Did climate empty the Lake District of southwestern Anatolia? The Gencali palaeolake record and the Middle Chalcolithic gap

Tolunay Bayram*, Ayşin Konak
Department of Archaeology, Faculty of Arts and Sciences, Kocaeli University, Kocaeli, TR; tolunay.bayram@kocaeli.edu.tr, ORCID: 0000-0002-7102-4021; aysin.konak@kocaeli.edu.tr, ORCID: 0000-0002-0620-2573
**corresponding author*

ABSTRACT – *The Chalcolithic of the Lake District, southwestern Anatolia, contains a gap of two millennia. Elsewhere in western Anatolia the Middle Chalcolithic is present; the Lake District alone lacks it. We present the first continuous, high-resolution geochemical record for the region, an ITRAX-scanned, radiocarbon-dated core from the Gencali palaeolake. The gap opens while effective moisture is rising, within the dated section of the core. Climate did not initiate it. Higher in the sequence, between* c. *6600 and* c. *5850 cal BP, clastic delivery reaches its Holocene maximum, and Middle Chalcolithic settlement elsewhere in western Anatolia appears to end within that interval.*

KEY WORDS – *Middle Chalcolithic; settlement dynamics; palaeolimnology; Holocene climate variability; Lake District; Anatolia*

Ali so bile podnebne razmere vzrok za izpraznitev Jezerske regije (Lake District) v jugozahodni Anatoliji? Zapis paleojezera Gencali in vrzel v srednjem halkolitiku

IZVLEČEK – *Halkolitik Jezerske regije v jugozahodni Anatoliji zaznamuje približno dve tisočletji dolga vrzel. Srednji halkolitik je, razen v Jezerski regiji, dokumentiran povsod v zahodni Anatoliji. Predstavljamo prvi neprekinjeni visokoločljivostni geokemijski zapis z radiokarbonsko datiranim sedimentnim jedrom iz paleojezera Gencali, ki smo ga analizirali s skenerjem ITRAX. Vrzel se začne v času naraščanja efektivne vlažnosti, znotraj datiranega dela sedimentnega jedra. Podnebne razmere torej niso bile vzrok za nastanek vrzeli. Višje v sedimentnem zaporedju, med približno 6600 in 5850 kal BP, doseže vnos klastičnega materiala najvišje vrednosti v holocenu. Zdi se, da se v tem časovnem intervalu konča srednjehalkolitska poselitev tudi drugod v zahodni Anatoliji.*

KLJUČNE BESEDE – *srednji halkolitik; poselitvena dinamika; paleolimnologija; podnebne spremembe v holocenu; Jezerska regija; Anatolija*

 DOI: 10.4312/dp.53.21

Introduction

The Middle Chalcolithic is the least visible phase of Anatolian prehistory. It is not simply that fewer sites are known. The period occupies a structural blind spot in how Anatolian prehistory has been written, and the blind spot has a shape. Ulf-Dietrich Schoop (*2005*) attributes the deficiency to inadequate archaeological data. Jak Yakar (*2014*) and Antonio Sagona and Paul Zimansky (*2015*) resolve the difficulty by passing over the phase and concentrating on the Early and Late Chalcolithic. Bleda S. Düring (*2010*) accepts the shortage of evidence but locates its cause elsewhere. The neglect, heargues, follows from a Childean reading of prehistory in which periods of stability and low complexity attract no attention. On such a reading the diagnostic features of the Early Chalcolithic began in the Neolithic, and the Late Chalcolithic is the opening phase of the Early Bronze Age. Between these two absorptions lies a period represented by little material, less complex than what surrounds it, and situated in the middle of the passage from village to city. A progressive model that requires villages to grow into towns and towns into cities has no place for an interval in which nothing appears to grow. Labelling that interval a dark age, and thereby setting it aside, allows the model to proceed undisturbed. The number of settlements assigned to the Middle Chalcolithic in western Anatolia has risen steadily (*Blum 2014; Derin, Caymaz 2017; Takaoğlu 2017; Takaoğlu, Özdemir 2017; Tuncel, Şahoğlu 2017; Özdemir, Özdemir 2021; Aykurt, Ayengin 2022; Yavşan 2022; Çayır Tığlı 2025*), and a coherent cultural horizon is now traced from south to north. What remains anomalous is the Lake District.

The Lake District is not an under-researched region. Systematic archaeological work began there in the early 1910s (*Ormerod 1912*) and has continued without long interruption for more than a century. Four of the region's tells have been excavated to sterile soil (Hacılar, Kuruçay, Bademağacı, Höyücek), and its Neolithic and Early Chalcolithic sequences are among the best documented in Anatolia (*Duru R. 1992; 1996; 2008; 2013; 2016; Duru, Umurtak 2005; 2019; Umurtak* et al. *2007; Duru G. 2011*) (Fig. 1.B). Yet no deposits or assemblages have been securely assigned to the Middle Chalcolithic. The excavated sequences terminate at the close of the Early Chalcolithic, several of them beneath destruction debris (*Duru R. 2008*). Reoccupation, where it occurs, follows some 2000 years later and inherits nothing from what preceded it (*Duru R. 2016*).

Surveys have recovered Early Chalcolithic sites and Late Chalcolithic sites, but no sites representing both periods (*Özsait 1976; 1984a; 1984b; 1989; Becks 2013*). In the regional chronological framework of Refik Duru (*2016*), the standard reference for the sequence, the interval between them carries no period name at all, and is entered as a question mark (Tab. 1), because no assemblage has been recovered that would warrant naming it.

The gap is therefore not an inference from negative evidence advanced here. It is a feature of the region's own chronology, and it has two properties that require explanation. The first is that it exists in a landscape that has been looked at very closely. The second is that it is confined to the region: through the same two millennia, Middle Chalcolithic settlement continues across the surrounding parts of western Anatolia.

Three explanations are available, and they have not been weighed against one another. The first is environmental. Conditions at the close of the Early Chalcolithic deteriorated to a degree that made the lake basins untenable. Duru (*2016*) rejects this on archaeological grounds, arguing that the destruction deposits sealing the Early Chalcolithic levels are the work of human agency rather than of natural causes. A climatic reading of the same deposits has nonetheless been proposed. Lee Clare *et al.* (*2008*) connect the fortifications and conflagrations at Hacılar, Kuruçay, Höyücek and Bademağacı with the interval of rapid climate change between 8600 and 8000 cal BP, and argue that climatic stress acted on these communities indirectly, through pressure on resources and armed conflict. Their proposal was set against the Greenland ice cores and a marine core from the southeastern Aegean, since no terrestrial

Period	cal BC	cal BP	Basis
Early Bronze I	3400/3300 – 3000/2900	5350/5250 – 4950/4850	typology, ^{14}C
Late Chalcolithic	3700/3600 – 3400/3300	5650/5550 – 5350/5250	typology
?	5800/5700 – 3700/3600	7750/7650 – 5650/5550	—
Early Chalcolithic	6000/5900 – 5800/5700	7950/7850 – 7750/7650	typology
Late Neolithic	6200/6100 – 6000/5900	8150/8050 – 7950/7850	typology, ^{14}C
Early Neolithic II	6600/6500 – 6200/6100	8550/8450 – 8150/8050	^{14}C
Early Neolithic I	8000/7200 – 6600/6500	9950/9150 – 8550/8450	^{14}C

Tab. 1. Regional chronology of the Lake District after Duru (*2016*), with calibrated BP equivalents.

archive from the settled landscape itself was available to it. Their proposal forms part of a wider programme on the impact of rapid climate change in the eastern Mediterranean (*Weninger* et al. *2009; Clare, Weninger 2010*).

