STRATIGRAPHY AND RADIOCARBON DATES OF THE PPNA SITE OF KÖRTİK TEPE, DİYARBAKIR

Marion BENZ*
Aytaç COŞKUN
Bernhard WENINGER
Kurt W. ALT
Vecihi ÖZKAYA

Introduction

Körtik Tepe (37°48'51.90" N, 40°59'02.02"E) is the first early Holocene site of southeastern Turkey that has yielded 418 single and some double burials and 114 round architectural structures until 2009 (Özkaya 2009). The excavations led by Prof. Dr. Vecihi Özkaya of Dicle University, Diyarbakır, are part of a large salvage program. They began in 2000 and have continued to the present (Özkaya 2004; Özkaya and San 2007; Özkaya and Coşkun 2007; Özkaya and Coşkun 2008). From July 20 to August 16 2009 we had the opportunity to take part in these important excavations and to collect archaeobotanical and anthropological samples.[1] In order to compare the ecological changes in the region with the development of Körtik Tepe social structure, it was first necessary to provide a reliable site chronology. With this aim in mind, four stratigraphic profiles were studied (Fig. 1). These include the two eastern profiles of Trenches A80 and A84, which are 6.40 m and 3.20 m long, respectively. Trenches A80 and A84 were excavated down to -300 cm, with a deep sounding (~1m^2) in Trench A80 dug down to 5.25 m. Two additional smaller profiles were studied from Trench A61 and Trench A84. The Profiles of A80 and A84 provided samples for radiocarbon dating. Altogether 12 ^{14}C-ages have now been processed at the Laboratory of Ion Beam Physics of the ETH Zurich and in this report we present first results of their stratigraphic analysis.[2]

* Dr. Marion BENZ, Department of Near Eastern Archaeology, Albert-Ludwigs-University, 79085 Freiburg/GERMANY. Marion.Benz@orient.uni-freiburg.de
Arş. Gör. Aytaç COŞKUN, Dicle Üniversitesi, Edebiyat Fakültesi, Arkeoloji Bölümü, 21280 Diyarbakır/TÜRKİYE.
Dr. Bernhard WENINGER, Institute of Prehistoric Archaeology, Radiocarbon Laboratory University of Köln/GERMANY.
Prof. Dr. Kurt ALT, Institute of Anthropology, Johannes-Gutenberg-University, 55099 Mainz/GERMANY.
Prof. Dr. Vecihi ÖZKAYA, Dicle Üniversitesi, Edebiyat Fakültesi, Arkeoloji Bölümü, 21280 Diyarbakır/TÜRKİYE.

1 We are grateful to Vecihi Özkaya and his team for their cooperation and for their support. The description of the stratigraphy and the radiocarbon dates is part of a cooperative project between Kurt W. Alt, Institute of Anthropology (AG Alt), Mainz, and PD Dr. Simone Riehl and Dr. Katleen Deckers, Archaeobotany of the University of Tuebingen. We owe our thanks to the German Research Foundation for financial support.

2 The archaeobotanical and anthropological analyses will be described in later reports.

Following detailed statistical studies of the radiocarbon ages, in combination with stratigraphic wiggle matching, we can now provide reliable time-ranges for the archaeological phases identified in the profiles. As will be shown below, it is possible to distinguish at least six sub-phases for the site occupation at Körtik Tepe, all of which date to the early Pre-Pottery Neolithic (PPNA).[3] For the oldest Phase VII a Younger Dryas (YD) date can be derived.

Stratigraphy of Trench A 80

The stratigraphy of Trench A80 is about 6 m large and 5.25 m deep in the deep sounding, Natural soil has not been reached so far but due to ground water further excavation was not possible. The stratigraphy can be divided in at least seven main phases comprising several floors and filling layers.

Phase I.1: The most recent remains under modern soil are only preserved in Squares G to H at the levels between -80 cm and -110 cm. They comprise two clay floors (F11/F11') and the remains of a pisé wall (W5) and of clay bricks (W4). Beneath W5 and W4 filling layers of ash and sediment mixed with bones and flints were distinguished in Squares D-H. These layers slope down from -130 cm in Square D to -160 cm in Square H. In Trenches D-E, a thin layer of sand and earth (F10) separates these filling layers from the remains of older constructions (W1; W2). F 10 runs up onto the bricks of W2 and indicates that the bricks are from an earlier phase. However, it is not excluded that W5/W4 and W2 all belong to the same construction, which at any rate appear to differ only slightly in time. From the top down to this layer several animal burrows were encountered in all squares and the transportation of material downwards seems possible. Therefore, none of the charcoal samples has been dated, because the risk of contaminations is very high.

Phase I.2: This phase comprises the remains of a pisé wall (W1) and of bricks (W2), which were preserved in Squares C and D. The stratigraphy in Squares B and C is not clear due to modern destruction. Beneath these constructions a compact clay fill could be traced from Squares C to H, where it is destroyed by two pits (P3/P5), which are full of small charcoal pieces, stones, animal bones, and a very ashy earth.

In Square C and D, the filling layer is separated from the older stone wall (W6) by a thin sand layer and compact clay floor (F1/F9). F1 starts in Square C at -150 cm and slopes down southward to -200/-210 cm in Square E (F9), where it covers the remains of W6. Beyond W6, F9 is destroyed by a pit (P2) with a very ashy fill. Whether F1/F9 represent a floor of Phase I.2. or the remains of a ceiling of Phase II is not quite clear.

Phase II: Beneath F1 (Squares C and D), an ashy grey to light-brown fill follows the course of F1/F9, with several embedded charcoal layers and a thin sand/loess layer, all running parallel. The thin filling layers abut to the remains of the ancient stone wall (W6). W6 is preserved to a height of 40 cm (-210 cm to -250 cm). Beneath W6 a shallow pit can be discerned, probably a foundation trench, with a dark brown filling. Underlying the clay fill at -210 cm to -240 cm in Squares E and F is a compact layer of pisé (F14'). In Square G, F14' rises to -200 cm/-210 cm, but it abruptly ends in the southern part of Square G. A charcoal sample [CH21] has been analysed from these remains. Under P3/P5 is a light clay structure (pisé?) with charcoal pieces. This structure probably belongs to the same installation as the remains to the north. Beneath it, a compact clay floor (F14) is preserved in Square H at -235 cm to -245 cm. It is covered by a thin charcoal band. Blackened stones and pieces of burnt clay indicate that a fireplace had been in this location. These features – the stone wall W6, the floors F14/F14', and the fill – could be the remains of a domestic structure, probably comprising two constructional phases.

