The chronology of Tell el-ᶜAjjul, Gaza: stratigraphy, Thera, pumice and radiocarbon dating

Peter M. Fischer

The intercultural importance of Tell el-ᶜAjjul is well documented through the rich find complex from W.M.F. Petrie's projects in the 1930s and the renewed excavations by P.M. Fischer and M. Sadeq. The historical identification of Tell el-ᶜAjjul from Egyptian texts is ambiguous but the Canaanite "Sharuhen" is a possible candidate. Tell el-ᶜAjjul was undoubtedly one of the most influential cities in the area in the late Middle and the Late Bronze Ages according to the rich find assemblages. The finds, which include sophisticated jewellery, the largest number of scarabs anywhere in the Levant, and a rich repertoire of imported pottery, demonstrate trading connections with Cyprus, Crete, Egypt, Lebanon, Syria, the Upper Euphrates, Anatolia, and the Mycenaean sphere of culture.

Amongst the finds were also numerous samples of pumice, which represent a powerful tool for relative chronological dating. The provenance of these pumice samples was studied by means of instrumental neutron activation analysis (INAA). The implications of a possible High Chronology based on the results of recent radiocarbon dates of material from the Minoan eruption of Santorini are therefore of great importance, not only for the chronology of the various societies of Tell el-ᶜAjjul but also for a number of associated cultures based on numerous imports to Tell el-ᶜAjjul.

Introduction

Excavations of Tell el-ᶜAjjul were carried out by W.M.F. Petrie and his team in the 1930s.[1] The last regular excavation of Petrie and his team was in 1938.[2] The duration and chronology of each of Petrie's "Cities III-I" and "Palaces/Fortresses I-V" represent a long-debated and as yet unsolved problem.[3]

Due to the overwhelming risk of the total destruction of the ancient city, and the stratigraphic and chronological problems which were evident from Petrie's inadequate reports it was decided in 1998/99 to renew the excavations as a joint Palestinian-Swedish project under the direction of P.M. Fischer and M. Sadeq in collaboration with the Department of Antiquities of Palestine.[4] Two seasons of excavations (1999 & 2000) have to date been carried out at Tell el-ᶜAjjul. The excavations have come to a temporary halt due to the current unfavourable political circumstances.

The importance of the site has been highlighted by many scholars during discussions of foreign relations and chronology. The results of the new excavations, which produced an almost unparalleled

[1] Petrie 1931–34.

[2] Mackay & Murray 1952. Illicit digging and "excavations" in connection with building activities have affected Tell el-ᶜAjjul to a large extent. Not much of the ancient city remains untouched.

[3] This old terminology should be used with extreme caution – or rather abandoned until an appropriate synchronization of the cultural horizons from the new excavations with those from Petrie's times has been carried out. The latter lack a number of strata which are evident in the new excavations, see Fischer & Sadeq 2000; 2002. The conclusions in quite a number of publications on the stratigraphy and chronology of Tell el-ᶜAjjul are based on the imprecise recording system and unreliable publications of Petrie – which were once virtually the only evidence available – and they consequently lack the required accuracy (see *inter alia*: Stewart 1974; Kempinski 1974; Bergoffen 1990; Dale 1994; Robertson 1999).

[4] The excavation permit was kindly provided by H. Taha, the director of the Department of Antiquities of Palestine. The excavations will be resumed as soon as the political situation allows.

accumulation of imported finds in relation to the size of the investigated area, mirrored very well the image of a cosmopolitan society with contacts all over the Eastern Mediterranean and further east. Ceramics and other imports came from Cyprus, Egypt, Lebanon, Syria, the Upper Euphrates, Anatolia, and the Mycenaean sphere of culture.

Lumps and tools of pumice, a find category which did not receive the appropriate attention during the old excavations but which represents a very important tool for the definition of the relative and absolute chronology of Tell el-ᶜAjjul and related sites, were found to be well represented in the occupational sequence of the *c.* 300 square-metre area which was opened in 1999 and 2000. Therefore, emphasis has been put on the provenance study of the 48 recovered samples of pumice by instrumental neutron activation analysis (INAA) and their stratigraphic distribution.[5] Many of the pumice samples were found in the process of soil flotation to extract botanical remains.

Stratigraphy: an overview

The new excavations were carried out close to today's highest spot on the tell, within the 5000 square-metre area fenced off in 1999.[6] Eight horizons, of which H8 (just above *kurkar*, *viz.* virgin soil) to H2 contain architectural remains, were exposed.[7] Each of the occupational phases H8-H2 came to an end through conflagrations. However, surviving walls were re-used and incorporated in new constructions. H8 is the only phase in which walls with stone foundations were built. The walls in all the other phases are all constructed of sun-dried mudbrick.

The preliminary interpretation of the architectural remains is so far limited to H5-H2 because there is not enough exposed in the lowest horizons H8-H6 and too much eroded above H2 to enable us to draw any reliable conclusions before we have more evidence from continued excavations. All structures are orientated north-west to south-east. The basic building plans of H5 and H4-3 are similar. There is a structure to the north, only a minor part of which has been exposed, which makes an interpretation problematic. It is, however, likely that this structure faces an open space or street to the south-west which is approximately 2.5 m wide and which separates it from a larger building to the south. This building to the south covers an area at least of 20 m in the north-south direction and 15 m in the east-west direction. Any detailed interpretation of the function of the building has to await the results of the continued excavations.

The precise correlation and synchronization of the cultural horizons from the new excavations with those of Petrie's excavations must likewise await the results of the resumed excavations.[8]

Pottery

A thorough discussion of the relative chronology of the pottery from the new excavations at Tell el-ᶜAjjul, with numerous parallels, can be found in various recent publications.[9] Our discussion here is limited to a few parallels which will be highlighted. Locally made ceramics include numerous cooking pots (Figs 1-3). These vessels are amongst the best chronological markers as far as ceramics are concerned: in all excavations of multi-period sites carried out by the author over the years the shapes of cooking pots demonstrated the most convincing diachronic pattern of change. It has been shown that four types prevail in H8 to H2:[10] the "collared" cooking pots of H8 with parallels from, for instance, Shechem XIX (MB II);[11] the cooking pots[12] with

[5] See also Fischer 2003.