Duru's judgement is a negative one drawn from the settlement record alone, and it has never been tested against an independent environmental archive, because no such archive existed. The second explanation is methodological. Settlement continued but has not been recognized, obscured by thin deposits, by alluvial burial of the plains, and by a survey record concentrated in the lake margins and islands rather than in the uplands and caves where the period is attested elsewhere. The third is cultural. The gap is real. Sedentary occupation ceased, and the region was not resettled in any archaeologically legible form until the Late Chalcolithic.

The first of these can be tested against a sedimentary record. A core from the Gencali palaeolake, within the settled landscape itself, was scanned by ITRAX and radiocarbon dated, and yields a high-resolution record of environmental conditions that is continuous across the entirety of the settlement gap. The terminus of the Early Chalcolithic falls within its radiocarbon-controlled section. At the onset of the gap, clastic delivery to the basin is rising rather than falling. Effective moisture was increasing at the moment the settlements ended. The environmental hypothesis is not supported, and Duru's archaeological judgement is independently corroborated.

Higher in the sequence, between *c.* 6600 and *c.* 5850 cal BP, the core records a sustained rise in clastic delivery culminating in the highest values of the Holocene section. The interval falls in the final third of the gap and cannot have initiated something already more than a millennium old. One further observation is worth recording, and we record it as an observation rather than as a finding. Across the regions surrounding the Lake District, Middle Chalcolithic settlement appears to terminate within the rising limb of that interval, before its culmination (*Blum 2014; Derin, Caymaz 2017; Takaoğlu 2017; Takaoğlu, Özdemir 2017; Tuncel, Şahoğlu 2017; Özdemir, Özdemir 2021; Aykurt, Ayengin 2022; Yavşan 2022; Çayır Tığlı 2025*). The core is a small, closed basin and speaks in the first instance for its own catchment, not for western Anatolia. But it is one of the nearest continuous Holocene environmental records to the region in which these settlements lie.

Regional setting

Physiography and settlement niches

The Lake District occupies the northern margin of the Western Taurus, a landscape of tectonic basins holding large lakes, among them Burdur, Salda, Yarışlı, Acıgöl, Beyşehir and Suğla, separated by steep carbonate ranges. Four settlement niches can be distinguished within it. The alluvial plains fringing the lakes carry the tell sites on which the region's prehistoric sequence has been built. The lake shores form a second and closely related niche. Beyond them rise the rugged uplands of the surrounding ranges, dissected and thinly soiled. Within the carbonate massifs lies a karstic system of caves and rock shelters. The last two account for the greater part of the region's surface area, and have received a small fraction of its archaeological attention.

The basins are hydrologically closed or nearly so, and their lakes are shallow. Under a Mediterranean regime of winter precipitation and summer drought, water level and clastic delivery respond rapidly to changes in the precipitation-evaporation balance (*Davraz, Çakmak 2016*). Shallow endorheic systems of this kind amplify climatic signals rather than damping them (*Cohen 2003*). The same sensitivity carries an archaeological corollary. Fluctuating lake margins repeatedly exposed and drowned the low ground on which the tell sites stand, and alluvial fans issuing from the surrounding ranges have buried substantial areas of it. Where prehistoric settlement lay on the plains, its visibility today is a function of Holocene sedimentation as much as of prehistoric behaviour.

Chronological framework and conventions

Dates in the narrative are given in calibrated years BC, following the regional archaeological literature, with calibrated years BP supplied where the geochemical record is discussed. Period boundaries are given in both conventions in Table 1. The 8.2 ka event is named conventionally where the published literature is discussed, and is not converted. The mid-Holocene interval discussed in this study is defined from the Gencali record itself and is not assigned an event name. Dates drawn from the published literature are cited in the unit in which they were published, and where conversion has been necessary it is indicated. Uncalibrated determinations are marked as such and are not converted.

The regional chronology follows Duru (*2016*), reproduced as Table 1. Its boundaries are typological. No absolute date anchors the transitions with which this

study is concerned, and Duru is explicit about the limitation, observing that radiocarbon determinations for these periods are too few to support generalization, that excavations conducted before the introduction of radiocarbon dating necessarily lack it, and that some published determinations carry errors of four to five centuries. The consequences are visible in the framework itself. The Late Neolithic and the Early Chalcolithic are each allotted some 200 years, a span that reflects how thinly these boundaries are constrained rather than any confidence about the duration of the periods. Between the Early and the Late Chalcolithic no period name appears at all. Comparisons of contemporaneity between the Lake District and its neighbours are therefore made at the resolution of the coarser of the two chronologies.

A century of investigation

The Lake District is among the longest-studied regions of Anatolian prehistory. Systematic work began with the surveys and limited excavations of Henry A. Ormerod in the 1910s (*Ormerod 1912*). In the 1930s and 1940s Kurt Bittel, Şevket Aziz Kansu, Muzaffer Şenyürek and İsmail Kılıç Kökten conducted surveys and excavations at Baradız, Kapalıin, Bozanönü and Senirce among other localities (*Bittel 1942; Kansu 1945; Kökten 1952*). From the middle of the century the pace increased. James Mellaart surveyed the area extensively and opened the region's first large-scale excavation at Hacılar (*Mellaart 1954; 1958*), and in the same years Ian Todd, David French, Ralph Solecki and Judy Birmingham conducted a series of projects on the prehistoric periods (*Birmingham 1964; French 1965; Solecki 1965; Todd 1980*). From the 1980s the surveys of Mehmet Özsait and the excavations of Duru transformed understanding of the regional sequence (*Duru R. 1992; 1996; Özsait 1976; 1984a; 1984b; 1989; 1991*). The prehistoric cultural sequence of the Lake District is in consequence defined more sharply than that of many other parts of Anatolia. This does not mean the chronology is fully understood, however, only that the absence of the Middle Chalcolithic cannot be attributed to a want of looking.

