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# Geomorphological and Palaeoenvironmental Setting of Asikli Hoyük

Catherine Kuzucuoğlu, Jean-Pascal Dumoulin, Ségolène Saulnier-Copard

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# THE EARLY SETTLEMENT AT AŞIKLI HÖYÜK

Essays in Honor of Ufuk Esin

Mihriban Özbaşaran Güneş Duru Mary Stiner





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**OFFPRINT**



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AŐIKLI HÖYÜK**  
**Essays in Honor of Ufuk Esin**

Edited by  
Mihriban Özbaőaran, Güneő Duru, Mary Stiner



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Mihriban Özbaşaran, Güneş Duru, Mary Stiner

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Aşıklı Höyük Kazı ve Araştırma Projesi

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## Preface

Aşıklı Höyük, 26 years after it was first discovered, came under excavation by a large group of scholars from Istanbul University led by Prof. Ufuk Esin, then the chair of the Department of Prehistory. Results obtained from each field season contributed not only to our knowledge of the cultural geography of the region, but also to increasingly pluralistic explanations of Neolithization.

We began organizing a new program of investigation at the site in 2006, and we commenced new excavations in 2010 with the aim of pursuing a more detailed understanding of trends first identified by Prof. Esin and exploring more deeply what remained to be learned about Aşıklı. We attempted to understand the individual actions and “snapshots” from the daily life of the inhabitants with our revised approach and methodology. The new multi-disciplinary project supported by researchers and scholars from all over the world not only enriched the intellectual environment and helped to refine earlier interpretations, but also allowed us to put forward new research questions and approaches. The revival of the project has also allowed younger generations to be trained in many new aspects of archaeology.

Our recent investigations have focused mainly on the early habitation at Aşıklı. This work contributes to the ongoing discussions on the Neolithization of Central Anatolia, together with new data from the sites of Pınarbaşı and Boncuklu on the Konya Plain and Balıklı in Cappadocia. Though mentioned only briefly in the present volume, we have also carried out parallel projects in experimental archaeology, cultural heritage management, and public archaeology in connection with the archaeological research. Other publications will follow the present volume on the results gained from these sister projects.

Here it is our privilege to forward the first results of our work at Aşıklı in a volume dedicated to Prof. Esin. We hope it will further stimulate Neolithic research in the region. The year 2019 represents the 30<sup>th</sup> anniversary of the start of the excavations at Aşıklı. After three decades of fieldwork, we are proud to offer unprecedented information on the early inhabitants of Aşıklı. We owe much thanks to all the former and current members of the project. However, our deepest gratitude goes to esteemed scholar and mentor, Ufuk Esin, from whom we have inherited not only the opportunity to continue archaeological research at Aşıklı but also the many scientific approaches and ethical values she fostered. We present this book to her memory with respect, love, and longing.





# Geomorphological and Palaeoenvironmental Setting of Aşıklı Höyük

Catherine KUZUCUOĞLU<sup>a</sup>, Jean-Pascal DUMOULIN<sup>b</sup> and Ségolène SAULNIER-COPARD<sup>a</sup>

## Introduction

Geomorphological research at Aşıklı Höyük started in the early 1990's in the framework of the archaeological excavation and associated projects run by Prof. Dr. U. Esin (1996, 1999a). A first field project was done by Prof. Dr. O. Erol, whose unpublished report we were unable to access. In 1995, Esin asked us to undertake geomorphological research in the Melendiz valley, where the Aşıklı Höyük settlement was founded. Esin's main question for us was whether the Melendiz river ever flowed, or was flowing at the time of the first settlement, along the eastern side of the mound. Today's river bed, flood plain and low terraces are positioned only along the western eroded edges of the mound. In 1995 and 1996, field survey and three cores in the valley (Kuzucuoğlu 2013) did not allow us to answer this question. However, the survey did allow us to define a suite of terraces within the valley, determine the position of the roof of the bedrock below the terraces in the western part of the mound at only -5 m depth, and develop hypotheses regarding the possible occurrence of a buried river palaeobed east of the mound (Kuzucuoğlu 2013). In 2010, additional questions were proposed to us by the new director of the excavation, Prof. Dr. M. Özbaşaran. Firstly, was the "road" in Level 3 descending toward the river bed and thus establishing some kind of continuity with the Late PPN Musular site on the opposite flank of the valley? Second, was this road connected to an erosion phase during the occupation of the mound, or did its riverward slope correspond to the normal mound-morphology accumulation at the time? Finally, what kind of environment was present in the valley when PPN people first settled at the site? In an effort to answer these questions, our more recent research is based on fieldwork performed between 2010 and 2015. The present paper provides some answers to the questions posed by Esin and Özbaşaran.

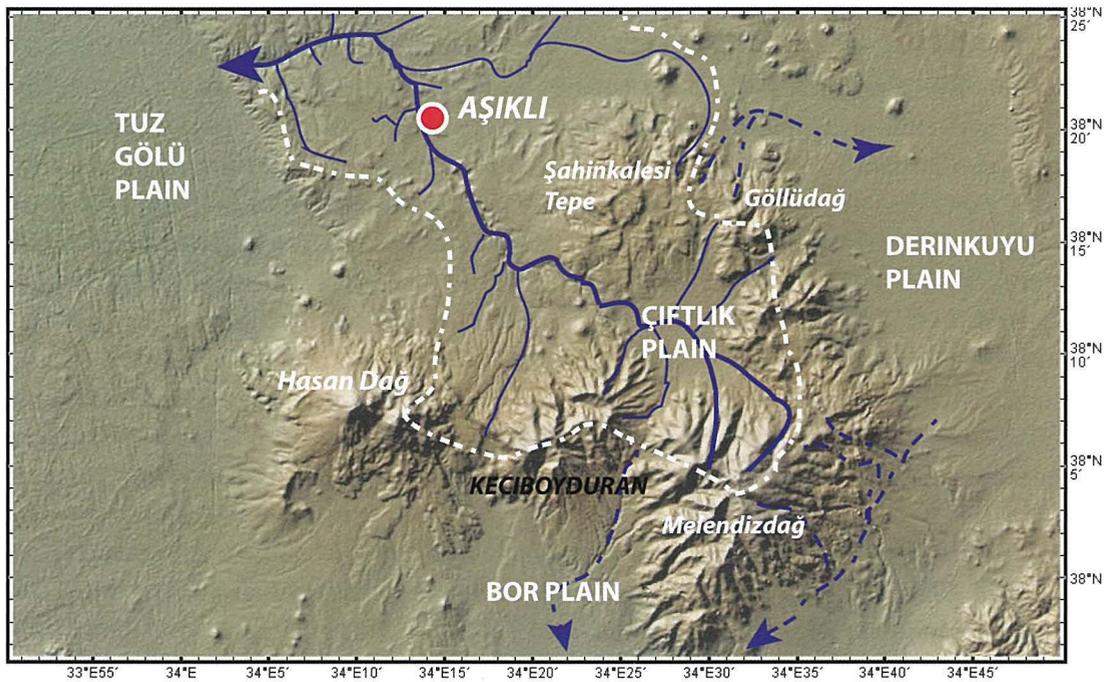
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## Geomorphological context of the Melendiz river watershed

The Pre-Pottery Neolithic site of Aşıklı Höyük is positioned on the valley floor of the Melendiz river in western Cappadocia (Kuzucuoğlu 2013) (Figure 1). It was occupied from about 10,350 ka cal BP (Level 5, Stiner et al. 2014) to about 9350 ka cal BP (eroded remains of Level 2, Özbaşaran 2011b, 2012). Preserved archaeological accumulations (Levels 5 to 2) below the eroded summit of the mound are about 12 m thick. According to the archaeologists, the discontinuities between levels seem to be mostly anthropogenic in origin (mound slopes, irregular topographies, remodeled surfaces, pits). The Melendiz river valley is 270 m wide at the location of the mound. The valley is defined by ca. 60 m cliffs that were eroded by the river inside a Neogene deposit. In the vicinity of the mound, these deposits are volcanic (ignimbrites, ash-rich lacustrine tuffites) and detritic (coarse alluvial formations). The river discharge is mainly nourished by the mountains of the Melendiz dağ (2963 m asl<sup>1</sup>) (Bayer-Altın et al. 2012). The river bed floor is about 1103 m asl next to Aşıklı Höyük. The river flows toward the Tuz Gölü plain at ca. 982 m asl, after passing through the modern town of Aksaray (Figure 1). In the Tuz Gölü plain, the river constructs a wide alluvial fan over and intercalating with the Tuz Gölü Upper Pleistocene and Holocene lake deposits.

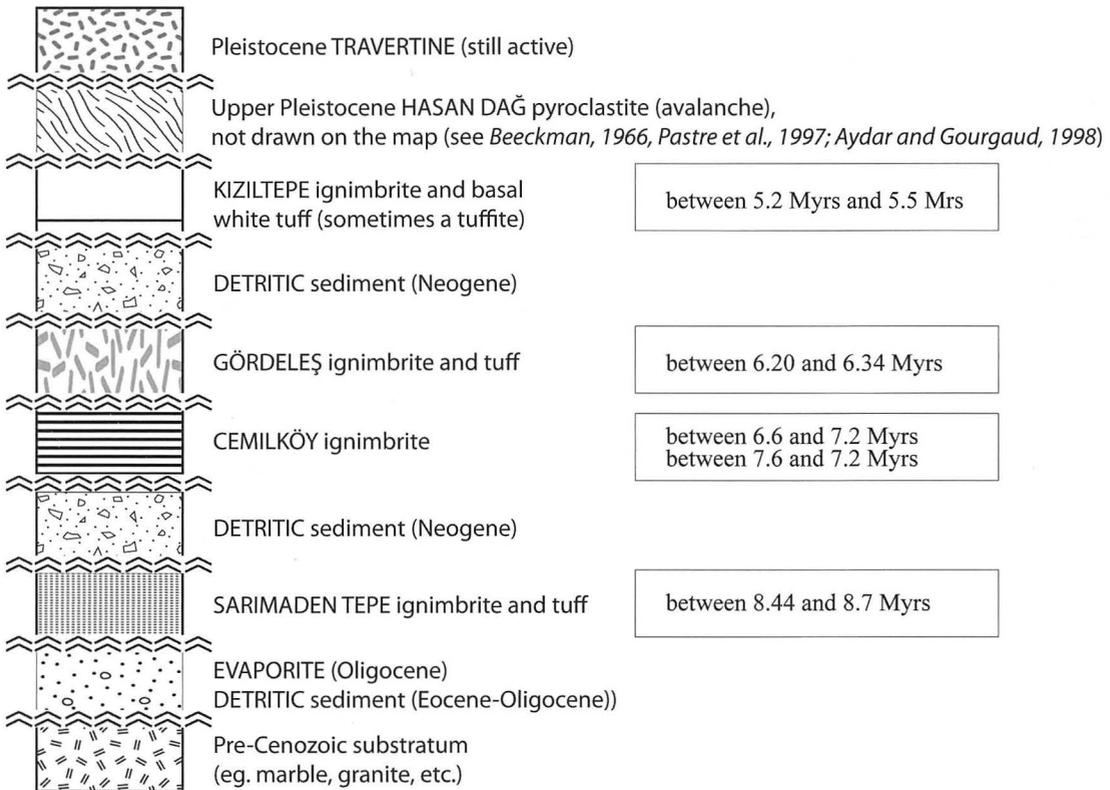


**Figure 1.** The watershed of the Melendiz valley in southern Cappadocia. Background GIS topographic map from GeoMapApp.