[6] See Fischer & Sadeq 2000; 2002.

[7] Consequently, H1 lies directly below colluvial soil.

[8] There is of course an overwhelming risk that it might prove very difficult or even impossible to separate certain mixed "City" or "Palace" strata retroactively.

[9] See *e.g.* Fischer 2003; Fischer 2006a, 369–74; Fischer 2006b, 181–9.

[10] See Fischer 2003, 271–91. I concentrate here on H7-6 and to some extent on H5 because these levels represent the later part of the MB and early LB.

[11] The MB I, II, III terminology is used in this paper with the exception of the references in original publications.

[12] There are certain common traits of the cooking pot in Fischer 2003, 278, fig. 6.2 and the Shechem (XIX) MB II cooking pot in Cole 1984, 149, pl. 25.k.

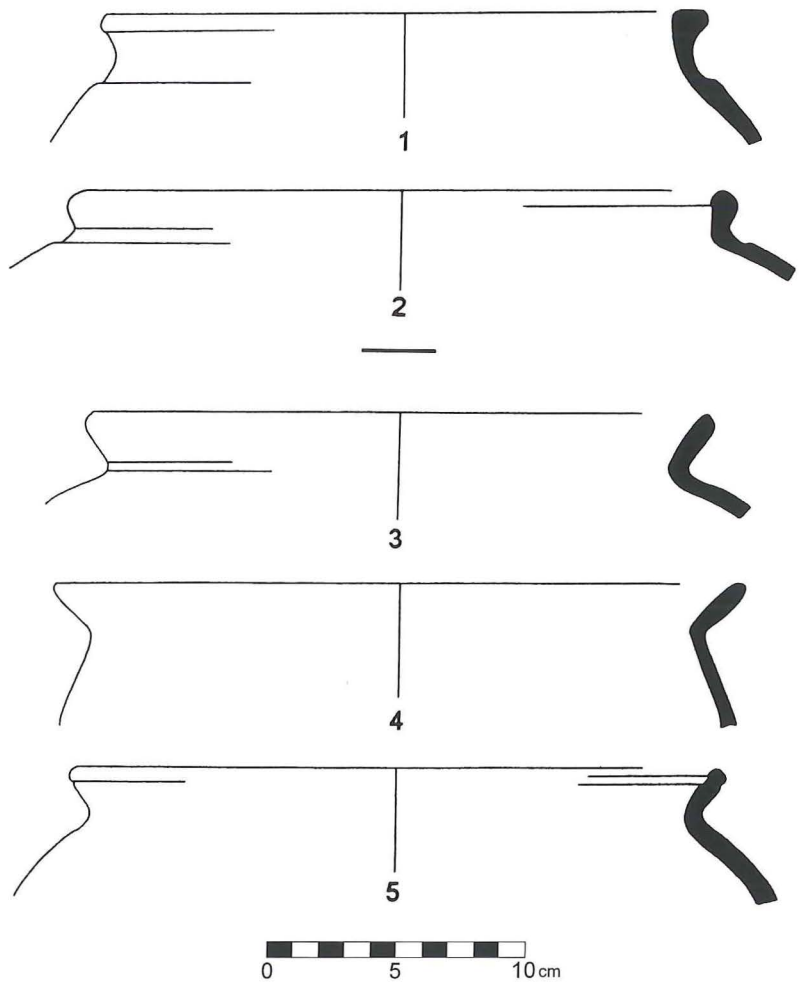

Fig. 1. The chronological distribution of cooking pots from Tell el-ᶜAjjul: 1,2 H8; 3-5 H7-6.

everted, straight or slightly outwardly curving rims and tapering or slightly thickened lips of H7-6 with parallels from MB Tell Deir ᶜAlla;[13] the three types of H5: the first with upright/slightly flared rims and one or more carinations on the neck, the second with the everted, straight or slightly outward curved rim with a tapering or slightly thickened lip which has also been found in H7-6, and the third, which dominates at the end of the Middle Bronze Age and throughout the Late Bronze Age in the Southern Levant, with everted, straight or slightly outcurved, square or triangular rims.

Another vessel which is considered to be a good chronological marker is the carinated bowl. There are bowls with very pronounced carination in H7-6 which are generally considered to be of MB II date and in a derivate shape of MB III date.[14] However, our examples fit the former group better. Parallels are from MB II Shechem,[15] from MB II/III Tell Deir ᶜAlla[16] and from MB II (III) Beth Shan.[17]

A complete dipper juglet from the floor H8, whose stratigraphic position at Tell el-ᶜAjjul indicates that it antedates the eruption of the Thera volcano (see below), deserves special attention.[18]

[13] Good parallels can be found in the MB cooking pots from Tell Deir ᶜAlla in van der Kooij 2006, 211, fig. 8.4a-b.

[14] Fischer & Sadeq 2002, 132, fig. 22.3–5.

[15] MB II examples from Shechem in Cole 1984, 131, pl. 17.a,b; see also his general discussion on pp. 55–9.

[16] MB II/III from Tell Deir ᶜAlla Phase IV in van der Kooj 2006, 212, fig. 9.7 which was found together with a juglet of the Tell el-Yahudiyeh Ware.

[17] See Beth Shan Strata R-5–R–3 in Maeir 2007, 250–1. The best parallels are from R–5 (pl. 14.18) and R–4 (pl. 23.11 and photo 4.9 on p. 251).

[18] Concerning an excellent parallel from E1 / a/2 ("MB IIB") see Kopetzky 2002, 235, fig. 5.4630.