Where the looking was done is another matter. Özsait's project, 'Prehistoric Research in the Environs of Burdur and Isparta', recorded Neolithic, Early Chalcolithic, Late Chalcolithic and Early Bronze Age settlements in considerable numbers and refers to no Middle Chalcolithic material (*Özsait 1976; 1984a; 1984b; 1989*). The same holds for Duru's surveys of the same years, and for every subsequent survey in the region. But these surveys were directed at tells, plains and lake margins, and Ralf Becks (*2013*) surveyed the islands and lake shores specifically. The uplands and karstic massifs have not been surveyed to a comparable standard, and it is in caves and uplands that the Middle Chalcolithic is attested in the neighbouring interior. Nor has the region produced a systematic karstic inventory of any period. The Palaeolithic and Epipalaeolithic are themselves poorly documented here, though well-known from the Antalya caves immediately to the south (*Kartal 2003; 2009; Atıcı 2011*). A century of survey directed at tells has left the caves of the Lake District largely unexamined.

Holocene climate variability

The Holocene was characterized by substantial climatic variability expressed at a range of temporal and spatial scales (*Wanner* et al. *2011*). Several palaeoclimate records identify an interval of climatic variability in the sixth millennium cal BP, referred to in some of them as the '6.2 ka event' (*Constantin* et al. *2007; Florescu* et al. *2019*), although we do not adopt the term. The interval discussed below is defined from the Gencali record itself, and its limits are those of the excursion the core registers. Mid-Holocene variability is in any case regionally heterogeneous and not uniform in its expression. Some records indicate aridification of small amplitude (*Gasse, Van Campo 1994*); others show marked drying, and others increased wetness (*de Menocal* et al. *2000; Florescu* et al. *2019*). Along the eastern Mediterranean and the Levant, mid-Holocene variability appears as fluctuation in precipitation rather than as sustained drought (*Schneider, Salameh 2015; Marks* et al. *2018*). This heterogeneity is not noise. At the regional scale, latitude, altitude, distance from moisture sources and the configuration of the surrounding landscape may contribute to substantial differences in the expression of climatic variability. Consequently, climatic changes documented in geographically distant palaeoclimate archives cannot be assumed to have occurred synchronously or to have produced comparable environmental responses in each region.

Holocene climate archives from Anatolia have accumulated rapidly, principally from lakes (*Yalçın* et al. *2015; Konak, Yalçın 2021*). The possible cultural consequences of climatic variability during this interval have been examined geoarchaeologically for Neolithic communities in Europe and Asia (*Angelucci* et al. *2007; Zielhofer* et al. *2008; Chen* et al. *2023*), while comparable relationships have also been discussed, although contentiously, for Mesopotamia (*Schneider, Salameh*

2015). Anatolia, which was Chalcolithic when Europe was Neolithic and Mesopotamia was Ubaid, has not been examined in this way. The Lake District is not without palaeoecological records. Pollen sequences from Beyşehir Gölü (*van Zeist* et al. *1975*) and Gölhisar Gölü (*Eastwood* et al. *1999*), and a stable isotope record from the latter interpreted in terms of the precipitation-evaporation balance (*Eastwood* et al. *2007*), cover the Holocene. What has been lacking is a continuous geochemical record at a resolution capable of resolving decadal change, and one drawn from a basin sharing the same geomorphological unit as the excavated tells. Gölhisar lies some 50km to the west, in a separate intramontane basin.

Materials and methods

The basin and core site

Gencali is a former lake basin lying between Lake Salda and Lake Yarışlı, at 37° 32' N, 29° 52' E (Fig. 1.A). Before it was drained by the Turkish State Hydraulic Works (DSI) in 1966 it covered 317ha and was fed by small streams and by groundwater issuing from the direction of Lake Salda (*Konak 2018*). Its catchment is developed on the carbonate and ophiolitic units of the Western Taurus nappe pile, chiefly the Marmaris Peridotite and the Kızılcadağ Melange, with Quaternary alluvium overlying these nonconformably (*Davraz, Çakmak 2016*). The catchment is small and the basin closed. A local report holds that the lake was fresh rather than brackish, and that its level varied markedly with rainfall.

Three properties recommend it as an archive. It shares the same geomorphological unit as the excavated tell sequences and is situated under the same moisture regime, and therefore records the precipitation-evaporation balance of the terrain those settlements occupied rather than the integrated discharge of a distant drainage. Being shallow and hydrologically closed, it responded to modest changes in effective moisture with disproportionately large changes in area and clastic delivery. It also accumulated sediment without interruption across the interval at issue, permitting a record at a resolution finer than the archaeological chronology it is set against. A mound on the former northern shore of the lake, 3km north of Gencali village, carries occupation of the Early Chalcolithic, compared typologically to the Hacılar sequence, and then, after an interruption, of the Early Bronze and Iron Ages; the core thus samples the environment of a landscape settled in the Chalcolithic before the hiatus.

The topmost 50cm of the core is an agricultural soil developed on the lacustrine sequence after the lake was drained in 1966. For the six decades since, these uppermost sediments have been exposed to oxidation, compaction and cultivation. Datable material is scarce through this upper part of the core, and the two circumstances are plausibly connected, since such exposure degrades the deposit and depletes the organic fraction on which dating depends. In this the drainage is a caution, but at the same time it is an advantage, for it renders the whole sediment column accessible to its base. The degradation is confined to this upper soil, and below it the lacustrine sequence records the Holocene without interruption across the interval the study addresses.

Coring and lithostratigraphy

The borehole was drilled in the former lake floor with a truck-mounted hydraulic rotary rig, advancing 1.5m

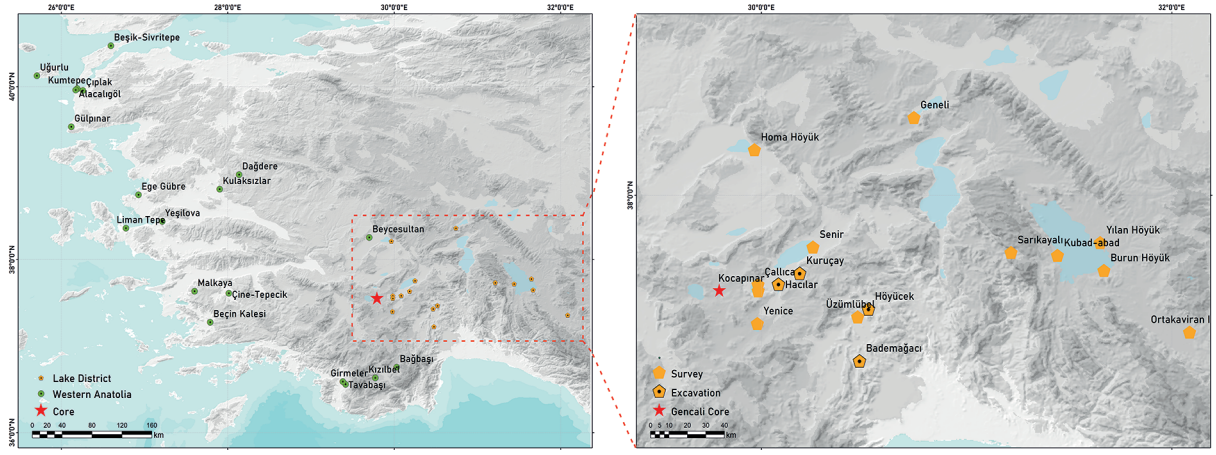


Fig. 1. Sites discussed in the text.* A *the Middle Chalcolithic sites of western Anatolia, with the location of the study area and the Gencali palaeolake borehole.* B *the sites of the Lake District, southwestern Anatolia.