<sup>1</sup> Apart from the altitudes used in Figure 9 (contours hand-picked up from Google Earth Pro), all altitudes asl referring to the Aşıklı site as well as surrounding flood plain and terraces are measured and calculated with the altitude reference used by the archaeologists, which is 1119.45 m asl at the top of the mound. Accordingly, today's bed floor is at 1003 m, and the river level is at 1003.5 m asl.

### *From the spring of the Melendiz river to Selime*

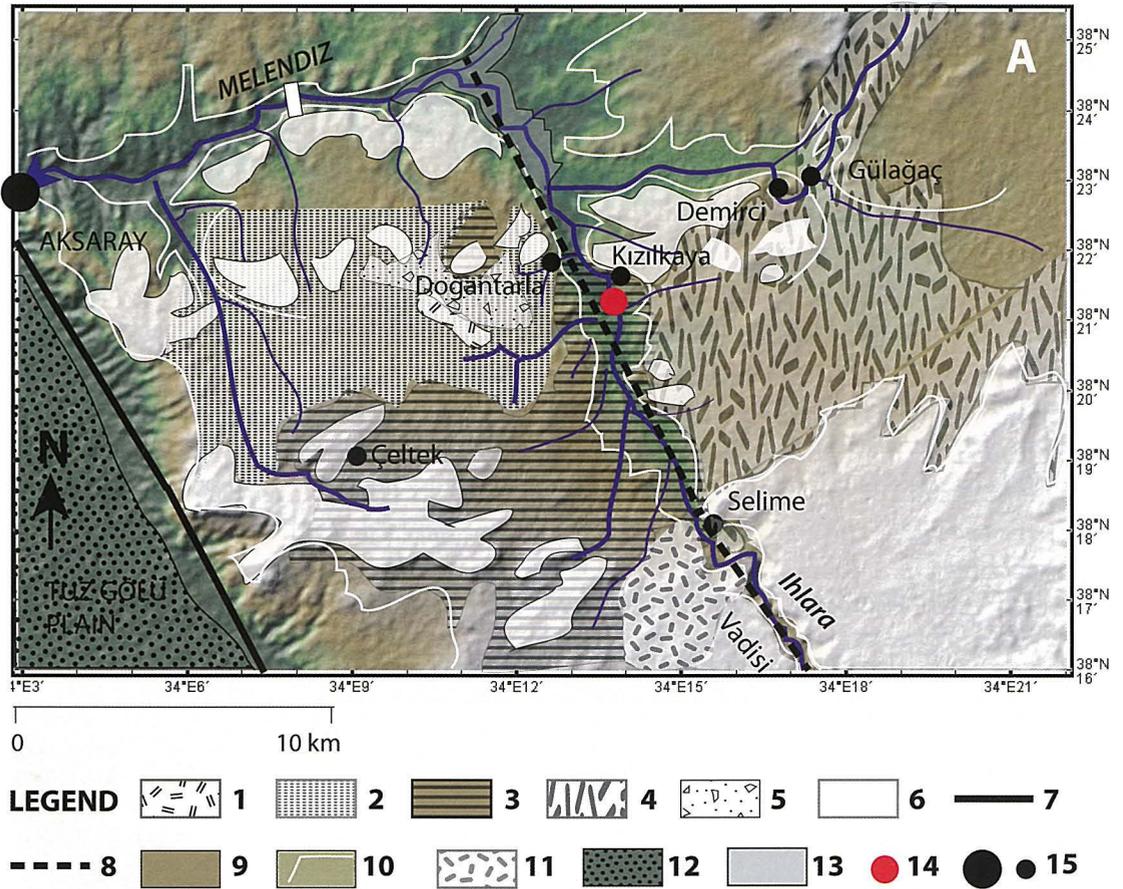
The Melendiz river has an approximate length of 70 km. It forms in the Çiftlik plain from the confluence of two mountain streams that flow from the Melendiz dağ (Figure 1). Downstream of the confluence, the river receives water from tributaries that drain the northern slopes of the Keçiboyduran dağ, the southern slopes of the Göllüdağ, and the Şahinkalesi Tepe volcanic massif. The river exits the Çiftlik plain through gorges incised in Mid-Pleistocene basalts that were emitted partly by the Keçiboyduran volcano and partly by the Şahinkalesi Tepe. After this basaltic area, the river continues into gorges, incising the Neogene<sup>2</sup> *Cappadocian ignimbrites*<sup>3</sup> as well as the younger volcanic clastic deposits that blanket them. The latter pertain to the Upper Pleistocene activity of the Hasandağ volcano (Beekman 1966; Pastre et al. 1998; Aydar – Gourgaud 1998) (Figure 2). These gorges incise the so-called “Kızılkaya ignimbrite” (aged 5.2-5.5 Myrs, Le Pennec et al. 1994; Aydar et al. 2012), which forms the famous 70 m deep Ihlara valley (Figure 2). The Ihlara valley ends at Selime, where two distinct ignimbrites resting one



**Figure 2.** Schematic geological log of the Neogene formations outcropping in the Melendiz river drainage area upstream and around Aşıklı Höyük. Sources are Beekman (1966), Le Pennec et al. (1994, 2005), Pastre et al. (1998). Dates are from Aydar et al. (2012); captions as in Figure 3.

<sup>2</sup> The Neogene is a geological period grouping the Miocene (20.44 - 5.33 Myrs) and the Pliocene (5.33-2.58 Myrs).

<sup>3</sup> An ignimbrite (from the Latin *ignis* [fire] and *imber* [rainfall]) is “a variety of hardened tuff... made up by crystal and rock fragments in a glass-shard groundmass... Ignimbrites are made of a very poorly sorted mixture of volcanic ash (or tuff when lithified) and pumice lapilli, commonly with scattered lithic fragments. The ash is composed of glass shards and crystal fragments. Ignimbrites may be loose and unconsolidated, or lithified (solidified) rock... Ignimbrites may be white, grey, beige, brown or black depending on their composition and density”. (Wikipedia, the free encyclopedia).



**Figure 3.** Geological sketch-map along the Selime-Doğantarla reach of the Melendiz river. (1) Palaeozoic substratum; (2) Sarımaden Tepe ignimbrite; (3) Cemilköy ignimbrite; (4) Gördeleş ignimbrite; (5) Neogene detritic formations intercalated between ignimbrite flows; (6) Kızılkaya ignimbrite; (7) Tuz Gölü fault; (8) Melendiz (probable) fault; (9) Unmapped outcrops downstream the Kızılkaya-Doğantarla gorges of the Melendiz river; (10) Cliffs bordering plateaus; (11) Selime-Zila travertine (Pleistocene); (12) Tuz Gölü lake formations (Pleistocene); (13) Reservoir lake of the Mamasun dam; (14) Aşıklı Höyük; (15) Town (large dot) and village (small dot). Adapted mainly from Beekman (1966). Note that the Late Quaternary pyroclastites emitted by the Hasandağ are not mapped; they cover, however, wide surfaces on both sides and south-east of the Ihlara valley gorge. Background GIS topographic map from GeoMapApp

above the other form an impressive mesa and badland landscape on the right bank of the river. The upper ignimbrite (Kızılkaya ignimbrite) is reddish and resistant to erosion, and it forms the surface of the plateau (Figure 3). The lower one is the light beige “Gördeleş ignimbrite”, which is very sensitive to erosion. Steeply incised by numerous rills, the ignimbrite set forms a typical Cappadocian badland landscape. At the base, troglodyte houses, barns and cellars have been dug into the Gördeleş ignimbrite.

As the thickness of the Kızılkaya ignimbrite decreases to the north and northwest, the morphology of the valley downstream from Selime changes completely. Until Kızılkaya village, the Melendiz river flows mainly between cliffs cut into the resistant, gray colored Cemilköy ignimbrite that forms the plateau on both sides of the valley (Figures 2-4). The cliffs are less impressive than in the Ihlara Valley. At places away from the valley, the Cemilköy ignimbrite is covered by loose Miocene continental deposits (e.g., southwest from Doğantarla) or by harder rocks

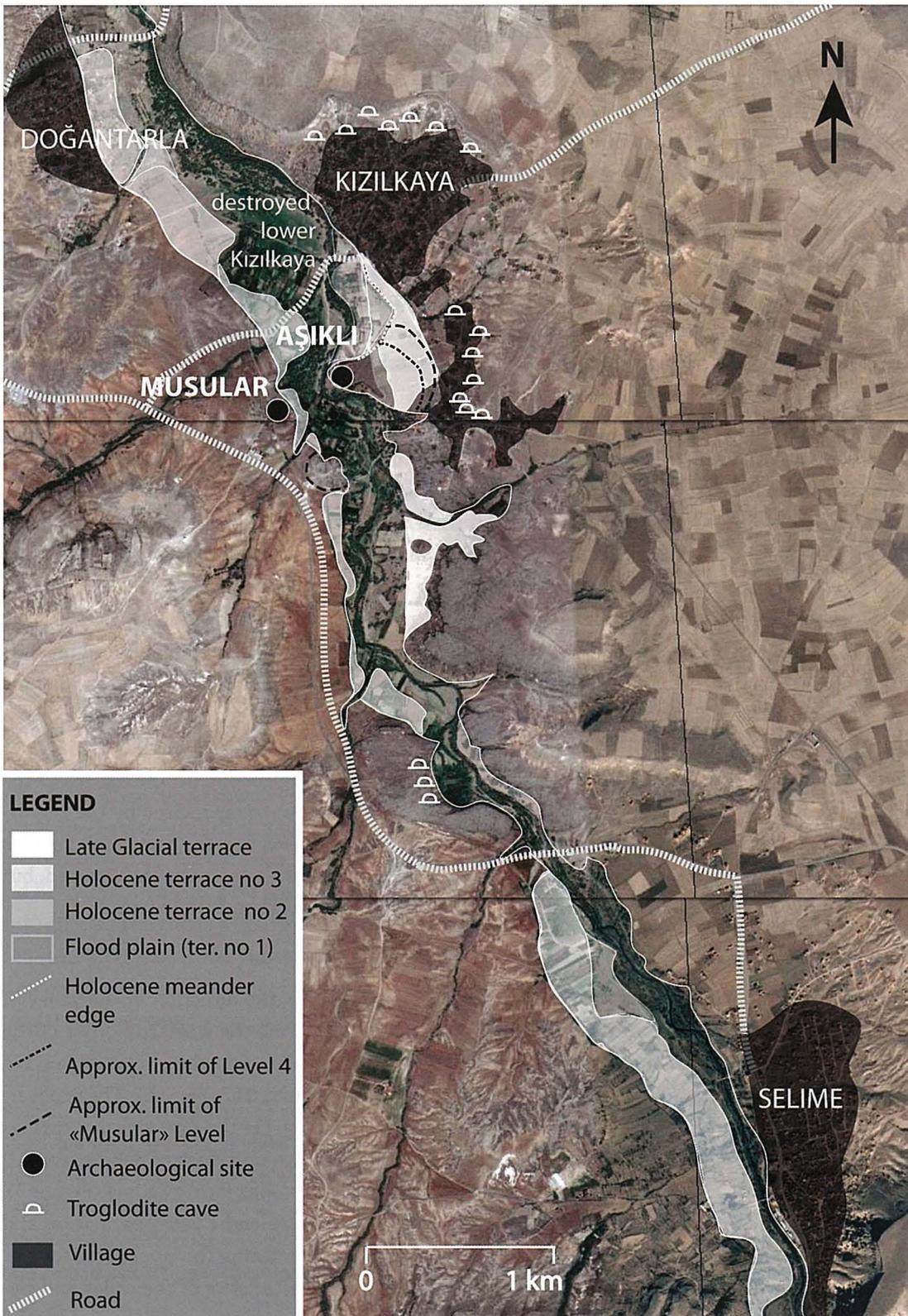


Figure 4. Late Quaternary landforms in the Melendiz valley between Selime and Doğantarla

(Kızılkaya ignimbrite and tuffite) (Figure 3). In the Kızılkaya village and north of the Selime bridge, the Cemilköy ignimbrite is also covered by the remains of the Gördeleş ignimbrite. West from the Cemilköy ignimbrite outcrops, flat plateau surfaces are formed by the Sarımaden Tepe ignimbrite, while the westernmost plateaus are formed by a hard facies of the Gördeleş ignimbrite (Figure 3). Both plateaus are, in turn, slightly depressed below the resistant remains of the Kızılkaya flow that dominates the landscape.