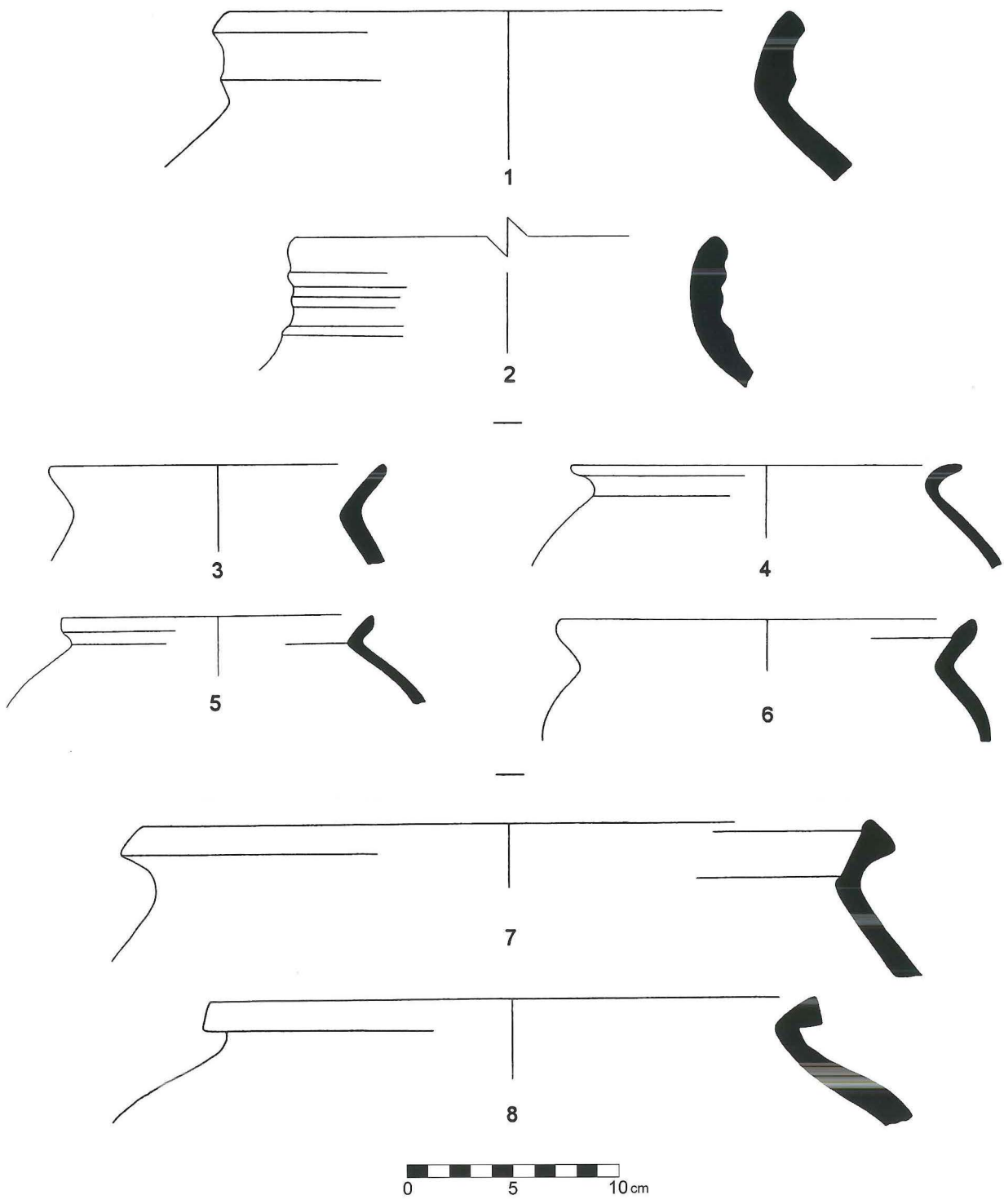

Fig. 2. The chronological distribution of cooking pots from Tell el-ᶜAjjul: all three types from H5.

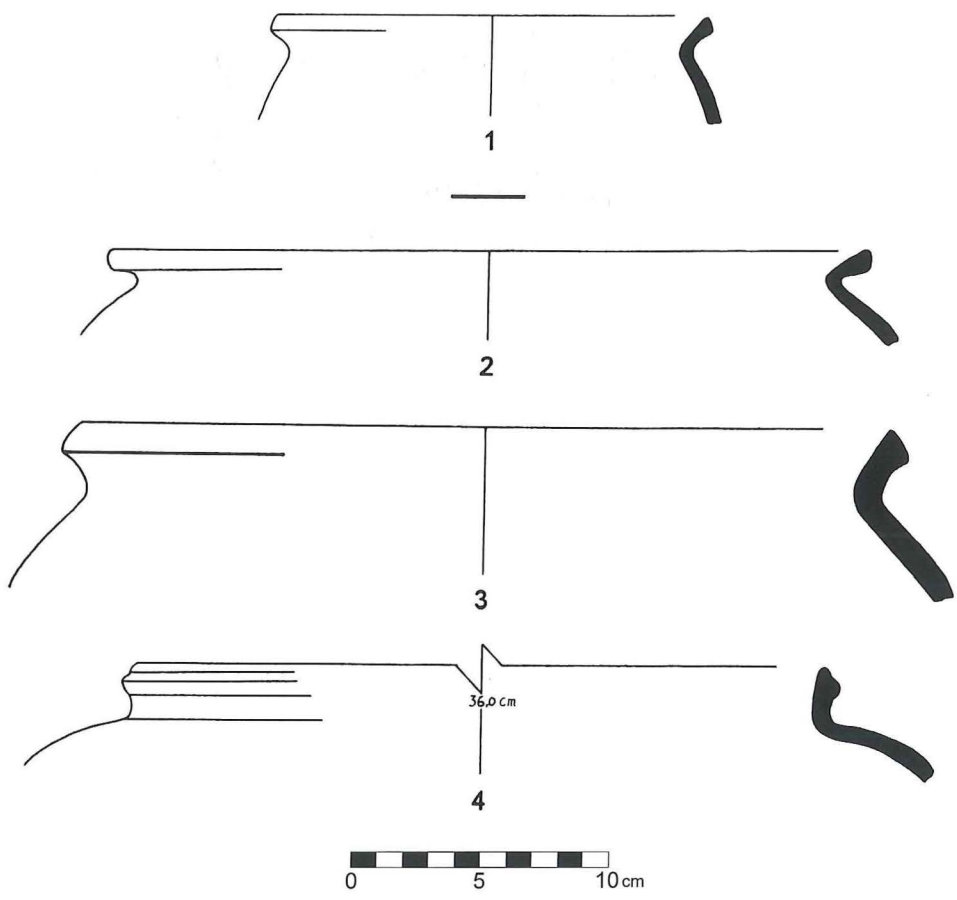

Fig. 3. The chronological distribution of cooking pots from Tell el-ᶜAjjul: 1 H4-3; 2-4 H2.