rods and recovering a 5cm core to a total depth of 16.87m (*Konak 2018*). Recovery was continuous except across coarse-grained horizons, which the rig washed out (below). The core was boxed with depth control, wrapped to prevent drying, transferred to the cold store of the EMCOL laboratory at Istanbul Technical University, split longitudinally and cleaned to expose sedimentary structures. One half was retained for subsampling and the other scanned.

Beneath the agricultural soil that caps the sequence, two lithostratigraphic units are distinguished in terms of lithology, colour and the density of carbonate clasts (Fig. 2). Unit I, from 50cm to 546cm, is the lacustrine sequence proper, dominated by dark grey to light grey clays of high plasticity with intercalated sand and carbonate-pebble horizons and, in its upper part, laminated carbonate levels. Unit II, below 546cm, consists of dark grey and dark brown clays with carbonate and marble clasts and holds the deposits that predate the disconformity. The uppermost 50cm is an agricultural soil developed on the drained lake floor. Three short intervals, at 546–526cm, 444–439cm and 402–382cm, yielded no core, because the hydraulic rig cannot recover the coarse, washed material inferred to occupy them.

The radiocarbon determinations bracketing 546cm differ by roughly ten millennia. The clay above it is Holocene, whereas the deposits below return Pleistocene ages of between roughly 18 000 and 40 000 cal BP, a distinct and far older sedimentary body. The discrepancy is consistent with a disconformity, and the boundary is drawn as such in Fig. 2. Independent sedimentological

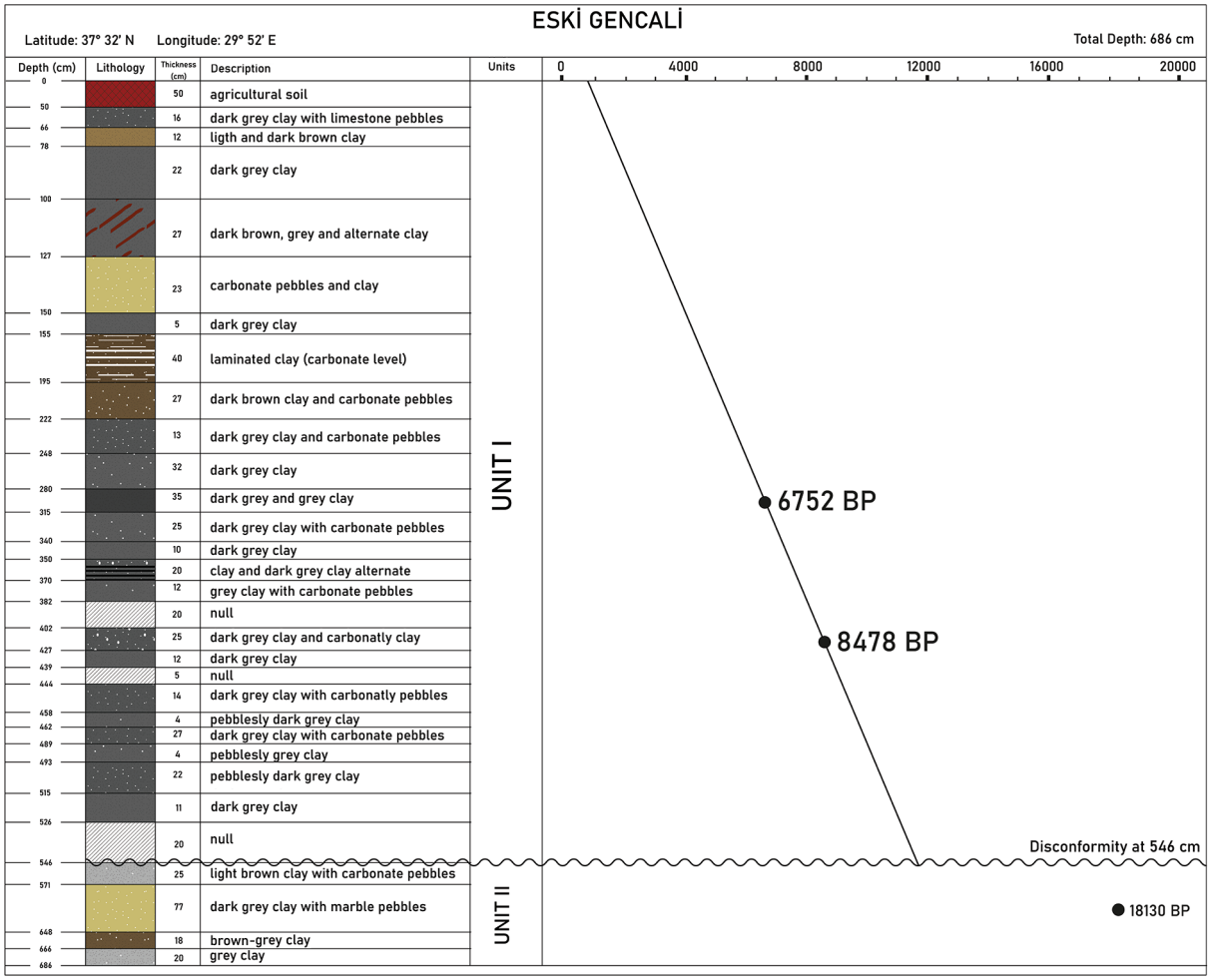


Fig. 2. Composite lithostratigraphic log and age-depth model for the Gencali borehole. The left panel details the stratigraphy, lithological descriptions, and the position of unrecovered (null) intervals for both the Holocene sequence (Unit I) and the underlying Pleistocene deposits (Unit II). The right panel displays the linear age-depth model based on AMS radiocarbon dates (indicated by black circles). The wavy line at 546cm marks the inferred boundary between the two units. The break in sedimentation is inferred from the age discontinuity alone, since the contact itself lies within an unrecovered interval.

confirmation is not available, and cannot be, because the 546–526cm interval yielded no core: the contact itself lies within a washed-out, unrecovered zone. The inference of a break in sedimentation therefore rests on the age discontinuity alone, and we treat it as a hypothesis rather than as a datum. The analysis presented below is confined to the sequence above 546cm, and none of the conclusions drawn from it depends on the mechanism by which the underlying deposits are separated. X-radiographs of the core, acquired at 20μm resolution during scanning, are available for any future test of the contact.

