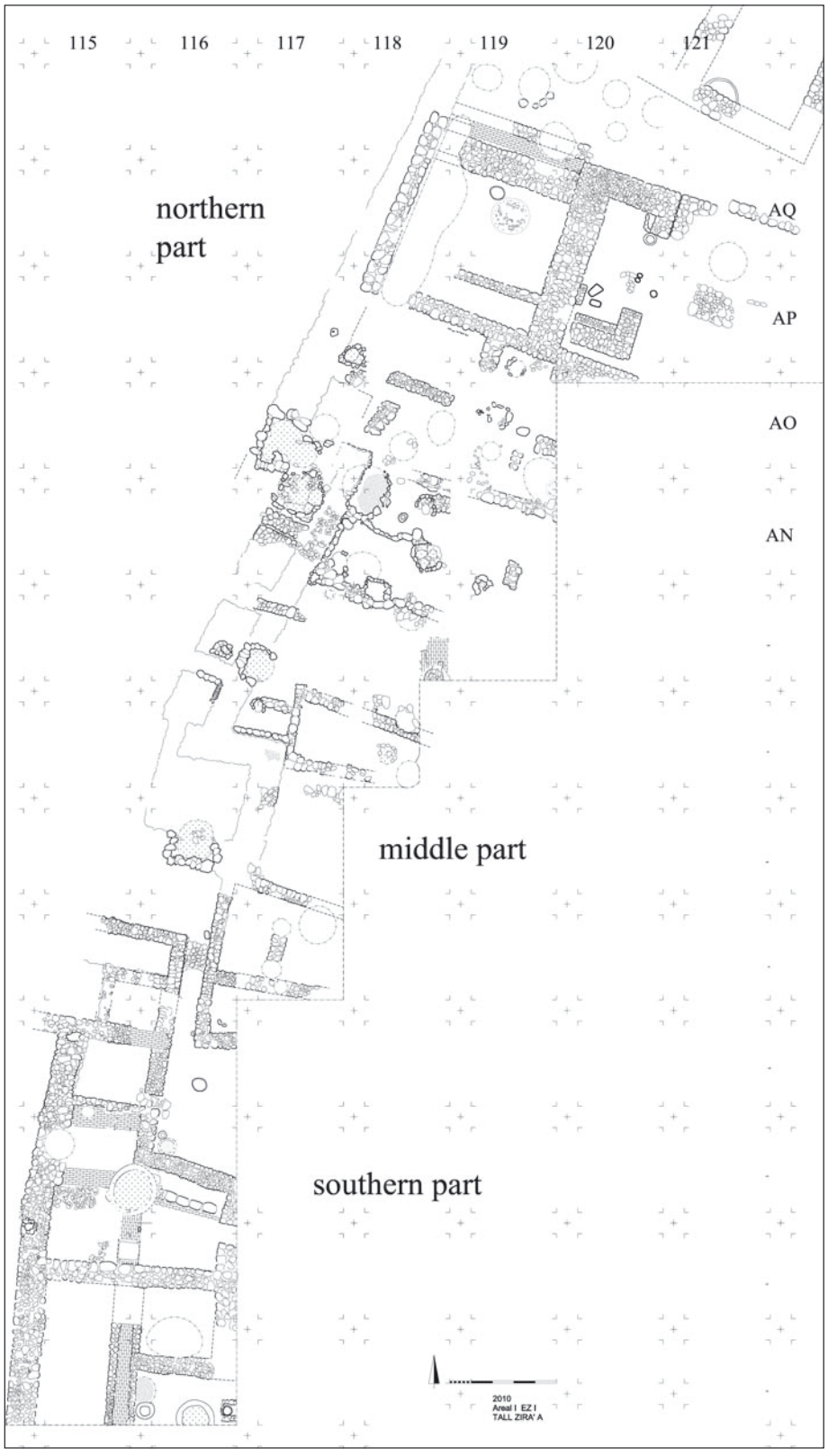

Fig. 7 Iron I stratum of area I (2010)

plain cylinder seal suggest that this part of the Tall may have been home to a faience- and glass-processing workshop in the Late Bronze Age. Further excavations in 2011 are needed to clarify questions about the function of the LB-complex and the special activities in each room.

2.2.2. Iron Age I (Fig. 7)

The settlement on Tall Zirā'a appears to have experienced a dramatic cultural upheaval in the period that followed (12th to 11th century BC). On the spot of the fortified city there now stood an open village inhabited by farmers, without even an outer wall.