Beneath the filling layer of W6, and rising from it to the north, is another clay floor (F2). It can be traced from Square C at -163 cm down to -263 cm immediately beneath W6. In Squares D-E a thin charcoal layer [CH 15] separates F2 from the filling above and from W6. Under F2 in Square C is a 2 cm thick layer of charcoal [CH17], which follows the course of F2 in Square D, and diminishes southwards. Both charcoal samples have been analysed and give dates for the construction of W6.

Phase III: The next older Phase in Square C comprises a compact clay floor (F3) and three thinner older floors (F4-F6), separated from each other by thin bands of charcoal and filling layers. Between F4 and F5 and beneath F5 lenses of chalky crumbles can be discerned. These may represent the remains of an ancient wall (or floor plaster). F3 is separated from the younger sediments by a fine charcoal layer [CH1]. This sample gives a date *ante quem* for Phase III.

Phase IV: The next occupation phase starts at about -260 cm with a charcoal layer and a filling layer with many clay lenses, probably representing wall or roof remains. These layers cover a 5 cm to 14 cm thick clay floor (F7). F7 starts in Square B at about -270 cm and slopes very lightly downwards to the southern part of Square C, to -290 cm. A charcoal sample [F11] from just above F7 has been dated and gives a date for the occupation phase of this installation.

3 Although it is highly probable that the people of Körtik Tepe lived there permanently, the term "Neolithic" does not really fit the findings at Körtik Tepe because no evidence for herding (Arbuckle and Özkaya 2006) or cultivation (Riehl pers. comm.) has yet come to light. We use PPNA here as a chronological period being aware that the material of Körtik Tepe is more of Epipaleolithic characteristics taken the lithics into account (Metin Kartal, pers. comm.).

In Square D, F7 thins (F7') and continues sloping downward to -315 cm, where it ends in the southern part of Square D at some kind of installation which included a few stones. South of this installation a large pit (P9) separates the northern part of the profile from the sourthern part (Squares F, G, H).

In the southern part, between -255 cm and -270 cm, another clay floor (F15) can be traced for a distance of at least 2 m. Below it is a thick layer of dark brown earth full of stones and animal bones. The same pavement has also been found beneath and south of House 68 across the whole surface of the southern half of Trench A80.

In Square B and C, beneath F7, at around -290 cm, another clay floor (F8, Phase IV') was found at around -290 cm. It also slopes down slightly to -310 cm, where it is destroyed by a pit (P8). As the deep sounding only continued in these two squares it is not possible to trace F8 further south.

Phase V: Beneath F8, a thick filling layer (-300 cm to -340 cm) covers several thinner clay floors (F12, F12') and an earlier sand layer (F13) which begins at about -340 cm in Square B and slopes downwards under F12/F12' to -400 cm. These thin clay layers differ from the later thick clay floors and might therefore be the remains of ephemeral occupations. Two charcoal samples have been taken of these layers, one between F 12 and F12' [Ch 26] and another one beneath F 12 [CH29]. They give a date *post quem* for the sand layer.

This sand layer appears to have been laid down by water movement; it gives the impression of flooding. A similar observation was made in the eastern profile of Trench A84 in the clay floor F4. The possibility that this part of the site was subject to temporary flooding is supported by the ephemeral nature of the structures of F12 and F12'.

Phase VI: Beneath the sand layer there is another thin clay floor (F16), which is hardly visible in the eastern profile but thicker in the northern profile of Trench A80. This clay floor is surrounded by dark brown earth which contains some stones, flints and sand lenses, but few finds otherwise. It might hint to an occupational hiatus in this part of the site. One charcoal sample [CH 33], which does not come from the profile, but from the sediments at a depth of -427 cm is stratigraphically the oldest sample that has been dated so far.

Phase VII: Between -440 cm and -485 cm a clay installation (F17/F18) can be observed, comprising two constructions which are lying upon each other and which are both covered by a thin charcoal layer. In the northern part of Square C they abut to two superposed pits separated by a very thin layer of clay. Within these pits, remains of burnt clay, stones with traces of fire, animal bones, and a lot of charcoal were found. They probably represent the remains of fire pits or hearths.

Beneath these earliest clay constructions there is an older cultural layer containing flints, pieces of obsidian, and some animal bones. As of mid-August, this layer was excavated down to about -525 cm. Charcoal samples of these lowest layers did not provide enough charcoal for radiocarbon dating, but it is planed to take further samples during the season of 2010.

Radiocarbon Dates of Trenches A 80 [4]

The five upper dates of Trench A80 correlate well with the stratigraphy and indicate one clearly younger phase, most probably within the range of 9450 calBC to 9290 calBC, and several older building phases (Tab. 1, Fig. 3). Most of the samples are from relatively short lived trees and shrubs; and the samples of oak and tamarisk do not hint at old wood effects. The dates ETH 38849 and ETH 38850 are stratigraphically very close and therefore the younger range of ETH 38849 between 9610 BC and 9450 BC seems the most probable. Except for the youngest date, there is no hiatus observable in the sequence of the dates. The sum of the dates hints to a rather brief occupation between 9660 BC and 9320 BC (1σ-range). It must be stressed that the dates of the oldest levels from –340 cm downwards also correlate with the stratigraphy, although at first sight they seem anomalously young for their depth.

Tab. 1: Radiocarbon dates of Trench A80 in stratigraphic order from upper to lower levels.