Radiocarbon dating and the age-depth model

Five bulk clay samples were dated by AMS radiocarbon at the Illinois State Geological Survey. All radiocarbon determinations reported here, both those from the Gencali core and those compiled from the excavated sequences, were calibrated with the IntCal20 terrestrial curve (*Reimer* et al. *2020*) in OxCal v4.4.4 (*Bronk Ramsey 2009*). The samples are of bulk sediment rather than of macrofossils or an extracted organic fraction. In a carbonate catchment fed partly by groundwater this raises the possibility of a hard-water offset, which we have not been able to quantify and which should be borne in mind, although the two upper determinations are in correct stratigraphic order and consistent with the archaeological expectation for the section. The results are showing in Table 2. The calibrated ages fall into two groups. The two uppermost samples, at 2.94m and 4.15m, yield 6702 and 8478 cal BP as 2σ midpoints. The three lower samples, at 5.86m, 11.90m and 15.94m, yield 18 130, 38 750 and 39 795 cal BP. Between the second and the third the age increases by ten millennia across 1.71m. The two groups are not treated as a single depositional sequence, and the analysis is restricted to the interval above 546cm.

For that interval the age model is a linear interpolation between the two dated levels (Fig. 2). Extended to the limits of the recovered lacustrine clay it places the base of Unit I, at 526cm, at approximately 10 110 cal BP, and the base of the agricultural soil, at 50cm, at approximately 3115 cal BP; the 476cm of clay between them accumulated over some 7000 years, at roughly 1470 years per metre. The model is recalculated here from the determinations in Table 2, and differs slightly from the values given by Ayşin Konak (*2018*), which were derived before recalibration with IntCal20. Two determinations define a straight line exactly, so the fit carries no independent information, and we do not report a coefficient of determination for it.

A linear model of this kind presumes a uniform accumulation rate across an interval in which environmental variability is precisely what is under investigation. If the climate varied, sedimentation rates plausibly varied with it, and a period of enhanced clastic delivery such as the one described below would be expected to accumulate faster and so to be misdated by a constant-rate model. A Bayesian age-depth reconstruction would address this, but requires additional determinations. The model is retained for want of an alternative, not because the assumption is thought to hold.

Radiocarbon control extends from 8478 to 6702 cal BP, that is from 6528 to 4752 cal BC, between 4.15m and 2.94m. Above 2.94m the chronology is extrapolated. The consequence is an asymmetry that bears directly on what can be argued. The terminus of the Early Chalcolithic, at *c.* 5800 to 5700 cal BC, lies at approximately 3.6m, well within the dated bracket. The Middle Chalcolithic of the surrounding regions begins at the upper limit of the bracket and ends above it. The clastic maximum at *c.* 5850 cal BP lies some 60cm above the uppermost date. The claim advanced here about the onset of the gap therefore rests on dated stratigraphy. Any claim touching the later interval rests on extrapolation, and is qualified accordingly.

It must be noted that the lacustrine sequence above the disconformity is not perfectly continuous. As recorded in the lithostratigraphy, an unrecovered 20cm interval between 402 and 382cm corresponds to approximately 8300–8000 cal BP in the interpolated age model. Importantly, this short hiatus predates the terminus of the Early Chalcolithic (*c.* 7750 cal BP) and the subsequent two-millennium settlement gap. The record resumes continuous accumulation well before the onset of the cultural hiatus and remains uninterrupted throughout the in-

Sample	Depth (mm)	^{14}C BP	±	cal BP (2σ)	cal BP (midpoint)
GNÇ 1	2932–2950	5880	15	6662–6742	6702
365GK	4148–4150	7700	37	8408–8548	8478
556GK	5858–5860	14819	41	18010–18251	18130
GNÇ 2	11898–11900	33980	310	37764–39735	38750
GNÇ 3	15938–15950	34510	330	39083–40507	39795

Tab. 2. Radiocarbon determinations from the Gencali core. All determinations on bulk clay; AMS, Illinois State Geological Survey; calibrated with IntCal20 (*Reimer *et al.* 2020*); ranges are 2σ at 95.4%, with midpoints.

terval in which later Holocene climatic variability and Middle Chalcolithic settlement dynamics are evaluated.

XRF core scanning

The half core was scanned at 2.5mm intervals with an ITRAX core scanner. At the mean accumulation rate of the lacustrine sequence this corresponds to a measurement approximately every four years. The method is non-destructive and yields high-resolution records of relative elemental variation (*Croudace* et al. *2006; Rothwell, Rack 2006; Francus* et al. *2009*). Intensities are reported in counts per second and are semi-quantitative. They respond to elemental concentration but also to water content, grain size, surface roughness and matrix composition, and cannot be converted to absolute concentrations without independent calibration (*Jahn* et al. *2003*). Ratios of elements measured under identical conditions are less affected than raw intensities. All raw data are deposited at Zenodo (*Konak 2026*).

The detrital elements Ti, Si, K, Rb and Zr are delivered to the basin as clastic material by physical weathering and surface transport, and are taken to increase with the flux of terrigenous sediment and hence, in this setting, with effective precipitation (*Riquier* et al. *2006; Rothwell, Rack 2006; Litt* et al. *2009*). Ca is interpreted as carbonate; following R. Guy Rothwell and Frank R. Rack (*2006*), high Ca marks intervals of reduced clastic input and evaporative carbonate precipitation, and low Ca the reverse. The ratio (Zr+Rb)/Sr expresses the balance between clastic input and carbonate, rising with the former, while grain size proper is better indicated by Zr/Rb (*Dypvik, Harris 2001*). Redox conditions are assessed through Mn, Ni, V/(V+Ni) and Ni/Co (*Jones, Manning 1994*), and biological productivity through P, Ba and S (*Tribovillard* et al. *2006*). Sr intensity and lake-water salinity are confounded by detrital and authigenic carbonate sources. We treat Sr as weakly constrained, report it, and rest no interpretation on it alone. To highlight long-term environmental trends and suppress high-frequency analytical noise, a Fast Fourier Transform (FFT) low-pass filter was applied to the raw XRF datasets (*Mudelsee 2014*), separating the long-term trend from the raw proxy signals.