The inhabitants of Tall Zirā'a 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 of storerooms and workrooms for various agricultural activities. The walls of stables and simple sheds came up against the remains of the Bronze Age walls. What has been found ties up with the traditional scholarly view of the beginnings of other settlements to the east of the Jordan, and of Israelite and Judean settlements in the highlands west of the Jordan, as being small and village-based.

Conversely, in the northern and southern part of Area I, very large and well-constructed buildings were uncovered. The two attached houses in the south (Fig. 7; AI–AE 115–116) were built with paved floors at the entrance and with thick and elaborately constructed stone foundations. A doorhinge stone was found in its original position. This

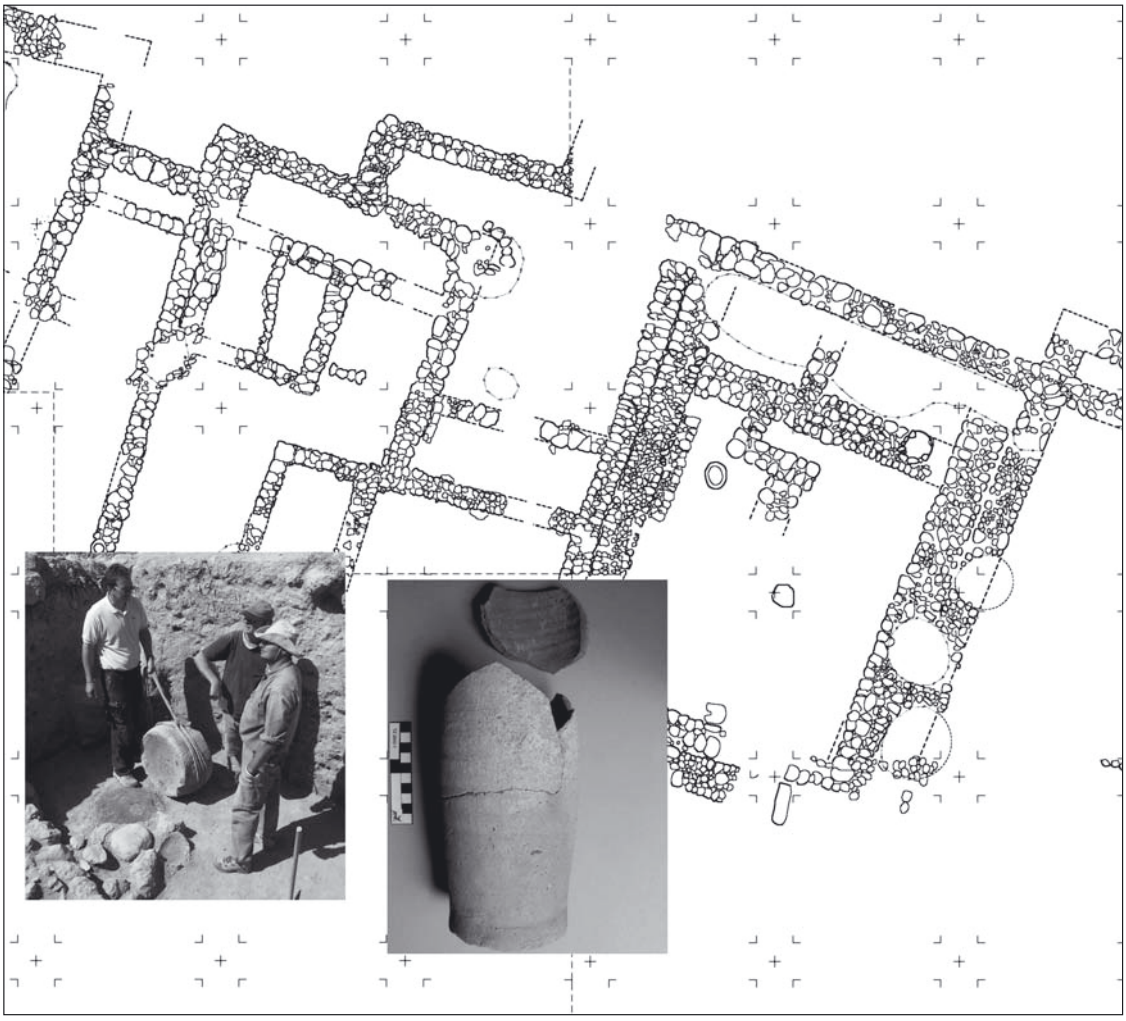

Fig. 8 Small part of the northern Iron II B stratum of area I (2009)

courtyard houses show clearly the extent of continuity of the Late Bronze tradition into the Iron Age architectural style. The courtyards contained large water vessels, tabun ovens and grinding stones. While stone-lined silos dominate the middle area (e.g. AK 116; AM 117; AN 117–118 and AO 117–118), the southern buildings contained two large, plaster-lined silos (AG 115–116; AE 116). Of particular interest is also a well-preserved oven made of various layers of mud, lime and pottery sherds that was found in the courtyard of one of these attached 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), its long, narrow rooms built to the north and south of the yard and its well-preserved main room in AQ 120, it can possibly be described as a so-called 'Four Room House' which is typical of the Iron Age tradition. In the spring of 2010 we uncovered in this house an elaborate faience- and glass workshop – like in Late Bronze Age times.