There are almost identical parallels from stratum E1 (and stratum E2) from the first half of the Hyksos period at Tell el-Dabᶜa in the Nile delta or in absolute terms the second half of the 17th century BC.[19] The associated locally produced pottery from H8 reflects very well the ceramic repertoire of a multitude of sites in the Southern Levant during the MB II.[20] Parallels to H8 come, for instance, from Shechem MB II contexts.[21] A juglet from H5 with a double handle and a knob decoration has parallels, for instance, at MB Beth Shan[22] and Shechem.[23] A crater from MB Beth Shan has an almost identical counterpart in another one from Tell el-ᶜAjjul H5.[24]

To summarize: it can be stated that the H8-6 belong mainly to the MB tradition of the Southern Levant, whereas H5-2 are principally at home in the LB tradition. There are, nevertheless, at present no well defined criteria which clearly distinguish between the material culture of the "late MB" and the "early LB" of the Southern Levant. Much of the attribution of the ceramics of a particular site to MB or LB is based on subjective definitions of, for instance, production techniques and shapes and decoration of parallels from other sites, the consideration of the position of the site, *viz.* isolation

[19] These dates are from Bietak & Höflmayer 2007, 16, fig. 3.

[20] See Fischer & Sadeq 2002, 135, fig. 25.

[21] *Cf.* the selected material from H8 in Fischer & Sadeq 2002, 135, fig. 25, and Shechem MB IIB (= MB II) in Cole 1984, pls. 16–49 *passim*. Parallels to the Shechem MB II ceramics already appear in H7/6, see *e.g.* the S-shaped bowls and the bowls with the marked carination in Fischer & Sadeq 2002, 132, fig. 22 which are considered a typical trait of the second half of the Middle Bronze Age.

[22] Beth Shan Stratum R–5a in Maeir 2007, 276, fig. 4.9 left and pl. 22.1.

[23] Shechem XIX and XVIII (MB II) *passim* in Cole 1984, 153–4, pls. 27–8.

[24] *Cf.* Fischer & Sadeq 2002, 126, fig. 17.6 and Maeir 2007, 343, pl. 14.2 (R–5).

Table 1. The preliminary distribution of the imported wares from the new excavations.

Horizons:	Coll + H1	H2	H3-4	H5	H6	H7	H8	*Total*
Cyprus:								
Base-Ring I or II	58							*58*
Base-Ring I*	4	13	27	2?				*46*
Base-Ring II	31	72	2					*105*
Bichrome Wm	11	18	51	35	8			*123*
Black Slip				5	2			*7*
Monochrome	9	21	64	96	7	1		*198*
Red Lustrous Wm	5	7		2				*14*
Red Slip					13			*13*
Red-on-Black			3	3	1			*7*
Red-on-Red			2	2	2	1		*7*
White Painted V/VI	2	1	2	5	1			*11*
White Shaved		2		4				*6*
White Slip I or II	5	1						*6*
White Slip I**	4	8	32	23				*67*
White Slip II	70	89	3					*162*
Total	*199*	*232*	*186*	*177*	*34*	*2*	*0*	*830*
Black Lustrous Wm	2	7	8	4	1***			*22*
Jordan Valley/Southern Lebanon								
CW Bichrome		1		1				*2*
CW I and II	7	3	11	10				*31*
Eggshell Ware		3	13	6				*22*
Total	*7*	*7*	*24*	*17*				*55*
Egypt								
Carinated jars	2		2					*4*
Piriform jars		2	3	5	4	4	1	*19*
Shallow bowls	1	4	1			1		*7*
Deep bowl			1					*1*
Totals	*3*	*6*	*7*	*5*	*4*	*5*	*1*	*31*
Middle Euphrates/North Syria			1	1				*2*
Mycenaean-type	1	4						*5*
Total	*212*	*256*	*226*	*204*	*39*	*7*	*1*	*945*

* It should be highlighted that differentiation between Base-Ring I and Monochrome vessels is sometimes very difficult or even impossible when small sherds are involved, *viz.* that *e.g.* the two sherds of assumed Base-Ring I in H5 might well be classified as Monochrome Ware (pers. comm. P. Åström).

** There are some bichrome decorated sherds in H5 which according to P. Åström (pers. comm.) represent transitional Proto White Slip / early White Slip I.

*** This minor sherd might well be Tell el-Yahudiyeh Ware.

Provenance	Number	Percentage
Cyprus	830	88
BLWM	22	2
Jordan Valley/S. Lebanon	55	6
Egypt/Egyptianizing	31	3
M. Euphrates/N.Syria	2	<1
Mycenaean-type	5	<1

Table 2. The distribution of the 945 imported sherds/vessels.

from contra inclusion in the intercultural exchange of goods and knowledge, and other factors. I therefore suggest a MB/LB transitional period of considerable length.

The imported pottery provides the possibility of cross-dating because of the presence of 945 imported sherds/vessels from Cyprus, the Jordan Valley, Egypt, the Middle Euphrates/North Syria, and the Mycenaean sphere of culture.[25] Imports from Cyprus dominate (a total of 830 sherds/vessels in H8 to H1/Coll), followed by those from the Jordan Valley (a total of 55 sherds/vessels), Egypt (a total of 31 sherds/vessels) and a few from the Mycenaean sphere of culture and the Middle Euphrates. The distribution and the proportions of the imported pottery can be studied in Tables 1 and 2.