Compilation and settlement record

The settlement evidence assembled here derives from published excavation reports and regional surveys. Because the argument turns on absence, the criteria of inclusion, exclusion and period assignment are stated. A site enters the compilation if a published source assigns it to one or more periods from the Late Neolithic to the Early Bronze I and states the basis of that assignment. For each entry we record excavated or surveyed status, landscape position, periods attested, evidential basis, and source. The distinction between excavated and surveyed evidence is preserved throughout. Assignments follow the source, and where sources conflict both are recorded.

Two Lake District localities have been reported as yielding Middle Chalcolithic material, and both are excluded from the positive record. Homa Höyük, at Beyşehir-Gümüşsu, was identified by Mellaart in the 1950s and assigned to the Middle Chalcolithic on the basis of surface pottery (*Mellaart 1954*). Sarıkayalı, also called Ayas Çiftlik, lies in a valley between Hoyran and Beyşehir; French recorded it in 1963 and assigned the collected material to the Early or Middle Chalcolithic by analogy with pottery of the Konya plain (*French 1965*). Neither collection has been restudied, neither derives from a stratified context, and the relative datings advanced in these early surveys cannot now be evaluated. Exclusion of contested material from a positive record is not equivalent to a demonstration of absence. Were either assignment sustained, the gap would be attenuated but not eliminated. The compilation records places at which durable, archaeologically visible occupation has been identified. It is by construction insensitive to occupation that left no such trace, and this is not a defect of the compilation but its subject.

Results

The Gencali environmental record

To elucidate the Holocene environmental dynamics of the basin, high-frequency analytical noise was suppressed using an FFT low-pass filter, allowing long-term trends to be isolated from the raw XRF proxy data (Fig. 3).

Throughout the lacustrine sequence, the detrital elements Ti, Si, K, Rb, and Zr exhibit strong covariation (Fig. 3.A). Between 10 000 and 8000 cal BP, the relative values of these elements remain low. A distinct rise initiates at *c.* 7800 cal BP, experiences a brief interruption at *c.* 7000 cal BP, and subsequently resumes its upward trajectory. Conversely, Ca declines progressively across this same interval, from *c.* 7800 to *c.* 5900 cal BP (Fig. 3.D). Evaluated concurrently, these two series describe a progressive increase in the delivery of clastic material relative to authigenic carbonate. This delineates a broadly humid interval that becomes increasingly pronounced from *c.* 6600 cal BP onward.

This rising trend culminates in a sharp, definitive maximum between approximately 5900 and 5850 cal BP. At this horizon, all five detrital elements register their highest Holocene values. Simultaneously, Ca and Sr drop to pronounced minima; Sr falls from a background level of approximately 2000 counts to roughly 700 (Fig. 3.E). Correspondingly, the (Zr+Rb)/Sr ratio, which expresses the balance between clastic input and carbonate precipitation, surges to between 1.0 and 1.4, significantly above its background average of 0.4 (Fig. 3.D).