To sum up, in the Iron Age I period, Tall Zirā'a was an agricultural settlement without any fortifications, but with some larger buildings and industrial activities. There were Late Bronze Age traditions still in use – Iron Age traditions emerged parallel to them. Two charcoal samples from this stratum give a dating of between 1220 and 970 cal. BC, and 1270 and 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 in 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. Overall, the settlement appears to have evolved in a conglomerate pattern, with houses built very closely together and domestic and administrative structures directly next to each other. House and property boundaries are indicated in many cases by double walls (two walls built directly next to each other).

On top of the Iron-Age I 'Four Room House' was built a similar one in Iron Age II. In the adjacent house to the south a glass workshop was also discovered.

At first sight the transition between the sophisticated late Bronze Age and less sophisticated Iron I settlement appears dramatic. The changes from Iron Age I to the Iron Age II settlement, again with its fortified, but very characteristic conglomerate architecture are also very distinct. Iron Age I sits very clearly between Late Bronze Age and Iron Age II traditions. It is truly a transition period, characterised by both Bronze and Iron Age traditions, and as such stands for both continuity and renewal, a parallel existence of different cultures in one settlement, one neighbourhood and perhaps even one family. The necessary conclusion is that the changes occurred after years of running a parallel course.

In looking at this mixture of continuity and change, of population decrease concomitant with the destruction of the Bronze Age city and population increase in Iron Age II, one's attention is, of course, drawn towards possible technical developments. It is especially the local and regional pottery industry that can shed light in this respect.

2.3. Archaeometric observations with regard to the transition from the Bronze to the Iron Age

(with contributions by Andreas Hauptmann[4] and Wolfgang Auge[5])

A study of developments in cookware is particularly helpful in addressing questions of technical history, and with it the socio-economic evolution of a settlement. Fig. 9 demonstrates the inside of such a vessel.

In order to fulfil their basic function as cooking pots, materials and forms had to be found which remained thermostable (at temperatures above 1000° on the external surface) and, in general case of lack of fuel, allowed an efficient transfer of heat, in other words, thin walls and a useful ratio of surface to volume.

There are also other important, although not essential, considerations, such as for example ease of carrying or the ability to copse the vessel with a lid, in other words, weight, size, the addition of handles, the working of the rim etc. There were also aesthetic considerations, such as form, surface appearance, colour etc. All of these determined, depending on the socio-economic context, the demands of the market on the manufacturers.

[4] German Mining Museum, Bochum.

[5] Biblical-Archaeological Institute, Wuppertal.

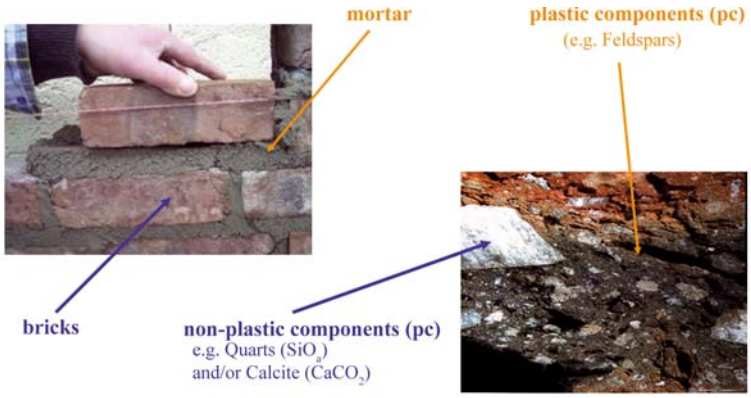

Fig. 9 Plastic and non-plastic components in pottery

As a result of these demands, the changes that occurred in the form and embodiment of cooking vessels, in other words, the rate of innovation, was particularly high over these periods, and can be observed distinctly on Tall Zirā'a due to its having continuous settlement over such a long period of time.

2.3.1. The relation between plastic and non-plastic components of cooking vessels

Generally, pottery consists of plastic (pc) and non-plastic (npc) components. The interaction between these two types of components can be illustrated using the example of a wall (Fig. 9):[6] The plastic components are like mortar – it can be moulded when wet, but during the drying and firing process its form can alter and has no outstanding strength by itself. The pc consists of minerals which basically contain aluminium and silicon (e.g. feldspars). The npc are like the bricks which gives hold and strength to a wall; the most frequent non-plastic components are calcite and/or quartz.