### *Modern dynamics of the Melendiz river in the area of Aşıklı*

In the Melendiz valley proper, fluvial terraces composed of gravels and sands enveloped in a red silty matrix occur at several places, especially on the left side of the valley (Figure 4). Active meanders of today's river channel construct a low (+ 2 m<sup>4</sup>) terrace in the valley floor. In this latter terrace, several landforms indicate the recent instability of the river bed. The modern river dynamics are controlled by the mountainous nature of the river regime, with high and sudden discharges at the beginning of spring. Such spring floods are capable of (1) incising the river bed at places, such as in 1996 when the river took away part of the terrace south of the mound, (2) commonly overflowing the +1 m terrace and even the + 4 m terrace, and (3) damaging the lower terrace such as when an old flood destroyed the old Kızılkaya village, which was moved and rebuilt on the slopes above the flood plain. All these changes in the river bed paths are typical of a flood plain constructed by lateral erosion of moving meanders (Figure 4).

Since the completion of the Kızılkaya dam 10.5 km north of the site, the river dynamics have been impacted by changes in the level of the lake dam, with clay and silt sedimentation increasing in the valley upstream of the dam lake reservoir between Doğantarla and Kızılkaya (Figures 3 and 4). Since the end of the 1990's, however, a combination of increasing dryness and increasing irrigation (especially in the Çiftlik plain) has caused a lowering of the annual discharge of the river in the dam lake. The consecutive change in the river longitudinal profile has led to the emersion of a new low terrace between Doğantarla and Kızılkaya, today incised by the regressive erosion that was triggered by the lowering of the river base level (i.e. the dam lake). For this reason, the Aşıklı mound is now threatened, not by the dam flooding as originally expected, but rather by the head-back erosion reaching the +2 m terrace that surrounds the mound.

### *Tectonic forcing*

From Ihlara to the confluence with the Karasu stream (Figure 1), the direction of the valley of the Melendiz river parallels the active Tuz Gölü Fault, which forms the western border of the Cappadocian plateaus (Beekman 1966). Three observations indicate a tectonic relationship between the Melendiz valley and the Tuz Gölü fault (see Şener et al. 2017: Fig. 1b). These observations are as follows, from south to north in the Melendiz valley: (1) the Iısu thermal springs south-east of Ihlara, (2) the abandoned Ziga thermal baths 3.5 km upstream of Selime; and (3) the wide travertine fed by warm water, which plasters the steep slopes facing Selime (Figure 3). These observations point to an active structural control on the Melendiz valley formation and its evolution, and a possible tectonic impact on the river dynamics during the Upper Pleistocene. This structural control may have caused three morphologic characteristics of the valley and river: (1) the valley incision within rocks as hard as the Kızılkaya ignimbrite and the basalts; (2) the

<sup>4</sup> A positive sign (+) indicates the number of meters in relative altitude above today's river flow channel; a negative sign (-) the number in meters in relative depth below the river channel.

orientation of the valley; and (3) the displacement of the river bed and meanders in response to the activity of the fault line that controls the left side of the valley (Figure 4).

### *Volcanic forcing*

Volcanic forcing effects should not be forgotten. Hasandağ dominates and partly contributes to the river drainage basin (Güvercin stream). Since about 1 Ma ago (Aydar – Gourgaud 1998), it has been both very productive and destructive, including during the Late Glacial (Pastre et al. 1998; Kuzucuoglu et al. 1998) and beginning of the Holocene (Schmitt et al. 2014). The construction of this stratovolcano also strongly impacted the morphological setting and dynamics of the river during the Pleistocene. Two elements of this process are (1) a possible impact on the topography due to the upheaval of magma and recurrent emptying of the magma chamber (three times during the Pleistocene according to Aydar and Gourgaud [1998]), and (2) the deposition of pyroclastites produced by eruptions, which not only covered the slopes around the volcano (Beekman 1966; Aydar – Gourgaud 1998; Pastre et al. 1998), but also blocked or destroyed parts or all of the stream valleys around the volcano (Kuzucuoglu et al. 1998; Pastre et al. 1998).

## **Today's environment in the Melendiz river valley between Selime and Doğantarla**

### *Climate*

Climate in the Aksaray region is moderately continental. Winters are not very cold, and summers are not excessively hot. The dry period lasts from July to September (<https://en.climate-data.org/region/611/>). At Kızılkaya village, the mean annual temperature is 10.8°C and mean annual precipitation is 311 mm. Values >250-300 mm are necessary for rain-fed agriculture, and the conditions in the study area can become marginal any time (van Zeist – de Roller 1995), especially when increasing dryness strikes. Such a drying trend is presently occurring in Central Anatolia. Bayer-Altın et al. (2012) calculated that the annual temperature in Central Anatolia increased by 0.4°C/yr between 1975 and 2007. In the same period, average rainfall intensity varied between 0.3% and 21% annually, with larger decreases in the south of the region. The same authors also state that the semi-arid and semi-humid climate types that prevailed in Cappadocia between 1975 and 1990 shifted to increasingly arid and semi-arid climate types. As a result of this trend and recent changes in agricultural methods and crop choices, the decrease in water availability is compensated in the Melendiz valley floor and other agricultural areas by irrigation.

### *Soils*

Soils in the Aşıklı area are of volcanic origin. Windblown carbonate or evaporitic dust from the Tuz Gölü fault scarp and plain may also be trapped in the soils (Figure 3). In the Melendiz river flood plain, alluvial soils developed over fluvial terraces. The highest terraces are cultivated as gardens and open fields. The lowest flood-prone ones are devoted to grazing. Upper slopes are blanketed by colluvial reworking of weathered volcanic bedrock and intercalated detritic formations. Although geochemical weathering and fragmentation of rocks result from long-term processes, the colluvium cover is not very thick over the bedrock, probably because of regular rain-wash erosion in the direction of the flood plain. The colluvium is evacuated by streamlets that incise the ignimbrites and terrace deposits along the valley sides. The geological succession and rock facies incised by the Melendiz river in the areas of Kızılkaya village and Aşıklı Höyük

(Figures 2 and 3) show the dominance of Neogene ignimbrites, with some noticeable occurrences of continental deposits composed of rounded gravels of a high petrologic variety and intercalated between the ignimbrites.

## Vegetation

The modern natural vegetation of the area is the *Artemisia* steppe of Central Anatolia. According to van Zeist and de Roller (1995: 180), “isolated trees and a mean annual precipitation of over 300 mm suggest that, in the Aşıklı area, the steppe may originally have borne scattered tree growth.” In the valleys of the tributaries, such as the one bordering the excavation house to the south, the mix of trees and bushes covering the ignimbrite slopes is the result of heavy exploitation of a former forest (Ergun 2016). Downstream of the bridge north of Selime, remarkable wetlands have developed on the left side of the flood plain (Figure 4). These marshes are fed by springs at the contact zone between the Cemilköy ignimbrite and a soft facies of the overlying Gördeleş ignimbrite. In the soft ignimbrite, abandoned troglodyte rooms resemble those in the backyards of Kızılkaya houses near the excavation house.

## Geomorphology of the Aşıklı Höyük area

### *Landscapes around the mound*

Aşıklı Höyük rises 13 m above the flood plain of the Melendiz river. The maximum altitude of the flood plain here is 1106.5 m asl (i.e. +2.5 to 3 m). South of the mound, the modern river channel turns west when encountering the mound (Figure 4). In doing so, the river erodes the mound and the low terraces surrounding it. East of the mound, a flat relief deepened in its centre by a shallow depression separating the archaeological site from the ignimbrite slope where modern village houses are built (Figure 4). Deepening southward, the depression forms a gutter, which downslope is cut perpendicularly by a small channel flowing in the direction of the flood plain (Figure 4). North of the mound, an old meander has eroded the slope below the modern village. Stepped in the concave bank of this meander, a +4 m flat terrace embraces the northern foot of the mound. Today, this terrace is cut by the river at the western end of the mound, while two lower terraces also fringe the topographic foot of the mound on the western and southwestern sides (Figure 5).

### *Geomorphological definition of terraces*

Within an alluvial plain, a river incises either the substratum or rock basement (a *strath terrace* in this case), or an older alluvium fill (a *fill terrace* or *erosional terrace* in this case) (Vandenbergh 2015). After incision, the terrace is constructed by the accumulation of alluvial sediments. When changes occur in the river regime, the incision reaches the substratum again (forming a second strath terrace), or it does not reach the base of the previous accumulation base and forms instead a fill or erosional terrace. Fluvial terraces thus result from the succession of three phases of formation —incision, deposition and incision. Once the initial incision by the river ceases, the construction of the terrace starts with an accumulation of coarse-sized sediments such as gravels and blocks called a *bedload*, deposited by channels moving more laterally than vertically. Later, the deposition of thinner sediments (gravelly sands, sands, silts) by laterally and vertically moving channels signals the adaptation of the river dynamics to a regular regime,

constructing the fill without incision in the rock basement. The initial incision can be caused by changes originating from (1) tectonic processes (e.g., a regional uplift or a fault movement), (2) a change in the longitudinal profile of the river caused by a change in the base level<sup>5</sup>, or (3) a climatic crisis that destabilizes the sediment and/or water input into the river bed. Later changes to the succession of the units forming the terrace (e.g., bedload, channel fills, bars, flood silts) record the incision (bedload), followed by stabilization (other deposits). Another cause of destabilization of river dynamics can be deforestation in the watershed caused by humans or climate (or rarely a volcanic event).

### *Fluvial terraces and flood plain of the Melendiz river near the mound*

The highest number of terraces encountered in the Selime-Doğantarla reach occurs in the area around the archaeological mound (Figure 4). Here, the Cemilköy ignimbrite forms a moderately eroded surface at about +30-40 m before disappearing under fluvial terraces stepped in the direction of the valley drained by the Melendiz river (Figure 5). Five distinct terraces fringe the flood plain. Today's minor bed (the channel and the regularly flooded +1 m terrace T1 in Figures 5-6) is inscribed in the four older terraces (T2 to T5 in Figures 5-6). All terraces are embedded within one another. The oldest ones (T5 and T4) outcrop upslope of the edges of the valley; the youngest ones form the present flood plain (T3 and T2). All are fluvial deposits composed of round gravels enveloped in reworked sands and brown clay. In the list below, they are identified by the mean relative altitude of their flat summit surfaces:

+10 m terrace is the oldest identified (T5). It presently is separated from the Cemilköy ignimbrite at Musular by an irrigation channel.