Cypriote imports are Base-Ring I and II, Bichrome Wheel-made, Red and Black Slip, Monochrome, Red Lustrous Wheel-made, Red-on-Black/Red-on-Red, White Painted V/VI, White Shaved, and transitional Proto White Slip / White Slip I, White Slip I and II. There are also 22 sherds of Black Lustrous Wheel-made Ware, whose provenance will be studied by petrography.[26] Imports from the Jordan Valley/Southern Lebanon are Chocolate-on-White Bichrome, Chocolate-on-White I and II, and Eggshell Ware (a total of 55 sherds). Egyptian and Egyptian-style pottery is represented by shallow bowls and piriform and carinated jars, the latter two of which were imports from Upper Egypt. There are two sherds of Grey Ware bowls, at least one of which (or even both) are imports from the Middle Euphrates and a link to Northern Syria: excellent parallels come, for example, from MB III at Lidar Höyük and Levels IX and VIII at Alalakh and Tell Hadidi LB IA.[27]

There are a number of examples of Tell el-Yahudiyeh Ware from the old excavations at Tell el-ᶜAjjul[28] but except for one rim/handle of a juglet no other stratified finds of this ware were recorded during the new excavations.

Scarabs

Scarabs are usually poor chronological markers because they could, for instance, have been kept as heirlooms for considerable time or they may have obviously been manufactured as imitations of older scarabs long after their original production date, for example, at Tell el-ᶜAjjul. Tell el-ᶜAjjul produced prior to the renewed excavations an astonishing 1,244 scarabs or scaraboids.[29] The renewed excavations resulted in five scarabs, four of which could be ascribed with fairly good precision to the later part of the Hyksos period in Egypt.[30] The fifth was incomplete. All of them seem to be have been made by a local cutter (according to Mlinar). The scarabs stem from H1, H6, H7 and from a tomb of the early Late Bronze Age I.

[25] The locally produced pottery from the new excavations comprises 65,056 sherds including the complete or intact vessels.

[26] The provenance of Black Lustrous Wheel-made Ware, under which name a number of wares may be included, is much debated (Hein 2007). It is planned to extend the petrographic studies to other wares, for example White Slip, in order to trace a more specific provenance.

[27] Our ware corresponds to "Ware J" at Lidar Höyük, the date of which is the end of the local MB III. Personal communication G. Kaschau; see also Heinz 1992, 64 as regards similar finds from Alalakh IX and VIII but they continue later on; Dornemann (1981, 42–3, fig. 13.22) dates his finds which are "an outgrowth of the MB II tradition" to the second half of the 16th century without references to absolute dating methods.

[28] See *e.g.* Merrillees 1974, 106.167 from "Palace III" (EXII.67/2; database *MontAjjul* input no. 2241), or another from City II (EXIII.78/9; *MontAjjul* input no. 5048).

[29] Keel 1997, 104–525.

[30] *Cf.* Mlinar 2002, 143–51.

Pumice from Tell el-ᶜAjjul

Pumice from excavations of well-defined cultural layers is an excellent *post quem* indicator of relative chronology under the precondition that its volcanic source can be traced and that the eruption can be defined in time (see discussion below). The possibility of correlating pumice finds from the cultural horizons of Tell el-ᶜAjjul potentially linked with the Minoan eruption of Santorini is therefore of great interest.

The essential properties of pumice make it a useful material for different purposes. Therefore this easily accessible pumice was no doubt used by the people of Tell el-ᶜAjjul who dwelled close to the Mediterranean littoral as an abrasive or as a component of polishing tools used for the manufacture of goods. Pumice is consequently a quite common find in most excavations in the Eastern Mediterranean. It has, however, been common practice in many excavations to collect only tools and possibly larger lumps of pumice. The use of flotation not only for the extraction of botanical remains but also for the detection of small pieces of pumice would certainly dramatically increase the proportion of pumice samples in many excavations and would give us a powerful tool for relative dating of material from the first half of the second millennium BC, *viz.* the time of the Minoan eruption of Santorini. This has been demonstrated by the flotation of 502 litres of soil from the present excavations at Tell el-ᶜAjjul, which added considerably to the number of pumice samples for later neutron activation analysis.

Lumps of pumice and (parts of) tools were collected both from first-class *loci* and from secondary contexts[31] both during the excavations and as a by-product of the flotation of soil samples, the organic remains of which were used for our paleobotanical analysis.[32] The distribution of the samples is as follows (Table 3): one sample is from the colluvial soil, two samples are from Petrie's old excavations,[33] 43 samples derive from 25 different loci in H5–1, and two samples derive from intramural tombs. Pumice could not be detected below H5, *viz.* in horizons H6 down to H8. All forty-eight samples of pumice were analyzed by neutron activation analysis in order to trace the source of their volcanic origin (Table 4).[34]

Horizon	Number of samples	Percentage
Colluvial	1	2
Old excav.	2	4
H1	2	4
H2	6	13
H3–4	12	25
H5	23	48
H6	none	-
H7	none	-
H8	none	-
Tomb (L198)	1	2
Tomb (L205)	1	2

Table 3. The distribution of the 48 pumice samples.

Neutron activation analyses have shown that pumice from the "Minoan" eruption of Thera can be identified and distinguished from other pumice sources by its trace element distribution pattern.[35] Instrumental neutron activation analysis (INAA) is therefore a suitable technique for determining simultaneously a large number of geochemically significant trace elements. It is used for the identification of eruption products by their element distribution patterns, the "chemical fingerprint". It has been shown that the best identification is achieved by using elements with immobile behaviour in sedimentary environments, because mobility leads to contamination effects as well as to depletion by

[31] These contexts include disturbed loci such as colluvial soil, areas with backfill and fills in tombs.

[32] The paleobotanical analysis has been carried out by M. Tengberg (forth.). The flotation equipment was used with the kind permission of P. de Miroschedji, the co-director of the nearby Palestinian-French Expedition at Tell es-Sakan.