One of the potters' skills was finding and/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 components, e.g., quartz and calcite in the right concentration.[7]

These skills were especially important for processing the cooking vessels, as they had to be very resistant (Vilders 1991/2: 69–81). They were used on a daily basis and were in so far subject to a great deal of strain. The walls of such vessels were put under great thermal (temperatures on the fireside of more than 1000°C and internal less than 100°C) and sometimes also under mechanical stress (when toppled or dropped).

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

The diagram (Fig. 10) shows that the cooking pot ware developed during the Middle/Late Bronze (MB/LB) by reducing the part of non-plastic components (npc/triangles) from >60% to 30–40% and keeping at this level until the Roman Byzantine (rom-byz) period. Until the Iron Age I/II, the calcite content (circles) remained at a high level (>55%) and the quartz content (rectangles) at a low level of <30%.

It seems that in all cooking pot wares of these periods of time, high calcite contents were a guarantee of good thermal behaviour and were – so to speak – the trademark of the cooking vessels.[8]

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[6] It is obvious that, in a wall, the ratio of pc and npc as well as the chemical and mineralogical composition is quite different to pottery.

[7] Beside that, potters intentionally add materials (temper) to the clay to increase the portion of non-plastic components. The temper can be quartz, crushed rock (e.g. calcite), organic materials (e.g. straw), etc.

[8] According to generally accepted theory, calcite, included in the form of smaller or larger crystals (temper), has an optimal thermal expansion coefficient in relation to many other components (Rice 1987: 228–230). A similar effect is apparently caused by mica which is present in the form of the mineral illite in most of the examined cooking pots from the Tall.

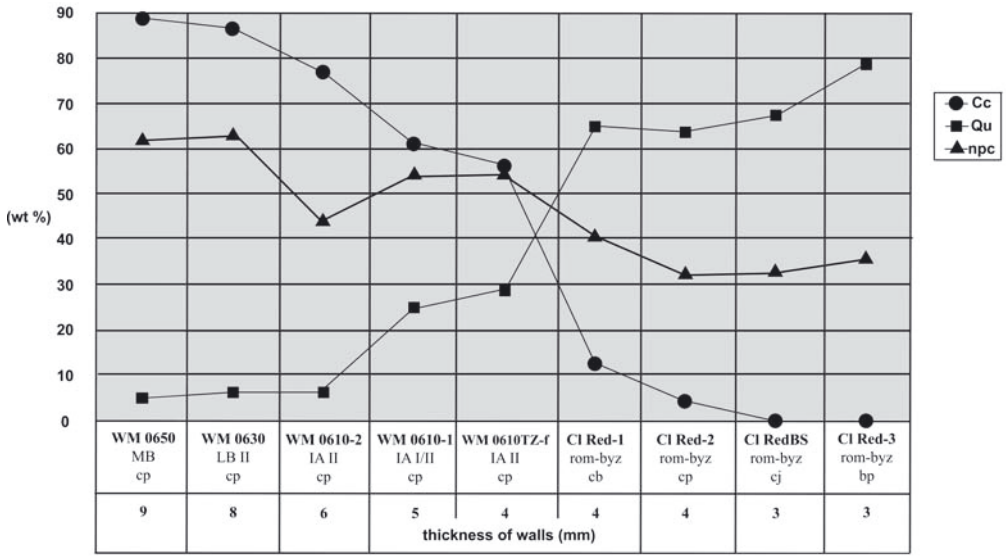

Fig. 10 Correlation between content of non-plastic components, calcite, quartz and wall thicknesses of cooking vessels in various eras (npc = non-plastic components; Cc = Calcite; Qu = Quartz; cp = cooking pot; cb = cooking bowl; cj = cooking jar; bp = baking plate; HM Hand-made; WM Wheel-made)

The cooking pot wares WM 0610-1/WM 0610-2 as well as the cooking-pot type WM 0610TZ-f, which was first discovered on the Tall, appear to indicate a paradigm shift: The share of npc shrinks to values of more than 45% and the quartz content increases up to nearly 30% at the expense of the calcite content.

The real paradigm shift, however, was to occur in the Roman period. Some Roman classic red (Cl Red 1) cooking vessels still have a relatively high npc share (approx. 40%) but their quartz content is already high (65%) and accordingly the calcite content low (<15%). However, it can generally be said that in most of the Roman cooking vessels of classic red (Cl Red 2 + 3) and classic red black slipped (Cl Red BS) the non-plastic shares lie at approx. 30–40%, whereas quartz can increase up to approx. 80% at the expense of calcite which can be as low as 0%.