Lab-Code	ID	Level	^{14}C-Age [BP]	±	STD	δ^{13}C [‰] PDB	±	STD	Material	Species	[calBC]	
											1σ	2σ
ETH-39510	CH21	-207 cm	9925	±	45	-34,4	±	1,1	CH	Tamarix	9450-9290	9660-9280
ETH-38849	CH15	-218 cm	10065	±	40	-25,2	±	1,1	CH	Quercus	9810-9450	9870-9400
ETH-38850	CH17	-238 cm	10035	±	40	-25,4	±	1,1	CH	Pistacia	9740-9450	9810-9380
ETH-39511	CH1	-194 cm	10100	±	60	-27,6	±	1,1	CH	Rhamnus	10050-9450	10050-9400
ETH-38853	CH11	-275 cm	10015	±	45	-25,1	±	1,1	CH	Amygdalus	9670-9410	9770-9330
ETH-39512	CH26	-348 cm	9955	±	45	-28,5	±	1,1	CH	Tamarix	9650-9310	9660-9290
ETH-38848	CH29	-365 cm	9985	±	40	-25,3	±	1,1	CH	Quercus	9660-9360	9740-9310
ETH-39509	CH33	-427 cm	9960	±	60	-29,9	±	1,1	CH	Populus/ Salix	9650-9310	9760-9280

4 All radiocarbon dates have been analysed by Irka Hajdas, Laboratory of Ion Beam Physics Radiocarbon Dating ETH Zürich, Switzerland. Katleen Deckers, Department of Palaeohistory and Quaternary Ecology, University of Tübingen, Germany determined the wood species of the samples. We are very thankful for their cooperation.

During statistical analysis of the ^{14}C-ages, to methodological problems became apparent, both of which are related two the shape of the ^{14}C-age calibration curve in the age range under study.

1. As independently shown by the combination of raw data using two different software packages (OxCal, CalPal) (fig. 4), between 9700 and 9620 calBC (i.e. during the final phase of the Younger Dryas, YD) a dating problem exists, which is related to the existence of a minor (but significant, downward-directed) wiggle in this period. After 9620 calBC the calibration curve rises. In consequence, all ^{14}C-ages with readings in the older part of this time-window will automatically produce calendric dates that are artificially too young. The time-window at stake extends from the end of the YD for many hundreds of years into the early Holocene. Thus, there is no possibility of differentiating the true (calendric) age of the respective samples merely on the base of ^{14}C-measurements. In fact, without stratigraphic control, all given dates could well be erroneously misinterpreted as belonging to the Early Holocene. Nevertheless, as will be shown below, the dates are indeed most likely older.

Before continuing, we note that between 9650 calBC and 9600 calBC many climate records show the transition from the cold/dry conditions of the YD to the generally warm/wet conditions of the early Holocene (e.g. Walker et al. 2009 with further references). Most precisely, as measured e.g. in the variations of tree-ring growth (Spurk et al. 1998), the YD/Preboreal transition dates to ~ 9650 calBC. At this time, as shown also e.g. by the $\delta^{18}O$ stable oxygen record of the NGRIP ice-core (GICCO5 age-model: Vinther et al., 2006), major changes in the North Atlantic Ocean circulation system occur (e.g. Walker et al. 2009; Muscheler et al. 2008).

Although we do not yet have any corresponding high-resolution climate records for the immediate vicinity of Körtik Tepe, and must therefore remain cautious as to the interpretation of the climatic/environmental development in this region, it does appear most likely that similarly abrupt (and major) climatic changes (of a type yet to be established) would also occur in Southeast Anatolia. The exact dating of the onset of the site occupation at Körtik Tepe is therefore of paramount importance.

2. Fig. 4 also shows that the calibration curve has a plateau exactly where most of the dates cluster. For these combined reasons it has not yet been possible to date the beginning of the occupation of Körtik Tepe precisely. The stratigraphy suggests that it started during the end of the YD, but it has to be kept in mind that the lowest layers (Phase VII) have not been dated so far.

Wiggle Matching of the Radiocarbon Dates of Trench A 80

By wiggle matching with OxCal and CalPal it is possible to combine stratigraphic information with the radiocarbon data and consequently to derive time ranges and gaps between the dates in a more precise way. Wiggle matching was originally developed for the correlation of floating tree ring chronologies (Pearson, 1996; Bronk Ramsey et al. 2001). By assuming the existence of gaps between stratigraphic levels, this method can also be used for the correlation of stratigraphic information with archaeological radiocarbon data.

Because sequencing the dates (see e.g. Edwards et al. 2004) does not give as precise results as wiggle matching, only the latter method has been used. In accordance with the stratigraphic information, the highest probabilities of gaps between the layers have been calculated by wiggle matching with OxCal. Gaps were chosen to achieve the best possible agreement of the dates with the stratigraphic information. The results were then further analysed using the CalPal 2007 software, which allows the integration of climate records in graphic output. The results of both methods are given in Tab. 2.

The youngest date ETH 39510 comes from the fill of a pit dug after stone wall 6 (W6) had been destroyed. The combined evidence indicates a date for the filling of the pit between 9400 calBC and 9320 calBC. As a result, the remains of W2, W4 and W5 must be more recent and might belong to the late PPNA or even younger periods.

ETH 39511 and ETH 38850 range between 9500 calBC and 9450 calBC. This range corresponds to Phase II and provides a date for the construction of stone wall W6. The upper end of Phase III is dated by ETH 39511. Given the range of the next oldest date, the highest probability range for ETH 39511 is between 9540 calBC and 9500 calBC. The results for ETH 38853 (Phase IV) indicate a range for this date between 9600 calBC and 9540 calBC. The probability range of the three oldest dates (Phases V and VI) can thus be suggested as between 9660 calBC and 9600 calBC.

The combined stratigraphic and chronological evidence thus suggests one clearly younger phase comprising W1-W5 and Floor 10 which is separated from the older phases by more than 100 years. This difference in time is supported by the difference in building material between the phases (clay instead of stone walls). By contrast, the three older radiocarbon-dated phases, Phase II-IV with living Floors 2 to 7 in the northern area of Trench A80 and Floor 14/14‘-15 in its southern part, represent an occupation of about 150 years between 9600 calBC and 9450 calBC. There may have been short intervals of abandonment, followed by reoccupation and reconstruction, but the architectural and material traditions and the burial customs suggest a continuous occupation.