[33] There are no records in Petrie's publications of earlier excavations in this area, minor parts of which were discovered in the north-western part of the new excavations.

[34] I am much obliged to M. Bichler, M. Exler, C. Peltz and S. Saminger from the Atominstitut der Österreichischen Universitäten for the rapid INAA analyses of the pumice samples from Tell el-ᶜAjjul (Bichler *et al.* 2003) and all additional information on volcanological and geochemical subjects.

[35] See *e.g.* Peltz *et al.* 1999; Bichler *et al.* 2003.

Horizon	Number	Provenance		
		Thera Bo ("Minoan")	Thera Bm/u ("Pre-Minoan")	Nisyros
Colluvial	1	1		
Old excav.	2	2		
H1	2	2		
H2	6	4		2
H3-4	12	12		
H5	23	23		
H6	none			
H7	none			
H8	none			
Tomb (L198)	1	1		
Tomb (L205)	1		1	
Proportion		94%	2%	4%

Table 4. The stratigraphic context and the provenance of the Tell el-ᶜAjjul pumice.

leaching. These effects can be observed for K and Cr in the samples related to the "Minoan" eruption. However, the good agreement of the immobile elements, especially the rare earth elements, allows a reliable identification.

The elements As, Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, K, La, Lu, Na, Nd, Rb, Sb, Sc, Sm, Ta, Th, U, Yb, and Zr are of particular interest and it was possible to determine their concentration. The applicability of this technique for the distinction of other, chemically rather similar, eruption products of other volcanic sources such as Kos, Gyali, Nisyros and Milos (*i.e.* the southern Hellenic volcanic island arc) has been demonstrated in previous studies.[36] This has been proved by analysis of stratified pumice from the excavations at Tell el-Dabᶜa in the Nile where even long storage under wet conditions did not interfere with the classification by chemical fingerprinting (Table 4).[37]

INAA of the Tell el-ᶜAjjul pumice samples was carried out after conventional preparation including a thorough cleaning procedure with *aqua destillata* in an ultrasonic bath, microscopy and homogenization of a representative amount in an agate mill. The samples were weighed out into a Suprasil quartz glass vial, sealed and irradiated together with standard reference materials in the neutron flux of the research reactor at Rez, Czech Republic. After suitable decay times, the activation products were measured by gamma-spectrometry and the concentrations of the respective elements were calculated.[38]

It could be proved that the main volcanic source of the Tell el-ᶜAjjul pumice samples is Thera by studying the element distribution patterns displaying the element concentrations normalized to the mean "Minoan pumice". Forty-five pieces, or 94%, of all pumice samples come from the Minoan eruption of Santorini, which corresponds to Upper pumice (Bo). Of these, 41 samples are from well-defined loci/cultural horizons from H1 down to H5 and none from H6-8. Two samples can clearly be related to the Caldera Pumice eruptions on the Aegean island of Nisyros (maximum 24,000,000 years BP).[39] One sample comes from the Middle (Bm) or Lower pumice (Bu) of Thera, which represent the result of an earlier eruption sequence deposited between one hundred and two hundred million years BP.[40]

How did the pumice from the Theran eruption arrive at Tell el-ᶜAjjul? Logically there are only

[36] See note 35.
[37] Peltz & Bichler 2001.
[38] The results can be studied in Fischer 2003, 266–70.
[39] Limburg & Varekamp 1991.
[40] Druitt *et al.* 1999.

two possibilities, either the "natural" way within a short time after the eruption or by trade which might have been caused a delay in their deposition at Tell el-ᶜAjjul. During the Minoan eruption of Santorini, a large volume of magma was ejected in the short time span of not more than a few days and the eruption products were distributed over a large area. The majority of the erupted material consists of chemically rather homogeneous pumice tephra and pumiceous flow deposits.[41] For a long time, the estimates of the volume ranged from 16 to 35 km^3 of magma,[42] but recent investigations suggest that a range of 100 km^3 of magma is more probable.[43] It is obvious that the major part of the material erupted was deposited directly into the sea. As it consists mainly of highly vesicular silicate glass, pumice floats on water. Depending on the size of the pumice lumps some time elapses before the fine glassy bubble walls break and the pumice becomes soaked and finally sinks. Experiments have shown that even relatively small samples of pumice can float on sea water for more than 1.5 years.[44] Pumice may therefore be expected to be transported by marine currents and wind over large distances all over the Eastern Mediterranean region. It can be assumed that within weeks after the eruption large amounts of pumice accumulated along the shorelines. Natural events, such as earthquakes, storms and erosion through water action, have certainly contributed to a continued distribution of floating Theran pumice not only directly after the eruption but also in the years that followed.[45] It seems, however, most likely that the distribution of floating pumice from Thera and its final deposition and accumulation along the shores of the Levantine coast was most intensive directly after the eruption.

The implications of Theran pumice at Tell el-ᶜAjjul

It has been said that forty-one samples from well defined loci within H1 down to H5 are from the Minoan eruption of Santorini. It is indeed interesting that there is an abrupt change from the absence of pumice in H6 to 23 pieces of pumice samples of Theran provenance in the subsequent H5. These 23 pieces represent 56% of all stratified pumice samples from a single horizon. It should also be also be pointed out that "Minoan" pumice from H5 could be collected in six of the eight excavated trenches from 2000. This shows a considerable spread of the sample locations within the 200 square-metre area opened in the year 2000. Let us therefore advance the following proposition: the Minoan eruption of Santorini took place before H5 (or it is contemporaneous with H5B). H5 consists actually of two sub-phases the older H5B and H5A: Theran pumice was found in both sub-phases.[46]

The "sudden" appearance of "Minoan" Theran pumice in H5 in most of the trenches and the absence of pumice in H6 might be in favour of the above postulate. Nevertheless, it cannot be excluded that Thera erupted in any of the horizons antedating H5 because of the limited excavated area (*i.e.*, 2000 AD): all horizons down to and including H5 have been excavated almost completely. Seventy-five percent of the totally excavated area is exposed in H6, sixty-three percent in H7 and thirteen percent in H8. It is therefore a possibility that "Minoan" Thera pumice might be discovered during the resumed excavations below H5. Had, however, the Minoan eruption of Santorini occurred in either period which is represented by H6 down to H8, it is astonishing that Theran pumice from this eruption – either traded or accumulated along the shorelines – has not yet been found below H5.