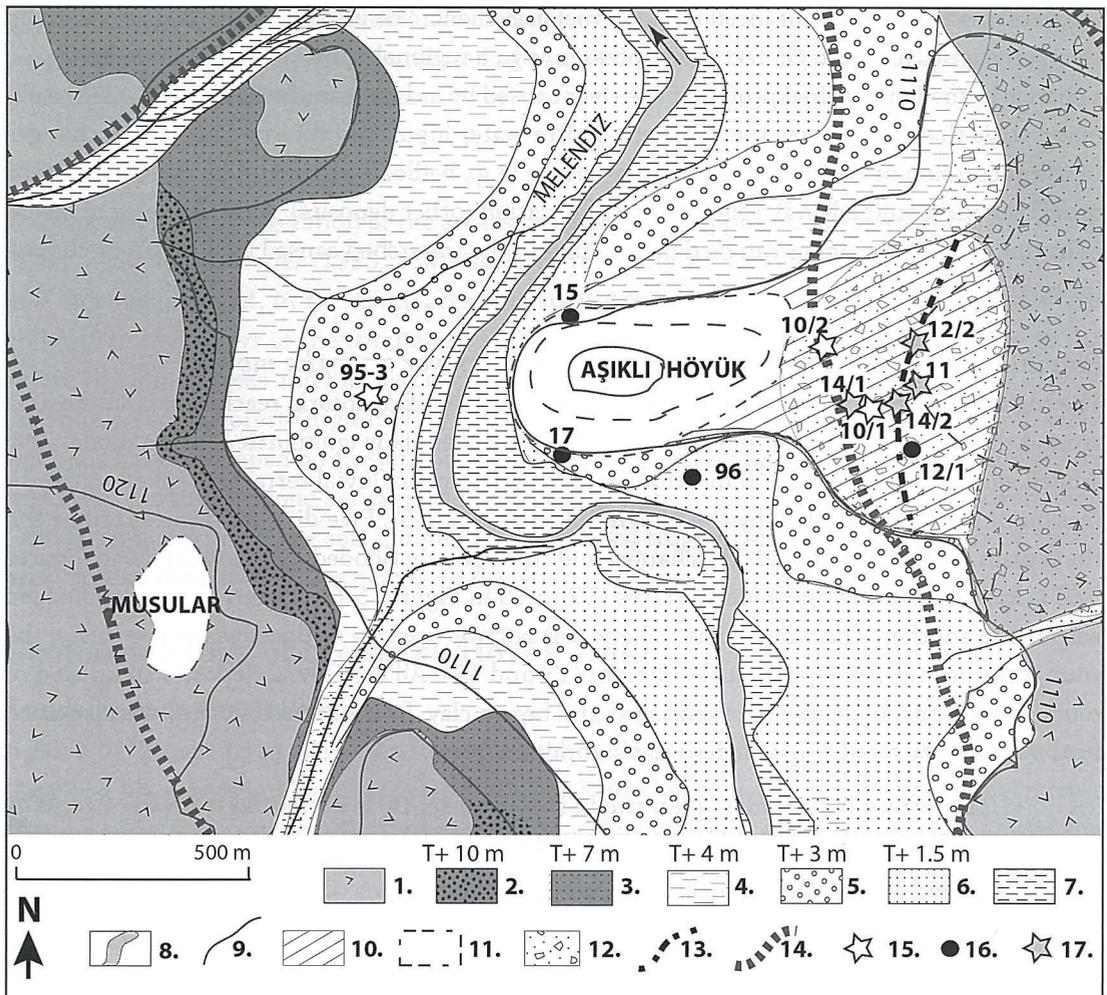
+7 m terrace (T4) also fringes the top edges of the valley. Out of reach of floods, both high terraces today are devoted to intensive gardening.

+4 m terrace (T3) is wide, especially on the left bank of the modern river. On the right bank of the river, it is preserved only along the northern edge of the mound. T3 outcrops correspond to the upper level of an old flood plain incised by the two younger terraces, T2 and T1. Reached only by the highest floods, T3 is used for gardens and cereal production.

+2.5 to 3 m terrace (T2) is depressed in T3. Its spatial distribution and width between T3 (when preserved) and T1 (minor river bed) record a high amplitude meandering system incised in T3. Covered irregularly by floods, T2 is devoted to animal husbandry and willow management practices. In 1996, a strong flood event eroded parts of T2 along the southern and southeastern edges of the mound, revealing mud-brick walls pertaining to archaeological Level 2, which had already been truncated during T2 formation. It is possible to see such walls in the bottom floor of the river channel at this location.

+1 to 2 m terrace (T1) is the lowest of all. Bordering the river minor bed, it regularly floods during spring and is unstable. In places, it hosts two active channels forming temporary stony islands.

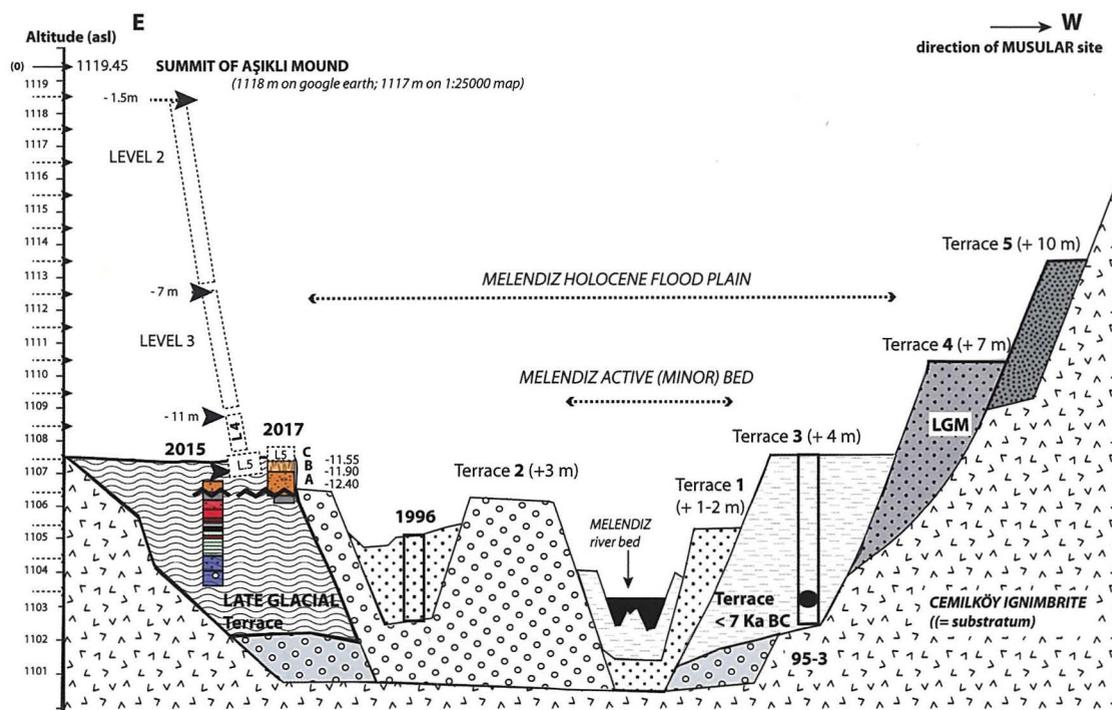
<sup>5</sup> The base level of a river is defined as 0 m at its mouth. For the Melendiz river, the 0 m level is that of the Tuz Gölü, a lake occupying a subsiding tectonic basin west of Aksaray. The levels of this lake have changed several times during Upper Pleistocene and Holocene. Other possible types of lakes that may have influenced the Melendiz river slope would be a lake formed by a volcanic dam (e.g., a volcanic avalanche similar to that described by Pastre et al. 1998 in the Güvercin and Ihlara valleys), a mass movement flowing into the valley (not found, but not looked for), or a human-built lake (e.g., the Mamasun dam).



**Figure 5.** Fluvial terraces in the Aşıklı Höyük area, with location of the sequences presented.

(1) Cemilköy ignimbrite (= rock basement); (2) T5: +10 m terrace (just below the Musular ignimbrite outcrop); (3) T4: +7 m terrace; (4) T3: +4 m terrace; (5) T2: +3/2.5 m terrace; (6) T1: +2 m terrace; (7) Present flood plain (+1/1.5 m), regularly flooded; (8) Active river bed channel; (9) Altitude contours from 1:25000 topographic map; (10) Area where in situ archaeological layers have been identified below the surficial colluvium cover; (11) Approximate extension of the archaeological outcrops on the surface; (12) Major colluvium fed by the ignimbrite slope above; (13) Pre-Late Glacial river channel identified in the cores; (14) Roads; (15) Locations studied with a truck-mounted corer; (16) Locations studied using archaeological pit or trench; (17) Locations studied with a hand-corer with open gouges.

Stratigraphic reconstruction and interpretation of the terraces described above can be summarized in the following way (see also Figures 5-6). T5, T4 and T3 are embedded strath terraces—landforms resulting from an incision of the river into the bedrock, followed by the accumulation of sediments over the bedrock floor. These terraces are embedded, meaning that the substratum does not outcrop in the topographic bench separating each terrace surface. T2 and T1 are embedded fill terraces, meaning that they are not incised in the bedrock but rather in the previous T3 fill. T2 and T1 comprise the modern flood plain, which associates closely with the dynamics of the modern river regime.



**Figure 6.** Late Pleistocene and Holocene fluvial deposits and terraces west of Aşıklı Höyük (this figure continues Fig. 7 westward). Captions as in Figure 5. The black circle represents an obsidian piece retrieved from within the lowest fluvial sediments in the 95-3 core. See also Figs. 3-5 in Kuzucuoğlu (2013). No importance is given to the distance scale which is considerably reduced, and does not reflect the proportions in the width of the terrace formations.

## Reconstruction of the landscapes around Aşıklı at the time of first settlement

### Methods

#### Coring

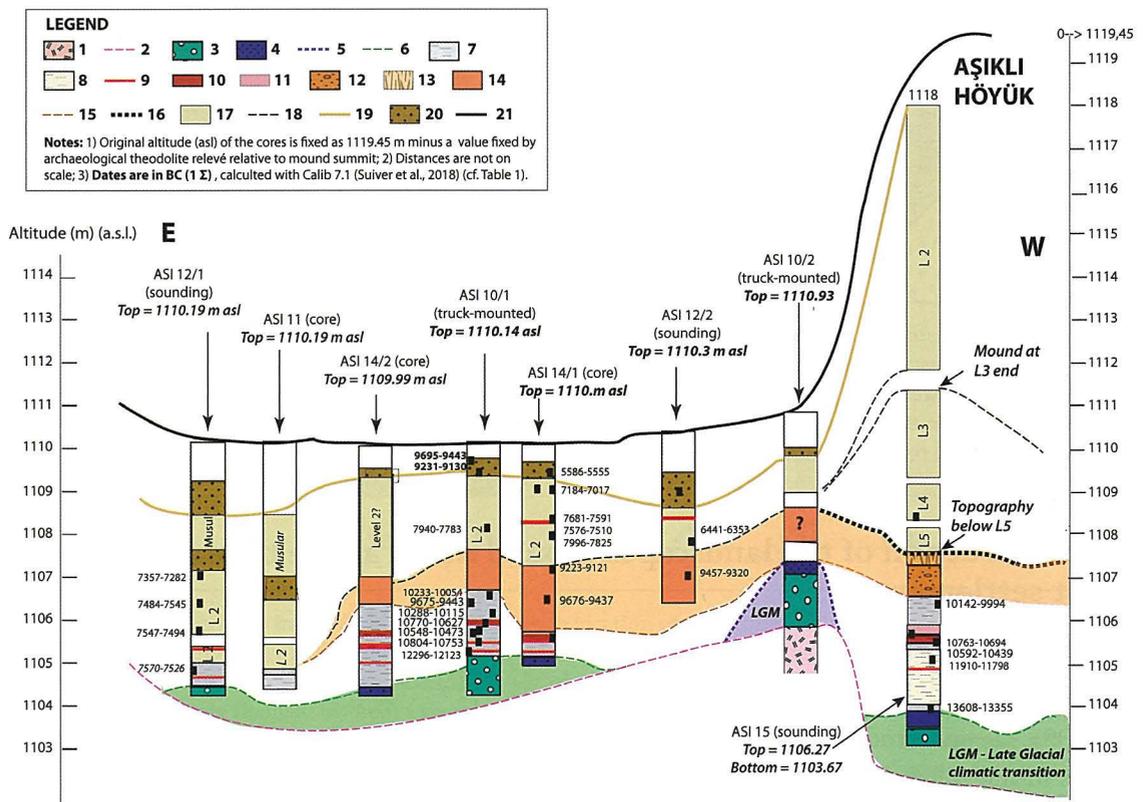
In 1995, we undertook coring using a truck-mounted rotary percussive core drill at three locations in the valley (core nos. 95-1, 95-2 and 95/3 in Kuzucuoğlu, 2013: Figs.2-4) (Figure 5). These cores were made within the modern flood plain, aligned N-S at distinct locations on two different terraces. The 1995-1 core was placed in the +2 m terrace at the entrance of the Doğantarla river gorge. The 1995-2 core was placed in the +2 m terrace at the point where a former part of the Kizilkaya village was destroyed by a flood during the 1950's. The 1995-3 core (5 m deep) was placed in the +4 m terrace facing the mound on the left bank of the river.