With both decreasing calcite and increasing quartz content, the walls of the vessels became thinner so that WM 0610TZ-f already reached a thickness of vessels' wall comparable to those of the Roman-Byzantine wares.[9] With thinner walls (and optimized composition) the cooking vessels became lighter and thermal properties improved.

The analyses of many firing and refiring experiments show that pottery with high calcite contents (WM 0610TZ-f/WM 0610/WM 0630/WM 0650; MB, LB, IA) was fired at temperatures between 550–700°C[10] and that with high quartz and low calcite contents like classic red and classic red black slipped (Cl Red and Cl Red BS/Roman-Byzantine) at temperatures up to 900°C, sometimes even more than 1000°C.

Overall, it seems that over time better and better workable clays as well as improved processing techniques supported potters' creativity enormous-

[9] According to the statistical analyses of the thickness of the vessels' wall of the cooking pot wares from the Tall, the values in Fig. 10 are the most frequent ones (Gauss distribution). This makes it obvious that there are also thinner and thicker walls. The second most frequent thickness of WM 0610TZ-f is 3 mm, whereas the Roman cooking vessels sometimes are thinner.

[10] Rice 1987: 98; Calcite ($CaCO_3$) decomposes at temperatures of >700°C forming CO_2 and CaO (lime). As lime is hygroscopic, it absorbs H_2O and forms 'quicklime' [$Ca(OH)_2$]. This process is accompanied by volume expansion, so that the surrounding clay body can be cracked if the lime particles are comparatively large ('lime popping').

ly. This cannot be shown only by the decrease in the thickness of vessels' walls but also by an increasing number of types, resp. shapes: from two during EB (HM Buff) to 23 during IA I/ II (WM 0610–1/WM 0610–2, inclusive WM 0610TZ-f).

Amazingly, the number of Roman-Byzantine cooking vessel types is lower than that of Iron Age I/II, although the Romans seemed to have had the knowledge of optimal clay composition and of adequate (especially firing) technology at their disposal. The reason for this apparently is the fact that Romans' processing of common ware was already mechanised and standardized – and in the late Roman era already centralized and "industrialized". Therefore individual creativity (in the form of small local workshops) in terms of various types was no longer needed (Homès-Fredericq and Franken 1986: 227–228).

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

Such a 'Roman' development of cooking vessels could not take place on Tall Zirā'a (on local basis) in the Iron Age or later because

– local clays have high calcite and relatively low quartz contents and
– high firing temperatures (>900°C) were necessary, but could not be achieved by using the kilns which were common during Iron Age.

Overall, we can observe from the Late Bronze to the Iron Age much more continuity than change. The Late Bronze Age cooking ware type WM 0630 (Fig. 10) evolved further into the Early Iron Ages. The new group WM 0610 appeared at the end of the Late Bronze Age and evolved further into the Iron Age (Fig. 10) due to its advantages of weight, thickness and thermal stability. It was for this reason that it went on to dominates and become the main cooking ware type during the Iron Age II.

We have thus on the Tall a continuity in pottery making – in production methods and kiln technology.

2.3.2. The chemical analysis

Even the cooking pots between the Late Bronze and Iron Ages are made in the same tradition and with the same technique we can also analyse and see from their colour and quality that they are also significant different. The chemical analysis of the locally produced pots deals with that difference (Fig. 11). In studying the essential oxide components of pottery, SiO_2 (red), Al_2O_3 (yellow), Fe_2O_3 (green), and the ratio CaO to Fe_2O_3 (blew), the following observations can be made:

The cooking ware type-groups from the Middle Bronze Age – our type WM 0650, from the Late Bronze Age – our type WM 0630 and from the Iron

Fig. 11 The chemical analysis of cooking pots

Fig. 12 Aerial view of area I (2010)

Age – our type WM 0610 are themselves important steps in the much broader scheme: to make the cooking pots more robust – lighter and harder. The different types overlap in time – they exist parallel to each other but eventually disappear to make way for more 'modern' types – like the types WM 0630 and WM 0610 during the Iron Age I.

In this chronological transition from the Late Bronze Age to Iron Age

- SiO_2 content increases (at the expense of CaO) considerably – and
- Fe_2O_3 and Al_2O_3 content also increase dramatically.

During the Iron Age I, both types of cooking pots were produced parallel – until the new ware of WM 0610 became dominant and at least solitary during the Iron Age II.

3. Resumé (Fig. 12)

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

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