The Thera eruption: radiocarbon and pumice from Tell el-ᶜAjjul

Two principal publications from recent years define the radiocarbon-dated chronological range of the Thera eruption.[47] Friedrich *et al.* dated a branch

[41] See *e.g.* Vitaliano *et al.* 1978; Pichler & Schiering 1980; Bichler *et al.* 1997.
[42] Sigurdsson *et al.* 1990; Friedrich 2000.
[43] F. McCoy (pers. comm.).
[44] Whitham & Sparks 1986.
[45] McClelland & Thomas 1990.
[46] *Cf.* Fischer 2003, 270–1.

of an olive tree with 72 rings which was buried alive in pumice: the radiocarbon date of the outermost ring, the year of the eruption, corresponds to 1627-1600 BC (2σ) or 1621-1605 BC within the 1σ range (frontispiece opposite title page). Manning *et al.* dated 127 samples from Thera itself but also from other related Aegean sites and came to the conclusion that the most likely date for the eruption is 1660-1613 BC (2σ) with 1639-1616 BC as the most likely subrange (1σ, and same results using the IntCal04). The overlap of these two sets of dates is consequently 1627-1613 BC (2σ) or 1621-1616 (1σ).

Let us assume that our fairly well-substantiated hypothesis is correct, namely, that Thera erupted in H6 (in any case before H5 or possibly during H5B) because of the sudden appearance of Theran pumice in H5 in most of the trenches and the absence of pumice in H6. The absolute date of H6 would then correspond to the time just before 1600 BC, or around 1600 BC at the latest, based on the radiocarbon dates of these two sets of data (Friedrich *et al.* and Manning *et al.*).

There are eight radiocarbon samples from the renewed excavations (2000) at Tell el-ᶜAjjul itself which were processed and dated by the VERA-laboratory in Vienna: [48] two are from H6, four are from H5A and two are from H4/3. All samples were treated as samples belonging to "Find Class 1", *viz.* their positions where recorded by the EDM in all dimensions.[49] The sequencing of their radiocarbon dates can be studied in Fig. 4.

These dates agree fairly well with the other radiocarbon dates of the Minoan eruption of Santorini and our hypothesis. Although they are somewhat lower than one would have expected from the results of Friedrich *et al.* and Manning *et al.* they are nonetheless comparable. Radiocarbon-based rough dates from Tell el-ᶜAjjul itself are for the eruption (H6) around 1600 BC, for H5A around the mid-16th century, and for H4/3 around 1500 BC, give or take a few decades. It is evident that additional samples and larger sets of radiocarbon dates from Tell el-ᶜAjjul will be a major concern when the excavations are resumed.

Radiocarbon, Thera, Tell el-ᶜAjjul and Tell el-Dabᶜa: Preliminary Conclusions and Hypotheses

The discrepancy of the chronologies during the second quarter of the second millennium BC based on radiocarbon dates from Tell el-Dabᶜa and on the Egyptian genealogy is well known.[50] It has been reported above that – by applying the hypothesis that Thera erupted in H6 – the radiocarbon dates from Tell el-ᶜAjjul are fairly compatible with the two sets of radiocarbon dates from Thera, but admittedly a little lower (Fig 4).

Essential factors which might support the historical chronology are the argument that a Cypriot White Slip I bowl has been found in the pumice layer of the Theran eruption and the absence of this typical ceramic ware in Hyksos layers at Tell el-Dabᶜa. By the possible acceptance of the ambiguous records of this unique White Slip I bowl from Thera, which was first recorded in 1872 but then vanished,[51] the Thera eruption might be placed at the beginning of Dyn. XVIII unless White Slip I appears in Hyksos layers during future excavations. It should, nevertheless, be remembered that White Slip I is a very uncommon find at Tell el-Dabᶜa considering the lengthy campaigns and the enormous size of the excavated area there: there are only five stratified and two unstratified sherds of undisputable White Slip I.[52] In comparison – after

[47] Friedrich *et al.* 2006; Manning *et al.* 2006a,b.

[48] Two samples were discarded because of the old wood effect. More samples would have been beneficial in this discussion; however, it should be remembered that the entire chronological discussion in this paper is based on the results of two short seasons at Tell el-ᶜAjjul where only a limited area was opened.

[49] See the description of the recording system in Fischer & Sadeq 2000; 2002.

[50] See *e.g.* Bietak & Höflmayer 2007, 13–4, and fig. 1 which is based on the VERA radiocarbon dates.

[51] See the thorough study of this elusive bowl in Merrillees 2001.

[52] I. Hein (pers. comm.); there are also ten White Slip I *or* II sherds (seven stratified and three unstratified) from New Kingdom layers. However, Hein emphasizes that there may be