In 1996, a sounding was excavated by the archaeologists in the +2 m terrace (T1) that is embedded in the southern side of the mound (location 1996 in Figure 5). The results are taken into account in Figure 6.

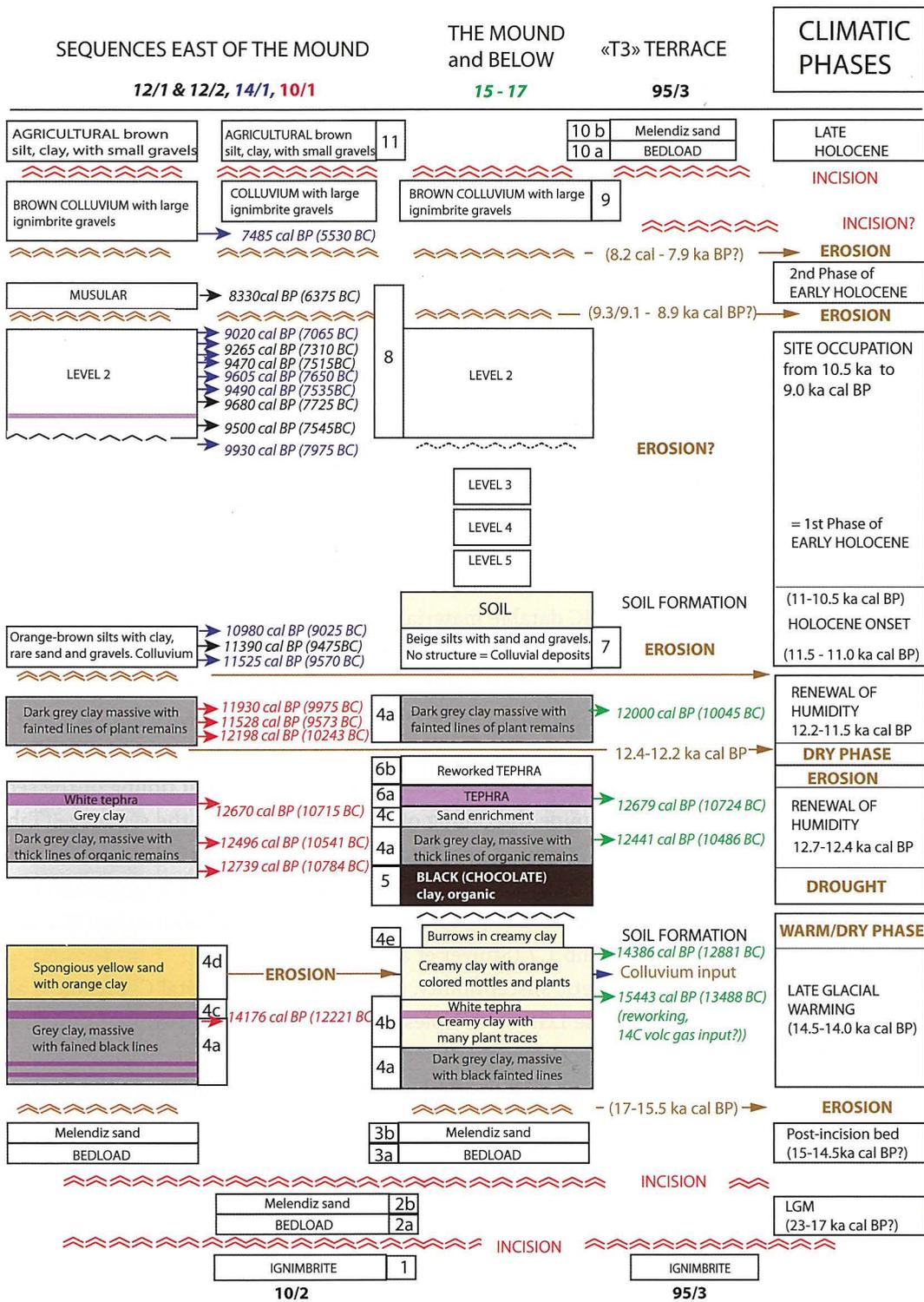
Two cores were extracted in 2010 with a truck-mounted rotary percussive drilling corer on the eastern side of the mound. The first core (10/1) was positioned in the topographic centre of the N-S gutter-like depression eroding the eastern horse-back landscape between the mound and the ignimbrite cliff. The second core (10/2) was positioned in the earth road edging the site property fence, and at the highest point of the horse-back east of the site (Figure 5). These

cores provided a preliminary stratigraphy of units defined on facies and depths relative to the surface, and samples for analyses and dating at intervals bracketing the main units identified during coring. A detailed stratigraphy of 10/2 is not available because of compression or mixing of sediment in some of the core drives.

In 2011, we cored the gutter with a hand-corer equipped with open gauges. The 11 core was positioned about 10 m away from the 10/1 location. In spite of the short distance between them, the results for the 11 core are different from those from the 10/1 core, with an important phase missing at the base of the 11 core. This result points to meaningful spatial variation in the records of past environmental dynamics within the gutter. No sampling for datable material



**Figure 7.** Late Pleistocene faciès, stratigraphy, and chronology of sediment formations east of Aşıklı Höyük (this figure continues Fig. 6 eastward). (1) Cemilköy ignimbrite buried below LGM, Late Glacial and Holocene sediments; (2) Tentative reconstruction of the erosion surface truncating the ignimbrite covered by the Pleistocene fluvial sediments; (3) Fluvial bedload; (4) Fluvial sand of the river Melendiz; (5) Tentative limit of the + 4 m terrace (1<sup>st</sup> fluvial series) buried below the road; (6) Eroded surface and volumes of the 2<sup>nd</sup> series of fluvial sediments deposited over the surface eroding the 1<sup>st</sup> fluvial series; (7) Grey massive clay, sometimes oxidized, sometimes enriched in pressed plant remains and charcoals; (8) Creamy clay full of small plant remains (dry peat); (9) Indurated or sandy thin layers representing short and/or important interruptions in the stratigraphy (calcretes, tephra, “chocolate clay”); (10) Thick pumice tephra; (11) Reworked pumice tephra (immediately following the fall); (12) Pumice-rich colluvium in ASI/15 sounding; (13) Soil; (14) Pumice rich colluviated orange sand separating the grey clay and the archaeological layers; (15) Erosion surface overlain by orange colluvium; (16) Eroded surface of the orange, pumice-rich colluvium over and in which some of the L5 buildings are dug and/or built; (17) Archaeological accumulations; (18) L3 mound shape and topography before development of L2 in a small valley incised in the colluvium; (19) Topography eroding the last archaeological occupation layers; (20) Latest colluvium layers (showing soil features) blanketing the last archaeological occupation layers; (21) Today’s topographic surface of the N-S elongated depression east of the mound.



**Figure 8.** Composite logs of all sequences associated with <sup>14</sup>C chronology of five sequences in relation to climatic phases identified in the ice cores. Broken red lines are stratigraphic unconformities (i.e. erosion phases producing either truncation or incision or reworking); dates are calibrated BP (with BC in brackets), written with colors allowing identification of the cores or trench to which they belong. From East (left) to West (right) of Aşıklı Höyük: The N-S elongated depression (cores 12/1, 12/2, 14/1); the road east of the mound (10/1 core); the sounding below the site (ASI/15); the Late Holocene +3-4 m fluvial terrace (1996 sounding and 95-3 core).

was performed on the 2011 core, as it was supposed to correspond exactly to the 10/1 core location. However, the 12/1 sounding that exactly parallels the 2011 core has been dated (see below).

In 2012, the sediment fill of the gutter was sampled with archaeological methods in order to provide a good control on the stratigraphy. Sounding 12/1 reached a depth of 4.97 m downslope toward the south end of the gutter. Sounding 12/2 was trenched to 3.8 m deep from the highest level of the gutter, in the threshold between the mound horseback and the gutter.

In 2014, two final cores (14/1 and 14/2) were made in order to obtain reliable correlations to earlier cores, with 14/1 positioned exactly at the 10/1 core location, and 14/2 only 1 m away from 14/1.

In 2015, an archaeological sounding (15) below the initial occupation level of the mound (Level 5) provided a detailed stratigraphy that clearly parallels (although with more units) that of the 10/1 and 14/1 cores in the gutter. In 2017, a section (17) was excavated along the southern foot of the mound, cutting a natural sequence buried by Level 5. Visual observations were taken of this section, but it is not yet dated (see Figures 7-8).

#### *Dating and physical and geochemical analyses*

The sediments cored in 1995 and sounded in 1996 did not provide suitable samples for  $^{14}\text{C}$  dating because of the absence of  $^{14}\text{C}$  datable material. Although all other sequences contained charcoals or sufficient organic matter for  $^{14}\text{C}$  dating, our dating strategy concentrated on five sequences: the 10/1 exploratory core operated with a trunk-mounted hydraulic percussion corer; the 12/1 and 12/2 detailed archaeological soundings; the 14/1 taken with a hand corer at the same location as 10/1; and the 15 archaeological sounding ca. 75 m below Level 5 at the northwest edge of the mound. Our goals were to constrain the depositional timing of the sediment units identified, and to determine the timing of possible hiatuses in the sequence (Table 1). Most of the  $^{14}\text{C}$  dating results (19) were obtained with the accelerator mass spectrometry method at the Saclay-LMC14-Artémis national facility (Moreau et al. 2013; Dumoulin et al. 2017). Seven other dates were performed by the Poznan Radiocarbon Laboratory (PL). Date calibration was performed using Calib 1.7 (Stuiver et al. 2018).

In addition to  $^{14}\text{C}$  dating, magnetic susceptibility, grain size analyses, total C, organic C and C/N analyses were performed at the LGP on samples from the 10/1 and 11 cores. Total C, organic C, and C/N results were collected with a CHNS Flash 2000 ThermoScientific analyzer. Grain size analyses were performed on a LS230 Beckman-Coulter Laser analyser. Magnetic susceptibility was measured by a Bartington MS2 apparatus. Analyses of the 14/2 sequences and 15 sounding are on-going and not presented here.

**Table 1.**  $^{14}\text{C}$  dates in cores and sections around Aşıklı Höyük, performed by Saclay/Artemis/LSCE (23) and Poznan (6) Laboratories. Calibration has been performed using Calib 7.1 (Stuiver et al. 2018).