The oldest Phases V-VI, which were radiocarbon dated, indicate an occupation during the transition from the YD to the early Holocene. Although the lowest Phase VII has not yet been radiocarbon dated, a date in the late period of the YD is likely.

Tab. 2: Results of different models for wiggle matching of the dates. For wiggle matching with CalPal an average standard deviation of 46.9 yr has been calculated by 100 iterations Monte Carlo Simulations.

Lab-Code	**Wiggle matching (OxCal) all ages calBC**	**Wiggle matching (CalPal 2007)**
ETH 39510	9450 (38.5%) 9390, 9360 (29.7%) 9320 [Gap 140y]	9350 ± 50 calBC (9400-9300) [130yrs]
ETH 38849	9580 (38.5%) 9520, 9490 (29.7%) 9450	9480 ± 50cal calBC (9530-9430) [5yrs]
ETH 38850	9580 (38.5%) 9520, 9490 (29.7%) 9450[Gap 20y]	9485 ± 50 calBC (9535-9435) [15yrs]
ETH 39511	9600 (38.5%) 9540, 9510 (29.7%) 9470 [Gap 50y]	9500 ± 50 calBC (9550-9450) [50yrs]
ETH 38853	9650 (38.5%) 9590, 9560 (29.7%) 9520	9550 ± 50 calBC (9600-9500) [30yrs]
ETH 39512	Not considered with this method	9580 ± 50 calBC (9630-9530) [5yrs]
ETH 39509		9585 ± 50 calBC (9635-9535) [25yrs]
ETH 38848		9610 ± 50 calBC (9660-9560)

Trench A 84

The eastern profile of Trench A84 was documented down to -3.20m. Beneath the remains of a possibly modern pisé construction are at least five clearly distinguishable prehistoric clay floors and two pits

Phase I: The most recent remains are preserved in Squares B, C and D at the level of -80 cm. In Square B the remain of a yellow-white pisé construction (W2) has been preserved between -80 cm and -140 cm. This remain is separated from another, more reddish-brown, pisé construction (W1), which continues in Square C and D and perhaps includes some sun-dried bricks. They reach down to -163 cm. On top of W1 in Square C is a thin layer of sand, similar to the sand layers observed in Trench A80.

Phase II: Beneath W1 and W2, and south of W1 in Squares D and E, is a grey ashy layer full of charcoal, obsidian, and clay lenses. At the level of -176 cm to -180 cm in Square B a thick clay floor (F1) can be discerned. It extends south into the northern part of Square C and is then destroyed by the more recent pit P1. The top of this pit has a diameter of 1.10 m, and it is preserved to a depth of 30 cm. The bottom of P1 is at -210 cm. It is covered inside by clay, beneath which a thin cultural layer can be observed. The floor of P1 has been penetrated by a recent animal burrow, which reaches as far down as F3, destroying part of this older floor.

Beneath F1 down to -200 cm, there is a dark brown layer of cultural debris with stones, charcoal, animal bones, and many pieces of clay. In Square B a thin layer of charcoal [CH28] separates this cultural stratum from a construction of light clay, tempered with some plant fibres and a compact clay floor (F2). CH 28 provides a direct date for the occupation of this construction.

F2 is separated from an earlier construction phase (F2") by a very ashy, light grey filling. F2 probably represents some kind of renovation of the original floor F2".

In Square D at the level of -210 cm, starting beneath P1 and continuing into Square E, the remains of another clay floor (F2') can be discerned. Perhaps F2' is the continuation in the southern part of the trench of either F2 or F2". F2' is horizontal, but turns upwards in Square E to -200 cm.

Phase III: Beneath F2' and F2" there is a dark brown cultural layer, 10 cm thick in the northern part and 20 cm thick in the southern part of the trench. A thin charcoal layer [CH35] separates this filling layer from the next living floor F3. The charcoal sample taken from this layer dates the last occupation phase of F3. F3 is bisected by at least two very thin charcoal layers. It is distinct from the more compact clay floors F2 and F1 and consists of several ephemeral living floors.

Beneath F3 in Square D, at -245 cm to -250 cm, is a small fire pit with some pieces of burnt clay and a lot of charcoal.

Phase IV: Beneath F3 a thick debris layer separates Phase III from the older Phase IV. In Square B this filling layer is about 20 cm thick and reaches down to the level of -260 cm. It becomes thicker in the southern part of the trench, reaching down to -280 cm in Square D. The southern part of this filling layer ends at pit (P2).

P2 extends down to -320cm and destroys all the adjacent cultural layers. At the bottom of P2 there are stones, pieces of charcoal, and a lot of animal bones.

In the lower part of the Phase IV debris layer in Squares C and D there are many pieces of clay and charcoal above a thick layer with several bands of charcoal. It appears that some kind of wooden construction – either a wall or a roof – covered with clay had burnt and collapsed. Between this wooden construction and the floor F4' is a thin debris layer which contains a lot of charcoal [CH41], animal bones, stones, and clay lenses up to 5 cm thick. CH 41 thus dates the occupation of the construction belonging to F4'. The compact clay floor (F4') can be traced from the southern part of Square D at the level of -300 cm up to -270 cm in Square B, where it merges with the older floor F4. F4' is probably a renovation of F4.

F4 starts in Square B at the level of -260 cm and then sharply drops in Square C to -290 cm. In Square C this clay floor looks as if it had been eroded by flooding. F4 is cut at its southern end by a fire pit containing some pieces of charcoal, burned clay and a thin layer of sand at its bottom. The southern end of the fire pit has been destroyed by P2.

Beneath F4 in Square B there is another cultural debris layer. A U-shaped construction of stones, covered with some charcoal, might be interpreted as a hearth. It is dated by the sample [CH 42].

Beneath this debris another compact clay floor (F5) can be discerned between -300 cm and -320 cm in Square B. It could not be followed further southwards because the more recent floor F4 runs down to this level in that square. Because excavation in Square B proceeded more quickly than further south, another cultural layer was found in B beneath Floor F5.

To conclude: At least 5 prehistoric floors could be observed, of which both F2 and F4 had been renewed at least once. The debris layer above F4/F4' gives hints of some wooden structure which had probably burned and collapsed. The pieces of clay above the burnt wooden remains might be from wall or ceiling plaster.