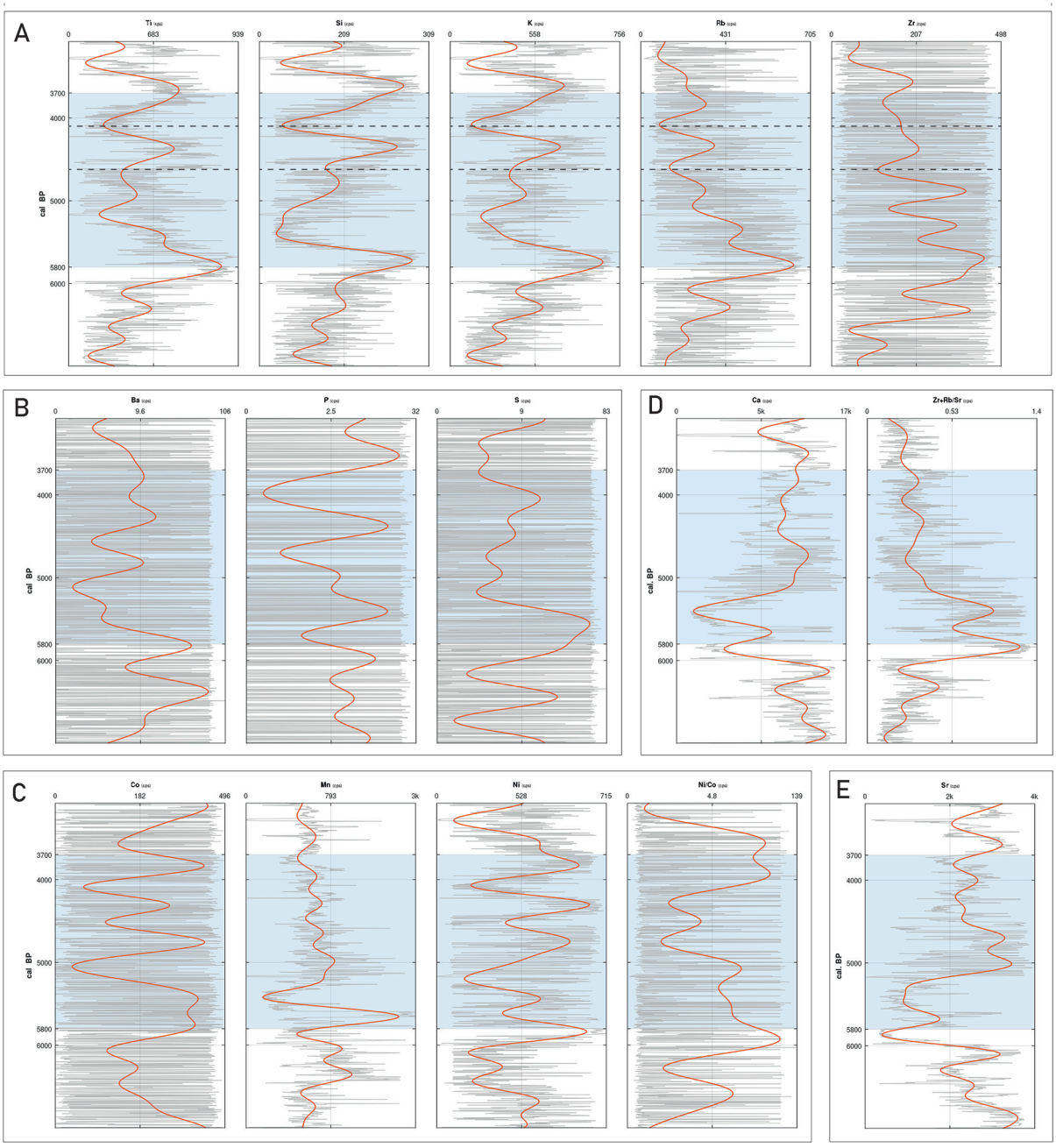


Fig. 3. High-resolution ITRAX XRF core scanning profiles of the Gencali lacustrine sequence. Raw proxy data (grey lines) are overlaid with long-term trends extracted using an FFT low-pass filter (red lines). The shaded horizontal band marks the Middle Chalcolithic settlement gap of the Lake District, from the terminus of the Early Chalcolithic at Hacılar IA to the resumption of occupation at Kuruçay 6A, c. 5800 to c. 3700 cal BC (c. 7750 to c. 5650 cal BP). Its limits are those of the radiocarbon determinations compiled in Tab. 3. The upper axis gives cal BC and the lower axis cal BP. **A** ***detrital elements indicating clastic input (Ti, Si, K, Rb, Zr). Broken vertical lines mark the limits of the clastic excursion discussed in the text, at c. 4650 and c. 3900 cal BC (c. 6600 and c. 5850 cal BP).*** **B** ***biological productivity indicators (Ba, P, S).*** **C** ***redox-sensitive elements and ratios (Co, Mn, Ni, Ni/Co).*** **D** ***carbonate indicator (Ca) and the clastic-to-carbonate balance ratio (Zr+Rb/Sr).*** **E** ***strontium (Sr).***

While Mn and Ni also display distinct spikes at this horizon (Fig. 3.C), they are unlikely to record altered redox conditions. Both elements are abundant in the ultramafic rocks of the Marmaris Peridotite and Kızılcadağ Melange, upon which the catchment is partially developed. Their strict covariation with the detrital proxies (Ti and Zr), coupled with a complete absence of any coherent response in the biological productivity indicators (P, Ba, and S; Fig. 3B), indicate that Mn and Ni arrived with the clastic pulse. Therefore, they record the provenance of the eroded material rather than the redox state of the water column.

In the proxy scheme applicable to this basin, aridity is expressed as elevated Ca with diminished clastic input. The horizon at *c.* 5850 cal BP presents the opposite consite configuration. Every detrital proxy reaches its Holocene maximum, and Ca falls to its Holocene minimum. The proximate reading of the horizon is a large influx of terrigenous clastic material relative to carbonate, delivered by intensified runoff and erosion. The proxies do not distinguish between a higher mean annual precipitation and a shift toward more seasonal and more erosive rainfall. What they establish is the magnitude of the change, not its cause. Finally, because no closely comparable Holocene record exists for the Lake District to allow external cross-validation, the internal sensitivity of the core must serve as its own baseline. The massive detrital excursion culminating at *c.* 5850 cal BP supplies a clear benchmark for what an environmental perturbation of archaeologically consequential magnitude looks like within this specific basin. Against this benchmark, the earlier interval from 7800 to 6600 cal BP contains no comparable signal. Therefore, across the onset and the first millennium of the archaeological settlement gap, the Gencali record does not register an environmental disruption of the magnitude it is demonstrably capable of recording higher in the sequence. It does not exclude minor environmental changes below that threshold, but it firmly excludes a massive perturbation comparable in magnitude to the excursion between *c.* 6600 and *c.* 5850 cal BP. The settlement gap opens during rising clastic delivery, not during the low-detrital interval that precedes it (Fig. 3).

The Lake District settlement record

Four long sequences anchor the region. The earliest Neolithic levels come from Hacılar, from the deposit Mellaart assigned to an aceramic phase and Duru enters as Early Neolithic I, a period the regional framework places between 8000/7200 and 6600/6500 cal BC (Tab. 1). It carries a single determination, BM-127, which calibrates to 8279 to 7379 cal BC with a median of 7819 cal BC. The phase is known from Hacılar alone, and both its existence and its dating are contested (*Duru R. 2013; Türkteki 2021*). Setting it aside, the earliest secure levels are Hacılar EN-II and Bademağacı EN-I, in the first half of the seventh millennium cal BC (*Umurtak 2005; Duru R., Umurtak 2019*). From that point until the close of the Early Chalcolithic the record is dense. It then stops. Hacılar ends in a destruction layer at the beginning of the Early Chalcolithic and is never reoccupied. Bademağacı is abandoned and not resettled until the Early Bronze II. Höyücek is abandoned in the Late Neolithic and no later occupation phase is de-fined (*Duru R. 1996; 2013; 2016; Duru R., Umurtak 2005*). Kuruçay alone carries both Early and Late Chalcolithic levels, and is for that reason the defining sequence of the regional Chalcolithic. Its Early Chalcolithic building level 7 ends, as at Hacılar, in a destruction layer, and occupation resumes in level 6A (*Duru R. 1996; 2013; 2016*). The two levels show no cultural connection.

The radiocarbon evidence for the four sequences is compiled in Table 3, recalibrated here with IntCal20. It is dense through the Neolithic and the Early Chalcolithic and it stops with them. The youngest Early Chalcolithic determination from any of the four is from Hacılar IA, at 5990 to 5669 cal BC. It belongs to the Pennsylvania series of the 1960s, and is entered here as a combined determination on P-315 and P-315A, two halves of a single charcoal sample given different pretreatments and carrying errors of ±95 and ±221 years. The combined age is 6952±84 BP, and its calibrated range spans more than three centuries. The terminus is therefore dated, but not closely. The resumption is better served. Five determinations from Kuruçay 6A, measured at Heidelberg on fragments of wooden posts, are statistically consistent and place the level between 3634 and 3103 cal BC, with calibrated medians clustering between 3529 and 3418 cal BC (*Duru R. 1996*). Not one of the four sequences contains a level assigned to the Middle Chalcolithic, and between the last dated Early Chalcolithic level and the first dated Late Chalcolithic one lies an interval of roughly two millennia.

One determination bears on that interval. A sample from Kuruçay 6c, measured at Hacettepe, returns 5450±52 BP, which calibrates to 4441 to 4066 cal BC (*Duru R. 1996*). Three considerations prevent us from reading it as a Middle Chalcolithic occupation. Its laboratory code is not reported. It is a single determination

on a fragment of a wooden post, and a post carries the age of the timber rather than of the building that used it, so that the result stands as a *terminus post quem*, and no Middle Chalcolithic material accompanies it. Duru (*1996*) declines, on the strength of it, to draw the beginning of the Late Chalcolithic back into the fifth millennium. Were the determination sustained as it stands, it would attenuate the interval and not eliminate it, and it would not supply the assemblage whose absence is at issue here.