STRATIGRAPHIC UNIT	DEPOSITIONAL ENVIRONMENT	Ref. LAB	Core -Sample # (depth in core)	Sediment facies and/or depositional environment	Dated material	Radiocarbon date				CLIMATIC PHASES (ka cal BP)		
						Raw BP date	Max	Min	confid %		Mean BC (1 sigma)	Calib BP
<b>AFTER 7.9 ka cal BP</b>												
UNIT 9	REWORKED SEDIMENT	Poz-66034	ASI 14/1 150-153	Above "Musular"	Charcoal	6580 ± 40	5586	5555	1	5530	7485	1 <sup>st</sup> half Mid-Holocene
		SacA 23897-Gif-12637	ASI 10/1 150-153	Above "Musular"	Reworked m.o.	10030 ± 60	9695	9443	0,888	9585	11540	
		SacA 23898-Gif-12638	ASI 10/1 167-170	Above "Musular"	Reworked m.o.	9660 ± 45	9231	9130	0,697	9135	11090	
<b>EARLY HOLOCENE</b>												
UNIT 8	SITE	SacA 30752	ASI 12/2 250-253	"MUSULAR-Type"	Charcoal	7510 ± 60	6441	6353	0,789	6375	8330	DRY/WARM 8.2-7.9 ka?
		Note	"MUSULAR-Type exists also in 12/1, separated by orange silts from older archaeological layers below"									
UNIT 8	COLLUVIUM			Orange silts, slightly sandy (pumice). No apparent structure								DRY/WARM 9.3-9.1 ka?
		Poz-66035	ASI 14/1 175-177	Uppermost level	Charcoal	8090 ± 80	7184	7017	0,702	7065	9020	
		SacA 30755	ASI 12/1B 335-345	Upper level of mid-archaeological site unit, indurated	Charcoal	8265 ± 35	7357	7282	0,529	7310	9265	
		SacA32315	ASI 12/1B 390	Level associated with pebbles	Charcoal	8430 ± 40	7545	7484	1	7515	9470	
		SacA 30754	ASI 12/1B 440-445	Above sterile level	Charcoal	8440 ± 35	7547	7494	1	7725	9680	EARLY HOLOCENE
		SacA 30756	ASI 12/1B 520	Red layer (tephra ?)	Charcoal	8470 ± 35	7570	7526	1	7545	9500	
		Poz-66190	ASI 14/1 2,5-2,53	Upper middle part	Charcoal	8640 ± 50	7681	7591	0,954	7650	9605	
		Poz-66036	ASI 14/1 2,70-2,72	Level associated with pebbles	Charcoal	8460 ± 50	7576	7512	1	7535	9490	
UNIT 8	SITE	Poz-66120	ASI 14/1 2,80-2,83	Indurated level	Charcoal	8840 ± 50	7996	7825	0,626	7975	9930	
		SacA 32313	ASI 10/1 260-262	Below indurated level	Charcoal	8785 ± 40	7940	7783	0,928	7853	9808	





## Results on stratigraphy and synthetic description of units

Cores and soundings delivered several, often recurrent rock and sediment units that could be defined by their facies (Figures 6-7). Here we present the facies from base to top, with information about the stratigraphic relationships between the units, specifically continuity or discontinuity.

### *The base of the environmental sequences: The geological bedrock (Unit 1 in Figure 8)*

The oldest formation is a hard in situ ignimbrite bedrock incised by the river (Cemilköy ignimbrite, most probably). Two cores have reached this bedrock, 95/3 and 10/2 (Figures 6-7). With different altitudes asl (1106 m in 10/2; 1102.5 m in 95/3), their stepped disposition indicates two distinct strath terraces. The lowest ignimbrite top corresponds to the base of the T3 terrace (95/3 core) (Figure 6). As would be expected, the older terrace base is at a higher absolute altitude. This older terrace rests above the eroded top surface of a horseback cut into the ignimbrite. The terrace deposit is separated from an archaeological accumulation above, by a hiatus.

### *Depositional environment no.1: Alluvial fills of strath terraces (T5, T4, T3), fluvial bedload overlain by laterally moving channels in flood deposits*

Rounded pebbles cover the ignimbrite at different levels. These alluvial deposits correspond to the bedload immediately following the initial incision phase, previous to the flood plain construction above it. At all locations, the lithology of the pebbles is richer than the surrounding substratum outcrops, indicating a long-distance reworking of mainly volcanic rocks, including basalts originating from the upper parts of the valley. Three different bedload levels have been reached by cores and soundings around Aşıklı Höyük (Figure 7). All of them are covered with alluvial well-washed sands that are black or gray colored, signalling the switch from incision to accumulation. The upward decline in grain size of the sediment (from coarse to small-sized elements) constitutes the normal aggradation evolution of sediments, recording the construction of a flood plain.

The relative depths at which bedload has been reached are as follows:

- (a) The base of the  $\geq 2$  m thick fluvial deposit crossed by core 10/2 above the ignimbrite is positioned at +2 m. This relative altitude corresponds to the base of the incision preceding the deposition of the bedload. The thickness of sands overlaying the bedload is uncertain (Figure 7). The +2 m altitude of incision correlates the bedload overlaying it (i.e. bedload no.1) to the base of the T4 alluvial fill. As shown in Figure 6, the T4 surface on the left bank of the river is at +7 m, and the base of its topographic bench is at +4.5-4.0 m. The base of T4 is not visible because T3 lies on top of it. The T3 terrace is post-dated by the occupation of the mound, given that a few obsidian shards have been found in 95/3. T4 corresponds to a terrace that existed before the mound formed (Kuzucuoğlu 2013).
- (b) Between +1.5 and +0.5 m in the gutter east of the mound, remains of a bedload and overlaying sands were reached. The bedload base was not reached, but the bedload-fluvial sands set is  $\geq 1$  m thick. In core 14/2, the top of the sand layer overlying the bedload is at +1 m. It occurs at +1.5 m in sounding 12/1 and core 10/1 (Figure 7), and it has been

found at +0.7 m in the 15 sounding (Figure 6). Here, the top of the water table fed by the modern river was reached at +0 m (i.e. in bedload no.2).

- (c) The 95/3 core, retrieved from the T3 surface, reached the top of the incised ignimbrite at -5 m depth (i.e. 1.5 m below the modern river bed) (Figures 5-6). The ignimbrite is covered by bedload no.3. Since the incision has cut the bedrock, T3 is a strath terrace. The erosional fill terraces T2 and T1 are, on the contrary, embedded in T3. The deepest level reached by the Melendiz river incision is thus found here at -1.5 or -2 m.

This analysis shows that the ignimbrite roof records three incision steps: +2 m which is the probable base of T4 accumulation; +0.5 to +1.5 m uneven topography for the second step (although the ignimbrite roof was not found for this step), which corresponds to the base of a terrace buried below the gutter; and -1.5 m for the third step that corresponds roughly to the base of T3.

*Depositional environment no.2: Massive gray clay with horizontal black layers, recording a humid period interrupted by drying in a volcanic context*

Figure 7 illustrates the sedimentary succession after the deposition of bedload no.2. Preserved below the gutter surface and below the site, the sequence that rests above fluvial deposits no.2 is never alluvial. According to the clay facies present at the bottom and top of the sequence, the landscape in the valley was characterized at the time by backswamps. An accumulation of thin particulates (clay) deposited in a water-rich vegetation environment (backswamps) was retrieved in all sequences east of the mound (except at 12/1 where the sounding was not deep enough to reach it), as well as in both the 15 sounding and the 17 section north and south of the mound (Figures 6-7). The facies recording the changes that affected the marshy environment through time vary from place to place, in relation to distance/proximity to the active channel at the time. This channel probably was positioned west of the mound, where the sequence is deeper, thicker and richer in changes that reflect variations in water presence and quantity. Four tephra layers have been recognized in the sequence.

A synthetic reconstruction in Figure 8 shows three distinct phases characterized by differences in humidity. The initial humid phase (1) is followed by increasing dryness (2). The final drought (3) is interrupted by renewed humidity at levels similar to the first phase. The palaeoenvironmental reconstruction thus starts with (1) the initial development of backswamps interpreted from the dark grey clay with faint black lines recording shallow lakes surrounded by patches of reeds and other hydromorphic vegetation favored by still water (Unit 4a). The marshes developed first in the deepest part of the valley (15 sounding). After a delay, the marshes also appear in the gutter. Later, the lowering of the water level (2) is indicated by the replacement of clay by peat (Unit 4b in 15 and 10/1). In the valley and the gutter, with sediment accumulation and low vegetation expanding over the plain surface. Shallow still water bodies are present, while surficial channels provide some drainage. Later, input of sand in the marshes (Unit 4c, light gray clay enriched in silts and/or sand in 15 and 10/1) indicates an increase in water discharge loaded with reworked sediment eroding from the plain, meaning that the river has started incising the valley fill. This change is followed by a colluvium input, reworking weathered volcanic sand over the slopes (Unit 4d in 15 sounding and 10/1 core). This episode may result from the disappearance of vegetation over the slopes, while the river bed may have moved to the western part of

the valley. Later, emersion is followed by the development of soils (Unit 4e in 15, burrows in dry peat). The complete drying of the marshes in the floor of the plain is recorded by dead marsh vegetation, transforming the sediment of the “chocolate” layer (Unit 5 in 15, 14/2 and 10/1, with the high density and dark brown color of the massive clay being due to drought stress).

After complete drying, the marshes reform (3) rapidly—as rapidly as during the first backswamp episode at the base of the sequence. The second accumulation of gray clay is richer in plant remains, which form thick black layers. This change corresponds to a warmer and wetter context (Unit 4a). During this second backswamp phase, a fourth eruptive event causes the deposition of a coarse 5-10 cm thick pumice fall (Unit 6a). This tephra is well preserved and thicker in the 15 sounding than in the cores east of the mound (10/1, 14/1, 14/2). It is rapidly reworked by runoff, which mixes it with ignimbrite sands (Unit 6b). Both of these observations confirm that the western part of the valley was progressively lower than the east of the mound.

#### *Depositional environment no.3: Colluvium recording intense erosion*

This fine-grained colluvium is formed by orange-brown clayey silts that are rich in sands with very few gravels (Unit 7 in Figure 8). Resulting from the destruction of soils around the area, it seems thicker on the sides of the mound than below the mound. It decreases sharply eastward in the direction of the ignimbrite on the edge of the valley, although this edge should be the main provider of the colluvium. It has not been found west of the mound because of the incision of the valley during the Holocene. The explanation for the variations in the thickness of this unit is an intense erosion of the colluvium after its deposition (Figure 7). This erosion is also clearly indicated by the absence of the colluvium in the 2011 core and the 12/1 sounding. As these two sequences are positioned downslope in the southern part of the gutter, the absence of the colluvium indicates that a small stream evacuates the material southward in the gutter. The reconstructed landform suggests that the modern gutter shape is initiated during this period.

A third input of colluvium occurs later in the gutter, and later again, in the gutter after the abandonment of the site (8.3 ka cal BP?) (Unit 9 in Figure 8).

#### *Depositional environment no.4: Archaeological accumulation*

Archaeological layers (Unit 8 in Figure 8) have been identified in all cores and soundings east of the mound. According to the dates (cores 10/1, 14/1), deposits relating to Levels 3 and/or 2 in the mound are present deep in the upper slopes of the gutter (sounding 12/1, core 11). On the threshold of (12/2 sounding) and down the gutter (12/1 sounding), the archaeological observations together with dating results identify deposits relating to mound Level 2 at the base of 12/1 and deposits relating to Musular at the top of 12/2 (Figure 7). In core 11 and sounding 12/1 (both located in the eroded southern part of the gutter), a sterile colluvium is intercalated between Level 2-type layers and the Musular-type layers. This latter colluvium may indicate that habitation ceased in the gutter area.