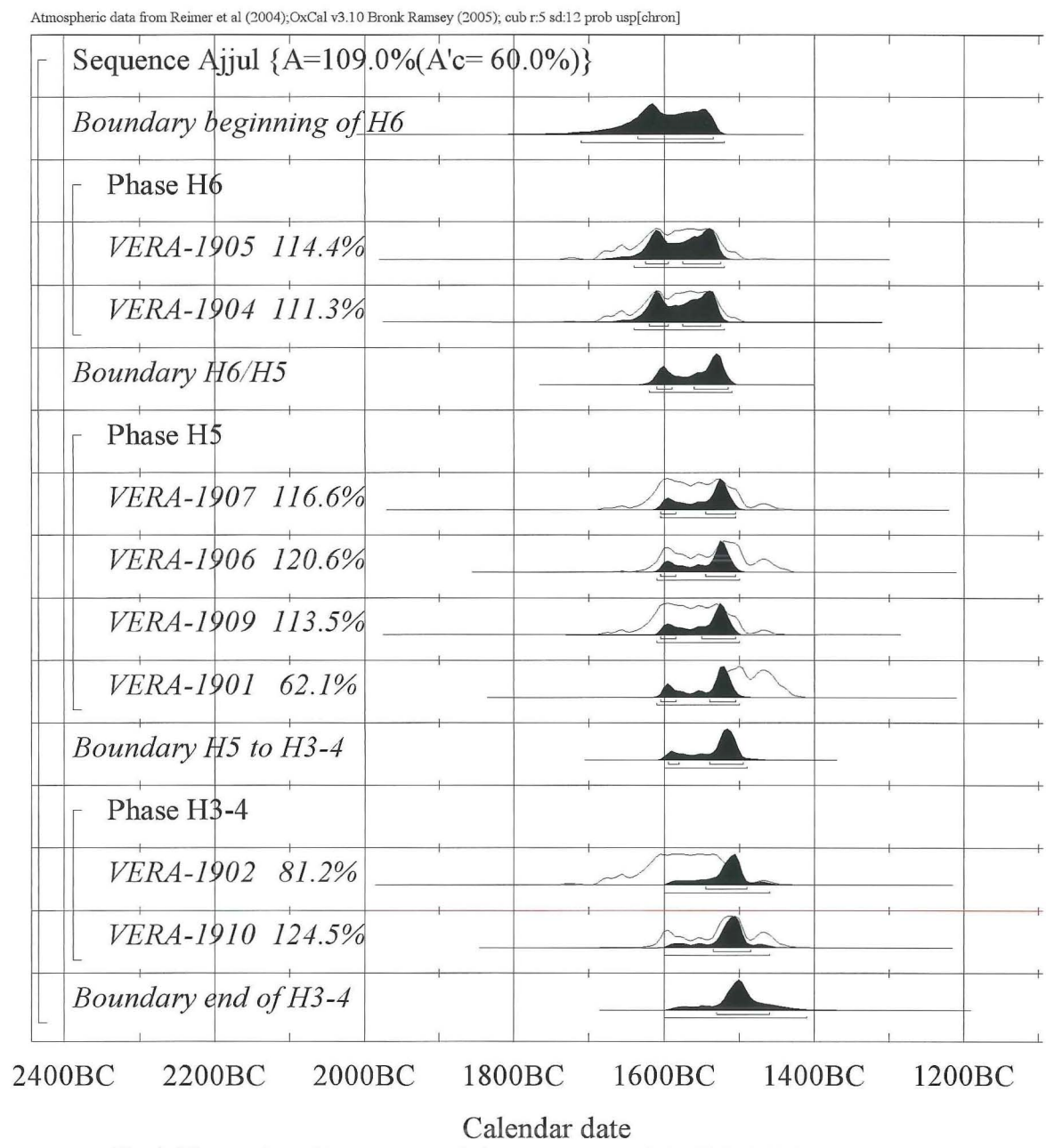

Fig 4. The stratigraphic context and the provenance of the Tell el-ᶜAjjul pumice.

only two short campaigns – the new excavations at Tell el-ᶜAjjul produced a minimum of 67 sherds of White Slip I within an area of little more than 300 square metres which in addition was only partly excavated (see above).

Another important observation is the absence of Theran pumice in Hyksos layers despite the considerable number of analysed pieces of pumice from Tell el-Dabᶜa. Nevertheless, it cannot be excluded that future excavations might discover Theran pumice in Hyksos layers and that finds of pumice in H6 or in even earlier horizons, which so far have not produced any Theran evidence, may be made at Tell el-ᶜAjjul. This would make it necessary to revise certain hypotheses.

Cross links between Tell el-ᶜAjjul and other sites and areas have been discussed at length in several

a few additional sherds which might have been processed by other colleagues during the last years.

publications.[53] As far as the evidence from Tell el-Dab^{c}a is concerned, Bietak (pers. comm.) pointed out that certain vessels of Egyptian origin or Egyptianizing vessels from H5A at Tell el-^{c}Ajjul[54] belong to the Tuthmoside period (no further precision), *viz.* from around 1500 BC or later. Hein[55] again classified an Egyptian shallow bowl from H7 at Tell el-^{c}Ajjul as belonging to the Hyksos period, which is in line with our observation deduced from a juglet in H8 that has parallels from the first half of the Hyksos period at Tell el-Dab^{c}a (see above).

Another very important piece of information which does not usually receive the necessary attention in archaeological reports and discussions concerns the temporal aspects of the lengths of various layers of occupation. In order to meet the radiocarbon results one would have to adapt and possibly "stretch" the lengths of the occupational horizons at Tell el-^{c}Ajjul. Let us assume a theoretical occupational length of 30 years for each of the cultural horizons at Tell el-^{c}Ajjul.[56] Let us put the end of H5A, from which there are (almost) complete Egyptian imports, around 1500 BC (give or take a few decades).[57] H5B would then last from 1560-1530 BC, and H6 from 1590-1560 BC. This hypothetical back-counting would lead us fairly close to the radiocarbon-based chronology of the Theran eruption which is obviously not acceptable to our Egyptian colleagues, in particular.

There is hardly anyone in the two opposing "camps" who would deny the importance of Tell el-^{c}Ajjul in connection with chronological discussions because of the unparalleled amount of imported material and numerous finds of Theran pumice. It is the hope of the author (and all the others involved in this discussion) that the excavations at Tell el-^{c}Ajjul can be resumed shortly.

---

[53] See *e.g.* Fischer & Sadeq 2000; 2002; Fischer 2001; 2003; 2004; 2006a,b; 2007.

[54] Fischer & Sadeq 2002, 129, fig. 19.7–10.

[55] I. Hein (pers. comm.).

[56] This has been used in the past. This time span is highly hypothetical but certainly not impossible.

[57] It should be remembered that the presence of complete or almost complete vessels in H5A (or any other cultural layers) is from the final part of occupation of this layer. In contrast, single sherds might be earlier (or are contemporaneous).