Radiocarbon Dates of Trench A 84

Four radiocarbon dates of Trench A84 have been analysed: CH 28, CH 35, CH 41, and CH 42. Wiggle matching shows that they all fall into the earliest Holocene. They confirm a relatively short occupation of no more than 250 years for levels down to –300 cm.

The dates are in good stratigraphic order, with CH 28 being slightly younger than the other dates, corresponding to the time range of the lower levels of Phase I in Trench A80 [CH 21]. The overall range of CH 35, 9810 calBC to 9460 calBC, is quite large. However, because of its stratigraphic position and the overlapping of its range with the other younger samples, a YD date can probably be excluded.

Tab. 3: Radiocarbon dates in stratigraphic order from upper to lower level.

Lab-Code	ID	Level	^{14}C-Age [BP]	±	STD	δ^{13}C [‰] PDB	±	STD	Material	Species	calBC 1σ	calBC 2σ
ETH-38852	CH 28	-198 cm	9965	±	45	-33,0	±	1,1	CH	Tamarix	9650-9310	9670-9290
ETH-38851	CH 35	-227 cm	10075	±	40	-25,3	±	1,1	CH	Tamarix	9810-9460	10050- 9400
ETH-38855	CH 41	-285 cm	10040	±	40	-24,0	±	1,1	CH	Indet	9750-9450	9810-9390
ETH-38854	CH 42	-284 cm	10000	±	40	-23,5	±	1,1	CH	Populus	9660-9390	9760-9320

Wiggle Matching of the Radiocarbon Dates of Trench A84

As with the data of Trench A80, the radiocarbon dates of Trench A84 can be combined with the stratigraphic information allowing the wiggle matching method to produce a more precise sequence of ranges and gaps. The following time ranges for the phases in Trench A84 can be suggested: The youngest date, ETH 38852 from the charcoal layer about 10 cm above F2, seems to be about 150-160 years younger than the older dates. Its absolute level corresponds to the levels of P3, P5, and CH 21 of Trench A80, which were dug into the remains of Phase II. The range between 9420 calBC and 9335 calBC for ETH 38852 confirms the younger probability ranges of the ordinary calibration. The older dates cluster into a very narrow range with time gaps of no more than 10 to 30 years. They hint at a rather rapid accumulation of living floors within a time range of about 200 ± 50 years. ETH 38851 comes from directly above the last renovation phase of F3 and can be dated between 9550 calBC and 9500 calBC. Only slightly older is the date ETH 38855 from directly above the living floor F4', which possibly belongs to the burnt remains above this floor. The date ranges between 9580 calBC and 9550 calBC. The most probable range for the oldest date, ETH 38854, is thus between 9625 calBC and 9580 calBC.

All the dates of Trench A84 are thus within the range of the earliest Holocene. The dates of Trench A84 hint at a younger phase between 9450/9420 calBC and 9335 calBC contemporary with the lower levels of Phase I of Trench A80. The dates of the older Phases II-IV of Trench A84 overlap significantly between 9600 calBC and 9450 calBC.

Tab. 4: Results of different models for wiggle matching of the dates. For wiggle matching with CalPal an average standard deviation of 41calyrs has been calculated by 100 iterations using Monte Carlo statistics.

Lab-Code	Wiggle matching (OxCal) all ages calBC	Wiggle matching (CalPal)
ETH 38852	**9450 (62.3%) 9370**, 9340 (5.9%) 9310 [Gap 160y]	9380 ± 45 (9420-9335 calBC) [160yrs]
ETH 38851	**9610 (62.3%) 9530,** 9500 (5.9%) 9470 [Gap 10yrs]	9540 ± 45 (9585-9495 calBC) [10yrs]
ETH 38855	**9620 (62.3%) 9540,** 9510 (5.9%) 9480 [Gap 30yrs]	9550 ± 45 (9595-9505 calBC) [30yrs]
ETH 38854	**9650 (62.3%) 9570,** 9540 (5.9%) 9510	9580 ± 45 (9625-9535 calBC)

Summary of all Radiocarbon Dates

Wiggle matching of all dates (Fig. 7) shows that the Phase I.2 of Trench A80 (9400-9320 calBC) is only slightly younger than the upper levels of Phase II of Trench A84 (9420-9335 calBC).

Phase II (the building of the stone wall W6) in Trench A80 probably ranges between 9500 calBC and 9450 calBC. Phase III ranges between 9550 calBC and 9500 calBC. Phase IV can be dated between 9600 calBC and 9550 calBC, with the lowest layer of Trench A84 being slightly older.

For Phase V and VI (Trench A80) a date between 9660 calBC and 9600 calBC can be suggested, with the highest probability for the oldest date at 9620 calBC. It must be emphasised that the lowest layer has not been dated so far, but a YD date seems to be very probable. The uppermost layers of Phase I also remain to be dated.

Some important conclusions can be drawn:

1. From Phase I.2 to at least Phase VI all dates are within the range of the PPNA, within which several sub-phases can be distinguished. The material richness of Körtik Tepe will make it possible to correlate these chronological phases with specific material remains. Körtik Tepe could thus become a reference site for the whole region.

2. It is probable that the climatic transition from the YD to the early Holocene is documented within the occupational stratigraphy of Körtik Tepe. The site of Körtik Tepe can therefore provide further ecological proxy data, largely unavailable until now, for the reconstruction of climatic conditions in this region (Robinson et al. 2006). It will be a major aim of our future research to compare the data from Körtik Tepe with Van-See data located at a about 200 km northeast of the site to discern any regional climatic differences during this transition (Wick et al. 2003).

Tab. 5: Correlation of phases of Trench A 80 and A 84 according to radiocarbon dating and stratigraphy.