#### *Depositional environment no.5: Channel and flood deposits constructing the flood plain, a facies similar to that of no.2.*

This unit (10 and 10b in Figure 8) has been identified only west of the mound, where it forms terraces T5 through T1 (Figure 6). The facies and stratigraphy are explained in detail in Kuzucuoğlu (2013). In the 95/3 core, an obsidian artifact retrieved from the base of the terrace

accumulation indicates either an age paralleling that of the mound occupation or, most probably, a post-site lateral erosion such as when the mound lost half of its volume. Thereafter, the terrace accumulation results from lateral displacements of the river meanders, together with the vertical incision of one or several river channels, such as in the present minor bed.

#### *Depositional environment no.6: Agricultural soil*

This unit (no.11 in Figure 8) blankets the top parts of all of the sequences studied, both in the gutter and on top of the terraces west of the mound. It is not present on the surface of the mound, the highest parts being intensely truncated.

### **Time-frame of the evolution of the Melendiz valley after the LGM**

The results of the dating program allow us to fix the chronology of the sequences (Figure 8, Table 1). Cross-checked with the facies analyses presented above, they bracket the climatic phases that preceded the occupation of the site. Those that occurred after its abandonment are not well dated, although identified in the present landforms in the Holocene T3, T2 and T1.

#### ***LGM (28-17 ka cal BP): Alluvial fill no.1 and T4***

Buried below Late Glacial sediments on the right bank of the river, the alluvial coarse fill no.1 (Unit 2 in Figure 8) may be connected with terrace T4. This terrace consists of at least 3 m of fluvial accumulation over the bedload (Figure 6). At that time, the Melendiz river possibly flowed in one ca. 500 m wide valley with channels incising the ignimbrite. Bedload no.1 and terrace T4 sediments may have then been deposited in a glacial regime characterized by high discharges that were fed by ice and snowmelt from the highlands. The dates bracketing such a period (28-17.5 ka cal BP) are well fixed in the Konya plain (Fontugne et al. 1999; Kuzucuoğlu, in press) and the Tuz Gölü plain (Naruse et al. 1997; Özsayın et al. 2013; in press), where lakes were fed by melt water and high humidity over the Taurus range. This humidity coincides with the coldest phase of the LGM and generated a glacial environment in the volcanic barrier of southern Cappadocia (Sarıkaya – Çiner 2015: Fig.7).

#### ***The transition from LGM to Late Glacial (ca. 17.5-15 ka cal BP)***

Following the LGM, the Heinrich Event 1 extreme cold event (H1, ca. 18-15.5 ka cal BP, Rasmussen et al. 2014) may have triggered the incision eroding T4, followed by the deposition of bedload no.2. After having reached the ignimbrite, the river slid in the direction of the western part of the valley, causing this part to be more deeply incised than the eastern part.

#### ***The Late Glacial (14.7 to 11.5 ka cal BP)***

In global climate records, the Late Glacial is divided into two periods. The first of these periods is comprised of two moist and warm phases, the Bölling (14.7-14 ka cal BP) and the Alleröd (14-12.9 ka cal BP). The Bölling warming peaked around 14.5 ka cal BP, and the Alleröd oscillation peaked around 13 ka cal BP (Nicoll – Küçükuysal 2013: Fig. 2). The second period is the cold and dry Younger Dryas (12.9-11.5 ka cal BP).

### *The Bölling-Alleröd warm and moist phase (14.7-12.5 ka cal BP at Aşıklı)*

Our sequences record a rapid start of the Late Glacial warming. In the gutter, the basal backswamps are dated ca 14.4 ka cal BP by in situ charcoal (Unit 4a in Figure 8). Similar marshes in the main valley (undated at the base) change into peat. This peat signals the local, relative drying of the western (still vegetated) part of the valley. The vegetation in the peat is composed of small steppic herb remains that are evenly distributed in the sediment. Analyzing the pollen in the clay below the mound, Woldring (1998: 108) reconstructed marshy areas in a landscape devoid of trees. Woldring (1998: 109) confirms the rapidity of the sedimentation. An older date (15.4 ka cal BP) is delivered by small plant remains contained in creamy clay corresponding to Unit 4b in sounding 15. The orange color of the sand present in this Unit suggests however a pollution by colluvial material (Figure 8). While peat was forming in the western part of the valley, the marshes in the gutter area remained wetter backswamps, thanks to their isolation from the western part of the valley. The ignimbrite capped with LGM bedload, which was then rising above the plain floor, may also have contributed to this contrast. In the valley, the formation of a soil after total emergence of the peat (15 sounding in Figure 6) signals a climatic change when vegetation probably developed on slopes over the whole area. The river meanwhile was moving laterally (forming meanders?) in a landscape similar to that of today. This change post-dates 14.4 ka cal BP (Bölling) and pre-dates 12.7 ka cal BP in the 10/1 and 15 sequences. This stable and humid phase corresponds to the Alleröd.

### *The cold and dry Younger Dryas (YD), dated to 12.9-11.5 ka cal BP in global records*

The stable humid phase recorded in the soil described above is followed by a climatic crisis. The vegetation dried up completely in the valley, signalling the end of the Late Glacial warm period (the chocolate clay, Unit 5 in Figure 8). After this punctuating drought, the most singular record of the Late Glacial sequences found in the Aşıklı mound area is recorded in both the gutter and the plain. The developing landscape is a poorly drained but well-watered plain covered once again by backswamps. Marsh plants are preserved as pressed black organic layers in the dark gray clay of Unit 4a (second series, Figure 8). These facies and the recorded environment are similar to those dated to the Bölling. In the gutter and the plain, organic layers from this second backswamp clay phase have been dated to 12.7, 12.5 and 12.4 ka cal BP (five dates). These dates correspond to the beginning of the Younger Dryas, the cold and dry episode ending the last Glacial. At this time, an important eruptive event, dated in both locations to 12.7 cal ka BP (Unit 6a), intermingles with the marsh deposits. This in situ pumice fall is followed by reworking that introduces sand and silt particulates that were eroded by runoff from the nearby slopes. After this event, the absence of sedimentation (drought) corresponds to a cold and dry phase within the YD, dated 12.4-12.2 ka cal BP. A late third humid environment in the YD is re-dated from 12.2 to 11.9 and 11.5 ka cal BP. The tripartite development of the YD is uncommon. In any case, the climate must have been cold throughout the YD (Sarıkaya – Çiner 2015).

### *The Early Holocene*

The end of the Younger Dryas signals the end of the Late Glacial and the beginning of the Holocene. At the location of Aşıklı Höyük, this transition is recorded by a great destabilization of the soils, and the deposition of a thick orange colluvium that is a reworking of weathered volcanic sand (Unit 7 in Figure 8). This event is dated 11.5 to 11.0 ka cal BP. The formation of

a soil follows, sealing the colluvium. This soil, which developed after the colluvium deposited at the transition YD-Early Holocene, must have been formed by a vegetation richer in trees than that typical of the YD.

#### *At the time of arrival of the Aşıklı population (ca. 10.5 ka cal BP)*

The early PPN population settled at Aşıklı Höyük (Level 5) on the soil that was weathering the colluvium (Figures 7-8). Their habitat was about 4 m above today's river bed. There is no way as yet to determine where and how profoundly the river bed was established in the valley at the beginning of the Holocene. What is certain is that there was only one or a few river channel(s) incising both Terrace 4 and the Late Glacial terrace. This situation corresponds to "Hypothesis 1" in Kuzucuoğlu (2013: Fig.5).

#### *During the occupation of the site*

Before Level 2, another erosion phase took away the YD colluvium from the central drain of the gutter and alongside it in a southward direction. In the southern part of the gutter, the Level 2 settlements rest directly above the Late Glacial gray clay, while upstream of the gutter slope the Level 2 settlements rest above the colluvium that dates to the end of the YD. Because of this unconformity (erosion), it is not certain whether the Level 5 to Level 3 occupations were ever present in the eastern part of the mound. In the western part and below the mound, however, an ignimbrite ridge may exist (see core 2010/2), that may have offered a rock shelter to the earliest populations (e.g., Epipalaeolithic). Settlements of Levels 5 and 4 would then be connected to a rock-shelter.

Another interesting result from the sequences, especially where the latest archaeological layers could be observed fully by the archaeologists, is that artifacts resembling those from the Late PPN occupation of Musular (across the river) have been found in the gutter cores. They are separated in the gutter cores from Level 2 by a late colluvium layer (in brown on top of the cores in Figure 7; Unit 9 in Figure 8).

### **Summary and concluding remarks**

Facies analyses and 26 <sup>14</sup>C dates allow us to identify several sedimentary units and sealing the site of Aşıklı Höyük. In addition, geomorphological field survey identifies three Holocene terraces embedded into one another (T1, T2, T3), and two higher stepped terraces (T4, T5). East of the mound, cores reveal another terrace buried below the mound and below the colluvium that covers the eastern flank of the valley. Following the incision of the LGM fluvial deposits, this terrace has no bench that could allow easy identification in the landscape. It is formed by Late Glacial backswamp clay and colluvium from erosion of the nearby slopes. Three volcanic falls are interstratified in the clay units.

Reconstruction of the landscape evolution in this area shows that the LGM valley was organized in two fluvial corridors wherein coarse alluvium was being deposited. The corridors were separated by a small ignimbrite relief which is today buried below the late Glacial sediments and the mound. At the beginning of the Late Glacial period, the river incision concentrated in the western part of the valley. Marshes appeared in the deepest corridor (now below the mound) with the beginning of the Late Glacial (Bölling phase). During the warmer Allerød phase, the marshes transformed into peat, ultimately drying completely before the transition

to the Alleröd/Younger Dryas (YD). This transition corresponds to a renewal of the marshes in both corridors—the lowest one west of the mound and the uppermost one east of the mound. The mid-YD corresponds again to a dry phase (no sedimentation). Before the YD ends, however, marshes expand again, triggering clay sedimentation which formed a flat topography up to the same altitude in both corridors. The landscape was then a large, flat valley covered with vegetated wetlands, above which a small LGM terrace remnant was rising almost imperceptibly near the middle of the plain.

At the onset of Holocene (i.e. before the occupation of the mound), a crisis led to the erosion of the Late Glacial sequence west and east of the mound, and the drying out the Late Glacial terrace that was covered by a  $\geq 1$  m thick colluvium. During the next millennium, a soil developed on the terraces and valley, which the river was again incising. The first archaeological layers occur on this soil that developed over the colluvium. Late in the history of human occupation of the site, the colluvium was eroded, as well as the settlements pertaining to Level 3 or Level 2. By the time of this erosion, the settlements had already expanded east of mound, toward the eastern flank of the valley.

After or because of the 8.2 ka cal BP erosion event (date uncertain), the river bed in the western part of the valley became lower; it deeply incised not only the Late Glacial sequences but also the archaeological site, except in the eastern part of the valley.

Since the Mid-Holocene, the river has built a terrace system composed of three terrace levels. Today, the river accumulates T1 that composes the minor bed. During lateral erosion of T1 and T2 that continues today, the river happens to incise also the Level 2 occupation layers positioned below T2. The inscription of today's active bed of the Melendiz river in the Mid-Holocene terrace system, shows that during Early Holocene Level 2 occupation layers extended west over a former level of the flood plain that was lower than today's.