Phase	Dating in Trench A 80 [calBC]	Phase	Dating within Trench A 84 [calBC]
Phase I.2	9400 - 9320	Destruction level of Phase II	9420 - 9335
Phase II	9500 - 9450		
Phase III	9540 - 9500	Phase III	9550 - 9500
Phase IV	9600 - 9540	Phase IV	9625 - 9580
Phase V-VI	9660 - 9600		

Conclusion

Körtik Tepe provides the first detailed stratigraphy comprising several layers of the early PPNA. The eastern profiles of Trenches A84 and A80 show two clearly distinguishable main periods of PPNA occupation with several sub-periods. The younger main PPNA occupation starts at about -80/-120 cm and reaches down as far as -180 cm in some places. This main period includes the lower levels of Phase I in Trenches A80 and the upper levels of Phase II in Trench A84.

The second main period of PPNA occupation, comprising the three Phases II-IV, is a continuous occupation with several horizons of destruction, rebuilding, and levelling down to -300 cm ± 10 cm. The oldest layers documented in Trench A80 (Squares B and C), attest at least two more occupation periods (Phases IV'-V and VII). Phase VI may document a slight hiatus or a shift of residential area within the site.

The radiocarbon dates of Trench A80 and A84 all fall within a very short time range between 9660 calBC and 9320 calBC. However, in both dated sequences the upper layers of the first main occupation period [CH 28; CH 21] were much younger, dating between 9450 calBC and 9320 calBC.

The older phases down to -300 cm overlap largely. They match the course of the calibration curve and correspond to a plateau. The calibrated dates are therefore lengthened, and it is impossible to decide whether they document a very short occupation period or in fact correspond to about 150-250 years. Wiggle matching suggests very short gaps of probably one generation or less between the different phases. The dates precisely fit the time range calculated for the early PPNA at other sites.[5] The oldest radiocarbon dated Phase VI suggests a date of 9620 calBC right at the transition from the Younger Dryas (YD) to the early Holocene. Though Phase VII, the oldest excavated so far, has not yet been dated, it is likely that a settlement had already been established on the site during the last phase of the YD.

Given its well-established chronology, Körtik Tepe might give Neolithic research important information about the development of the material culture within the early PPNA. The combination of stratigraphic and chronological information with the numerous artefacts from the site might make it possible, for the first time anywhere, to differentiate several cultural phases within the early PPNA. Körtik Tepe therefore has the potential to become a reference site for all other early Holocene sites of the region. The ecological development documented at Körtik Tepe will provide significant information about climatic and ecological changes during the transition from the YD to the early Holocene[6].

5 For a compilation of radiocarbon dates from PPNA-sites see: http://www.exoriente.org/associated_projects/ppnd.php.

6 The detailed data discussed herein provides a profound opportunity to compare the social development at the site, as documented by the many burials, with the ecological development.

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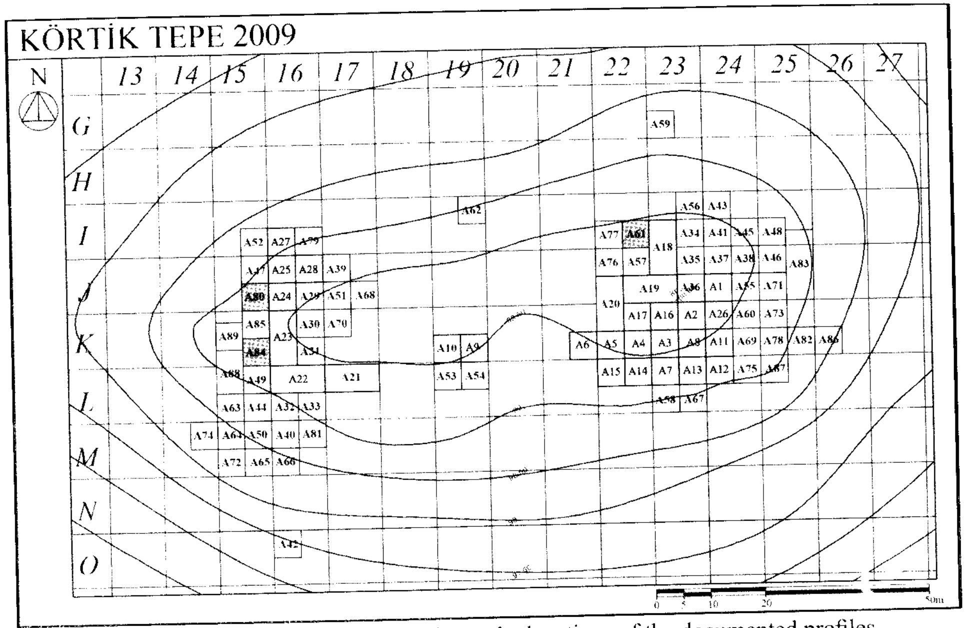

Fig. 1: Trenches of Körtik Tepe. Arrows point to the locations of the documented profiles.

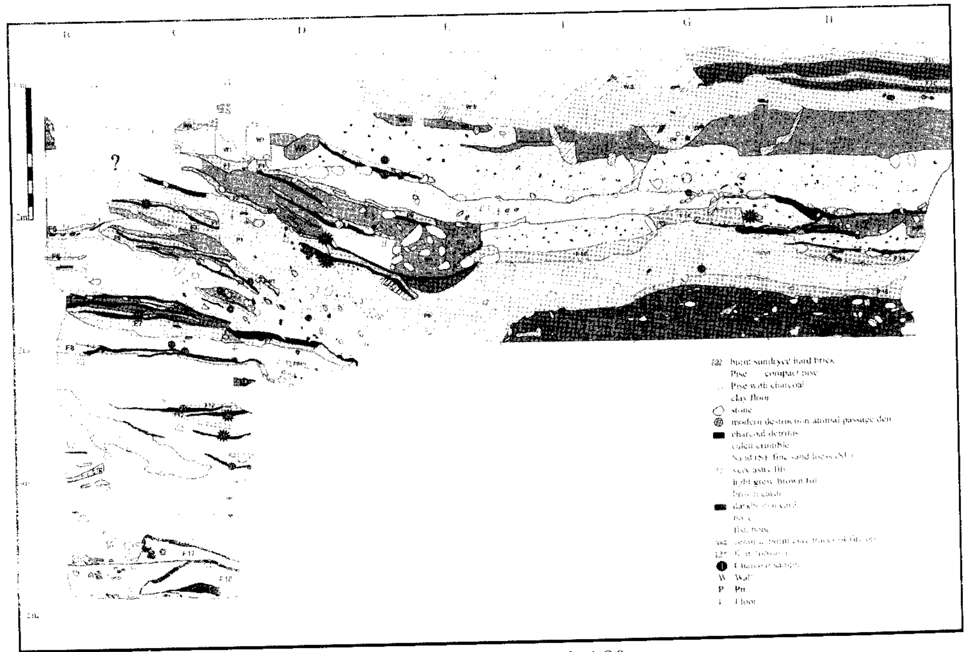
Fig. 2: Schematic drawing of the eastern Profile of Trench A80.

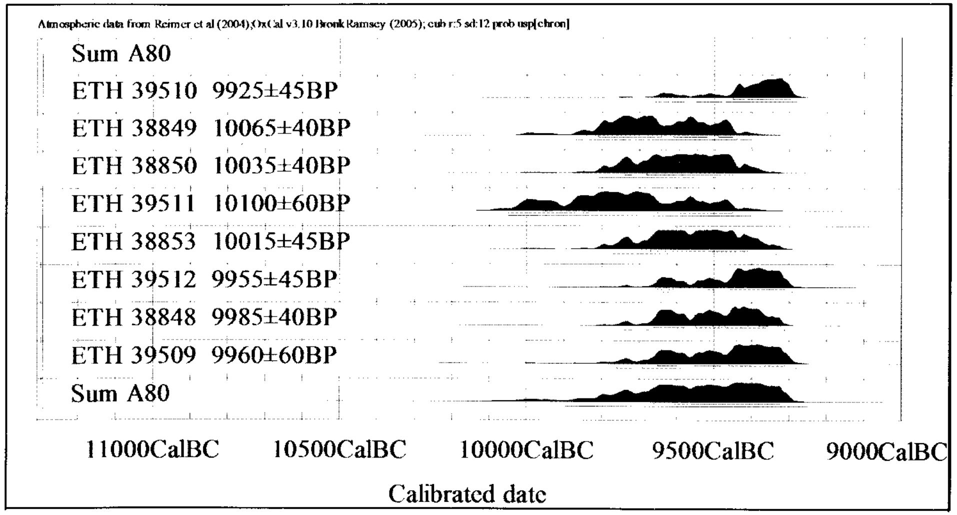

Fig. 3: Ranges of calibrated radiocarbon dates in stratigraphic order (from top=youngest to bottom=oldest dates).

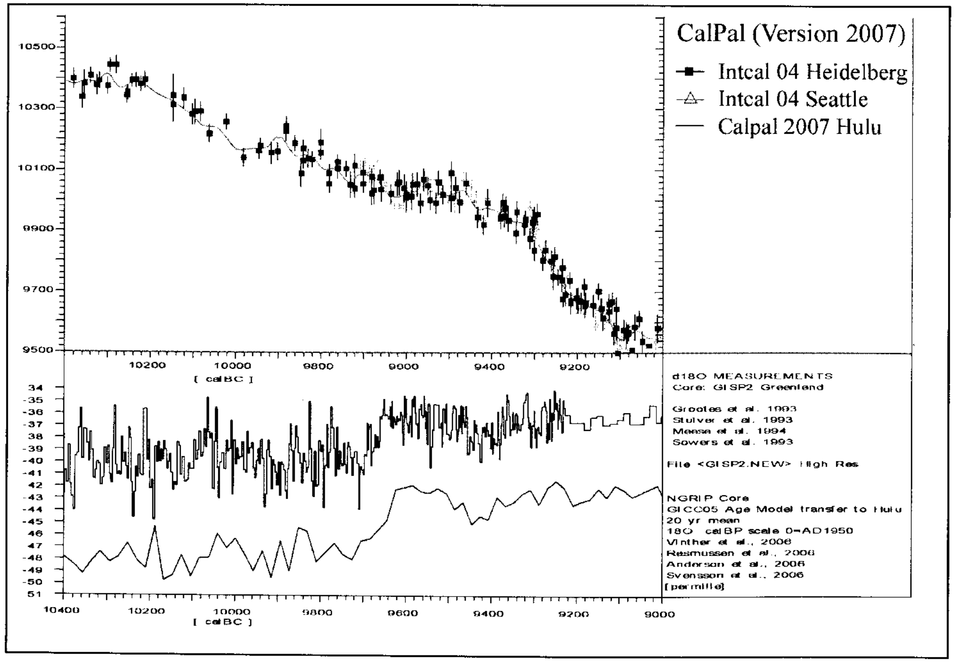

Fig. 4: Tree-Ring ^{14}C-Age Calibration Data (IntCal04, Reimer et al., 2004) in comparison to Stable Oxygen $\delta^{18}0$ Data from Greenland GISP2 Ice-Core (Grootes et al. 1993) and from NGRIP Ice-Core (NGRIP-Members, 2004). Graph produced by CalPal-Program (Weninger, Jöris 2008) using CalCurve CalPal-2007-Hulu.