### ***A chronology paralleled in the Konya Plain?***

Paleoenvironmental records in the Konya Plain evidence local wet environments at the end of the LGM (ca. 16.5-16.0 cal ka BP) and during the Late Glacial (14.5-13.5 and 13.0-12.5 cal ka BP), with dry phases occurring 16-14.5 cal ka BP, 13.5-13 cal ka BP and during the Younger Dryas (Bottema – Woldring 1984; Naruse et al. 1997; Fontugne et al. 1999; Kuzucuoğlu et al. 1999). In addition, a rise in humidity during the onset of the Holocene in the Konya plain is dated to ca. 11.4 cal ka BP in a marsh deposit (Kuzucuoğlu et al. 1997). It evolved into a wetland that retreated back to a swampy area around 10.3 cal ka BP. At 9.1-8.7 cal ka BP, the Akgöl sub-basin dries, but humidity is high enough to support the formation of soil over the floor of the dried lake (Bottema – Woldring 1984).

### ***A possible role of tectonism in the formation of the terraces?***

As noted above, incision of a river bed into a hard substratum usually indicates that the river faces a tectonic movement. In the Melendiz valley, T5 to T3 incisions could be related to climate as well as to the fault which controls the N-S orientation of the valley and parallels the very active Tuz Gölü fault (Figure 3). The eastward displacement of the river with time—given that a higher number of terraces are preserved on the left edge of the valley—may have been caused by such a tectonic forcing. Today's incision of the river does not seem to be related to climate. It instead may relate either to an uplift of the plateau west of the valley, or an uplift of one or more

reaches upstream of Kızılkaya (e.g., Hasandağ area?). Alternatively, it is possible that the incision responded to a modification of the longitudinal profile of the river caused by the lowering of the river base level (e.g., the level of the Mamasun lake since 1995).

### ***When did the disconnection between the eastern and western parts of the LGM valley occur?***

The uneven topography of the base of the incision that preceded bedload no.2 below the gutter (cores 10/1, 12/1, 14/2) and the site (15 sounding) indicates clearly that the depth of the incision is less pronounced east than west of the mound (Figure 7). There is a difference in depth between the buried paleochannel found east of the mound, and a stratigraphically similar channel identified below the mound. In addition, relative altitudes of the top of the basal fluvial sediments in the cores from the gutter and 2015 sounding reveal the existence of a Late Glacial terrace, which has no morphological expression in the modern valley landscape. Positioned between T4 (post-T5) and before T3 (post-site), this hidden terrace is a strath terrace, as shown by the ignimbrite at its base. The disconnection between the two LGM branches of the river therefore occurred between the LGM and the Late Glacial. But at the end of the YD, the valley was filled evenly on both sides with a 1 to 2 m high rock island in its middle. This relief was formed by the LGM terrace shaped during the disconnections of the river branches. This means that the decisive disconnection occurred after the deposition of the early Holocene colluvium, before the Level 5 human occupation of the mound at the earliest, and before the Level 2 occupation at the latest. However, the erosion that preceded Level 2 (or Level 3?) has removed all older archaeological remains in the eastern edge of the mound.

### ***What caused the development of backswamps and peat in both members of the Melendiz valley?***

The Late Glacial terrace is composed exclusively of a thin sediment accumulation in the locations of our cores and soundings. The terrace records no fluvial process. Instead it records almost exclusively a rapidly deposited marsh clay, and variations in the water table in the western part of the valley. A probable channel was incising marshes and peat in the western part of the valley during climate-caused stabilization (soil) or destabilization (colluvium) of the landscape. Such clay deposition in a fluvial plain, forming a terrace, is usually attributed to a warm and humid phase (Vandenberghe 2015: Fig. 2, Scenario 3). Indeed, the very start of the Bölling phase in the Melendiz valley corresponds to a marsh and backswamp landscape rich in stable shallow lakes. However, the development of a similar landscape during the YD cannot have occurred in a warm context.

### ***Humidity, the controlling factor of the tripartition of the Late Glacial sequence at Aşıklı Höyük***

There is no evidence of a tripartition of the YD in global climate curves (e.g., Broecker 1992; Severinghaus – Brook 1999). However, one can expect that any change has an initial phase, a peak phase, and an end phase (Kuzucuoğlu – Tsirtsoni 2015). There are also several reasons why continental ecosystems would react differently than global indicators of atmospheric circulation in the northernmost part of the hemisphere. These reasons include environmental sensitivity of systems to small changes in humidity, regional relief, distances to sources of humidity, regional

variations during spatial changes in atmospheric circulations, and so on. Tripartition of the YD does not concern temperature (cold) but rather humidity (humid, dry, humid) in a specific ecosystem, such as in a flood river valley. For each humid spike at the beginning and end of the YD, marsh development is very rapid but also very short in duration. The thickness of deposits measures the importance of marsh development in terms of duration and intensity, which in this case clearly responds to a very high sedimentation rate.

***The importance of slope factor,  
whether climate is warm (Bölling and Alleröd) or cold (YD)***

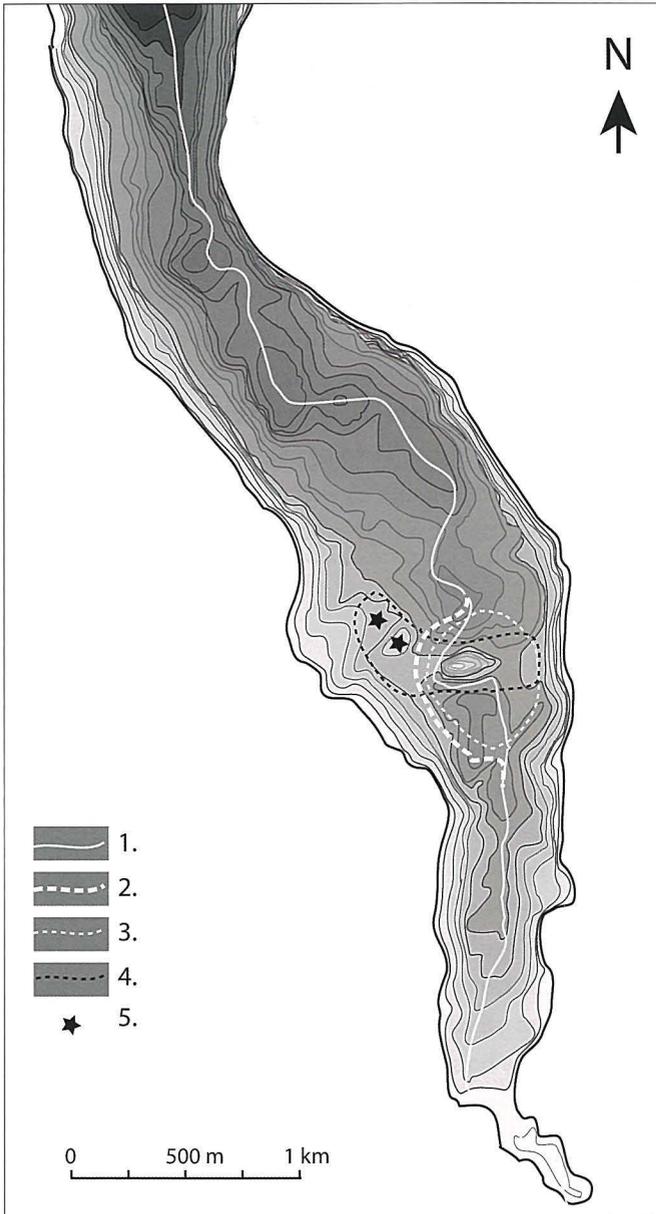
No formation in the cores and soundings records fluvial activity during the Late Glacial. At that time, clay deposits and peat bogs seem to have invaded the valley while incision ceased, because of a decrease in water or relief slope. Processes responsible for the emergence of marshes similar to those in the Melendiz valley have been studied in glaciofluvial valleys in northern Europe and America (Fraser – Keddy 2005). The formation of peat bogs and backswamps is common in previously glacial or periglacial areas after deglaciation, but their formation requires (i) humidity, (ii) acidic water with low nutrient content, (iii) low slope, and (iv) insufficient drainage. According to Fraser and Keddy (2005), temperature and humidity from rainfall or snow melt are not limiting factors for the development of such an ecosystem; only the acidic characteristic of the water is limiting. Consequently, the formation of the Bölling and Younger Dryas wetlands in the Melendiz valley points to a valley (or water flow) gently sloping over the post-H1 fluvial coarse and fine deposits (pictured in green in Figure 7; Unit 3 in Figure 8). A question then arises: if the timing of the Late Glacial humid periods dated in the Konya plain were paralleled in the Tuz Gölü, could the 0 base level of the Melendiz have risen during the Late Glacial marshy periods, explaining a slope decrease in the lower course of the Melendiz river? The dates, however, do not match with our case, as Late Glacial humid phases in Konya plain are dated 14.5-13.5 and 13.0-12.5 cal ka BP (Fontugne et al. 1999).

***What role for the geological context?***

The geological successions around Aşıklı and the southern end of the Kızılkaya village are very similar to those of the marshes located north of the Doğantarla-Güzelyurt road bridge. The hard Cemilköy ignimbrite in these successions is eroded by a Miocene reddish detritic loose formation that contains a confined aquifer, itself overlain by the soft and easily carved base of the Gördeleş ignimbrite. The modern marshes downstream the bridge are fed by springs outflowing along the base of the continental reddish formation that covers the Cemilköy ignimbrite. South of the Kızılkaya village, the same contact feeds the small stream that incises the gutter and the horseback of the site to the southeast. We do not know the base of the LGM end alluvial fill or the reddish formation containing the aquifer at either of these locations. The resemblances between both sites are intriguing nevertheless. Could a population previous to the Early Holocene PPN settlement (i.e. a Epipalaeolithic population) have lived in shelters such as those that today exist above the marshes near the bridge?

***The preservation of the buried Late Glacial-Early Holocene terrace***

The units overlying bedload no.2 are a fill that was deposited after T4 was incised, and before T3 formed. Such a situation has been demonstrated for a Late Glacial terrace similar to that



**Figure 9.** A 1 m contour map representing the surface topography of the main fluvial formations in the Melendiz valley today. (1) Today's river bed; (2) Supposed path of the active river bed at the time of the Level 2 occupation of the mound; (3) approximate (minimum) extension of the site at the time of the Level 2/Musular occupations in the valley; (4) Limits of a topographic bench crossing the valley, formed by the accumulation of Late Glacial deposits and Early Holocene slope/archaeological formations; (5) Locations where other sequences may deliver complementary information on the Late Glacial/Early Holocene climatic and archaeological archives in the Melendiz river valley. Because of the scale used (1 m contours), the data used for tracing the contours have been collected using google earth images. They cannot be compared to the altitude data used in Figures 8 and 9, which are calculated on the basis of theodolite measurements plotted by the archaeologists at the core and section sites.

of the Aşıklı Höyük in a context of lateral migration of rivers in a valley (Jansens et al. 2012). A detailed map of topographic 1 m level curves for the Melendiz valley is presented in Figure 9. This figure details the damming of the river in its valley by a flat relief, partly destroyed, which in turn points to another location on the left side of the river of the buried terrace to which it seems to be connected. Figure 9 also details, south of the mound, a heritage of the eastern part of the LGM valley in the SSW-NNE hollow that deforms the surface of the T2 terrace, hitting the same terrace exactly where the 1996 flood uncovered adobe bricks of the Level 2 settlement in the eroded front of the terrace. While it is very difficult to find the position of the river bed during the different phases of the Aşıklı Höyük occupations because of erosion by the river, Figure 9 also shows that the river bed was incised between the mound on its east (fine dotted white line) and the probable Late Glacial terrace remains (two black stars), flowing in a bed with a possibly wide meander (thick dotted white line).

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