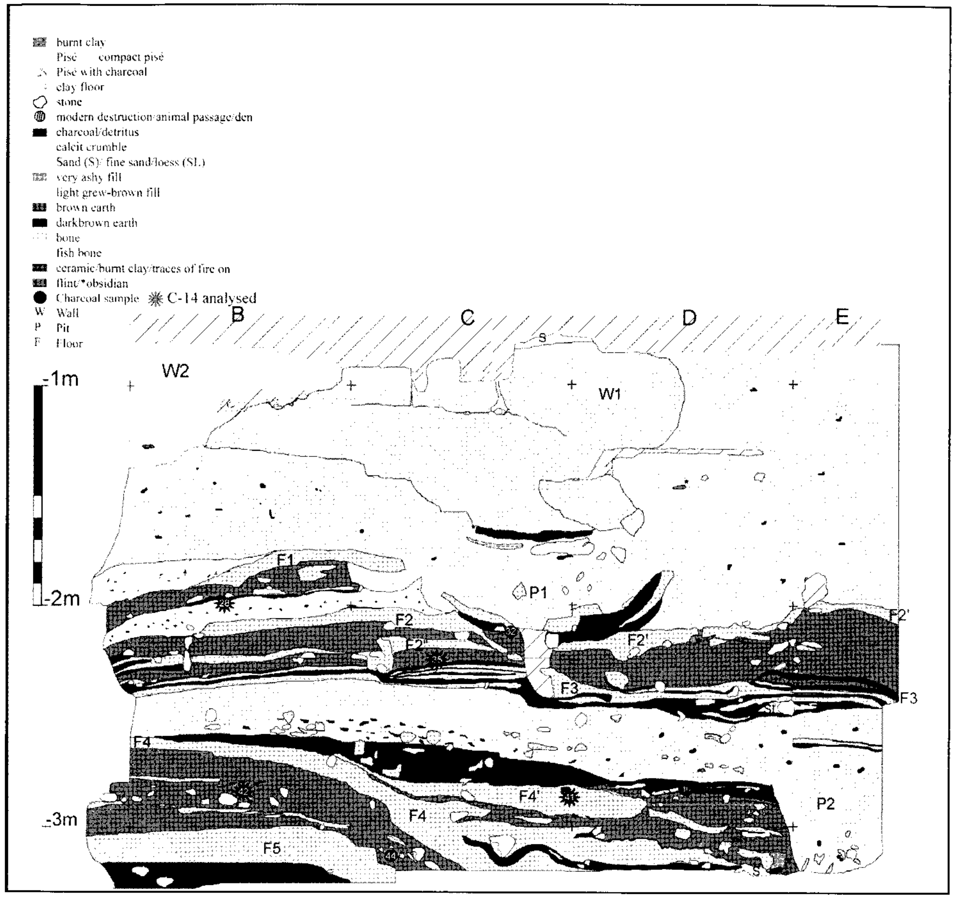

Fig. 5: Schematic drawing of the eastern profile of Trench A84.

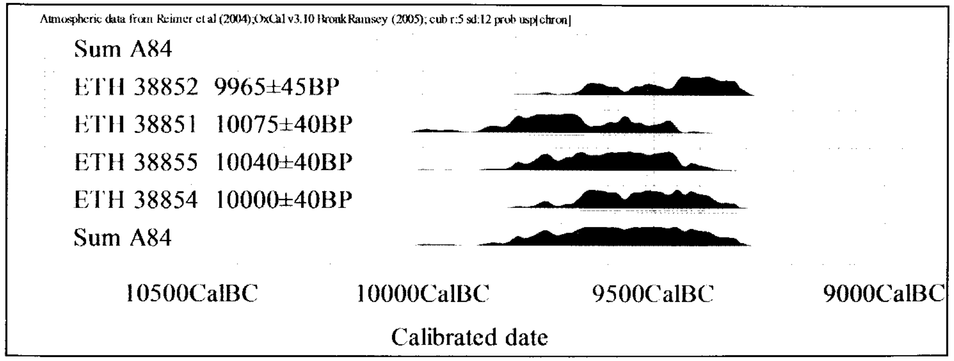

Fig. 6: Ranges of calibrated radiocarbon dates of Trench A84 east in stratigraphic order.

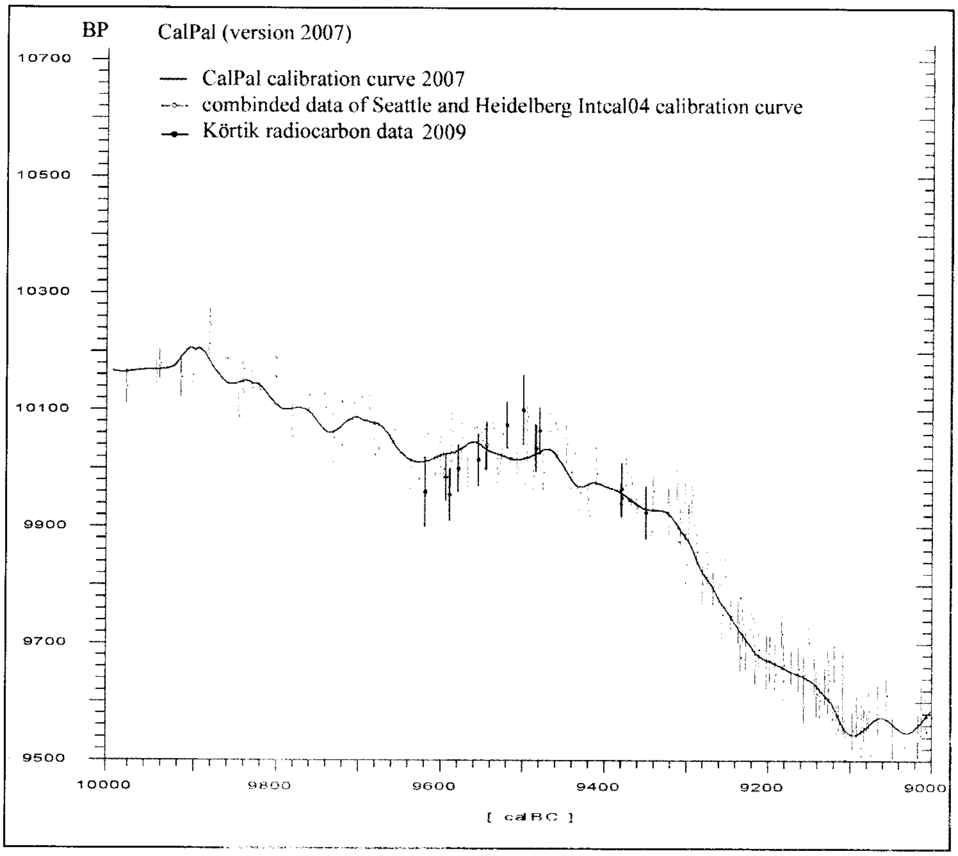

Fig. 7: Wiggle matching with CalPal 2007 of all dates of Körtik Tepe. Gaps have been averaged according to stratigraphical information and separate wiggle matching of Trenches A80 and A 84. An average standard deviation of 41 calyrs for positioning of the dated samples on the Early Holocene radiocarbon plateau has been calculated by Monto Carlo statistics.