Becks (*2013*) records ten Chalcolithic sites among the islands and lake shores. Five are Early Chalcolithic: Yılan Höyük, an island site on Beyşehir; Ortakaraviran

Site	Level	Lab code	Material	^{14}C BP	cal BC (2σ)	median
Bademağacı	Early Neolithic I/8	Hd-22340	charcoal	7949±31	7034–6695	6866
Bademağacı	Early Neolithic II/4	Hd-22339	charcoal	7553±31	6463–6274	6422
Bademağacı	Early Neolithic II/3	Hd-20910	charcoal	7546±41	6467–6259	6413
Bademağacı	Early Neolithic II/4	Hd-21015	charcoal	7481±40	6423–6243	6341
Bademağacı	Early Neolithic II/4	Hd-22279	charcoal	7465±27	6407–6243	6321
Bademağacı	Early Neolithic II/3	Hd-21058	charcoal	7459±51	6423–6232	6322
Bademağacı	Early Neolithic II/4	Hd-21016	charcoal	7424±37	6395–6225	6311
Bademağacı	Early Neolithic II/1	Hd-21046	charcoal	7307±41	6233–6072	6154
Höyücek	Shrine Phase	Hd-14219/14007	charred post	7556±45	6474–6257	6419
Höyücek	Shrine Phase	Hd-14218/14002	charred post	7551±46	6471–6257	6415
Höyücek	not reported	DEM-256	charcoal	7480±34	6422–6244	6341
Höyücek	not reported	DEM-302	charcoal	7478±44	6423–6241	6337
Höyücek	Early Settlements 2	Utc-3793	animal bone	7393±38	6389–6089	6279
Höyücek	Shrine Phase	Hd-14217/13822	charred post	7349±38	6355–6077	6173
Kuruçay	13	Hd-12915/12673	animal bone	7310±70	6367–6025	6163
Kuruçay	7	not reported	charcoal	7214±38	6217–5992	6061
Kuruçay	12	Hd-12916/12674	animal bone	7140±35	6067–5922	6013
Kuruçay	11	Hd-12917/12830	animal bone	7045±95	6067–5733	5914
Kuruçay	6c	not reported	not reported	5450±52	4441–4066	4290
Kuruçay	7 (intrusive)	not reported	charcoal	5170±70	4227–3791	3980
Kuruçay	6b	not reported	not reported	4795±82	3751–3369	3563
Kuruçay	6A/6	Hd-9989-10360	charred post	4740±50	3634–3375	3529
Kuruçay	6A/6	Hd-9991-10362	charred post	4720±60	3631–3371	3502
Kuruçay	6A/6	Hd-9990-10361	charred post	4690±60	3629–3363	3465
Kuruçay	6A/6	Hd-9992-10363	charred post	4650±55	3625–3194	3448
Kuruçay	6A/6	Hd-9988-10341	charred post	4620±60	3619–3103	3418
Hacılar	Aceramic	BM-127	charcoal	8700±180	8279–7379	7819
Hacılar	VII	BM-125	charcoal	7770±180	7122–6238	6658
Hacılar	VI	BM-48	charcoal	7550±180	6895–6019	6399
Hacılar	VI	AA-41602	juniper charcoal	7468±51	6424–6234	6328
Hacılar	VI	AA-41603	juniper charcoal	7452±51	6423–6229	6318
Hacılar	VI	AA-41604	juniper charcoal	7398±63	6397–6085	6273
Hacılar	not reported	P-326	charcoal	7386±131	6464–6010	6245
Hacılar	IX	P-314	charcoal	7340±94	6395–6027	6196
Hacılar	VI	P-313 + P-313A	charcoal	7266±65	6240–5998	6139
Hacılar	IIA	P-316	charcoal	7170±134	6358–5745	6039
Hacılar	IA	P-315 + P-315A	charcoal	6952±84	5990–5669	5835

Tab. 3. Radiocarbon determinations from the excavated Lake District sequences. Conventional ages compiled from the 14SEA database (*Reingruber, Thissen 2016*) and the NERD database (*Palmisano *et al.* 2022*), and recalibrated here with IntCal20 (*Reimer *et al.* 2020*). Ranges are 2σ at 95.4%; medians are of the calibrated probability distribution. All ages are cal BC. Where a sample was divided and given different pretreatments, the halves are entered as combined determinations; this applies to P-313 and P-313A, and to P-315 and P-315A. Determinations not held in the source databases are not included. AA-41602 to AA-41604 are decadal samples from a single tree sequence. The four Kuruçay determinations without laboratory codes were measured at Hacettepe. The Kuruçay level 6A/6 determinations were made on fragments of wooden posts and the Höyücek Shrine Phase determinations on carbonized posts, and these carry the age of the timber rather than of the buildings that used it. The stratigraphic attribution of the Kuruçay level 13 sample is doubted by the excavator, and the level 7 determination of 5170±70 BP is regarded as intrusive from the Late Chalcolithic level 6.

I on Suğla; Senir on Burdur; Kocapınar on Yarışlı; and Yenice on Karataş. Five are Late Chalcolithic: Çallıca on Yarışlı, Üzümlübel on Kestel, Geneli on Karamık, Kubad-abad on Beyşehir, and Burun Höyük on Beyşehir. No site carries both. The Late Chalcolithic sites all carry Early Bronze levels, and some Early Chalcolithic sites do as well. The Late Chalcolithic is itself barely visible. Outside Kuruçay, Duru (*2016*) knows it from a handful of sherds at Bademağacı and from a single surveyed locality at Bağbaşı near Elmalı. The problem of detection does not end when the gap does. The same surveys, applied to the same landscape, yield a different picture two millennia later, with 39 settlements in the Early Bronze I, 146 in the Early Bronze II and 43 in the Early Bronze III (*Becks 2013*).

This settlement gap and stratigraphic discontinuity in southwestern Anatolia is, in fact, a fundamental chronological problem that has long been debated in the literature. For a long time, the traditional Chalcolithic sequence in the region was based solely on the excavations at Hacılar (representing the Early Chalcolithic) and Beycesultan (representing the Late Chalcolithic). The complete lack of observable relationships or stratigraphic overlap between these two cultures initially led researchers to propose a sudden invasion hypothesis, suggesting a fully developed Late Chalcolithic culture was brought into the region from the outside (*Mellaart 1960; Lloyd, Mellaart 1962*). However, Christine Eslick (*1980*) argued against this, asserting that this discontinuity actually represents a long chronological hiatus spanning much of the fifth millennium BC. She introduced ceramics recovered from Kızılbel and Lower Bağbaşı in the Elmalı Plain as 'Middle Chalcolithic' evidence; these assemblages fit into none of the known southwestern Anatolian traditions but showed distinct parallels with finds from the eastern Aegean islands. Eslick's pioneering observation remains a crucial historiographical reference point for understanding this obscure phase, as it suggests that Late Chalcolithic cultures did not emerge from a sudden external influx, but may have been shaped by local factors, such as the Kızılbel-Lower Bağbaşı tradition, that were not entirely disconnected from earlier traditions.

Settlement record from southwestern to northwestern Anatolia

Beyond the Lake District the Middle Chalcolithic is not a gap. A cultural horizon extends from Southwestern to Northwestern Anatolia, dated approximately to 4900/4800 to 4300 cal BC (*Takaoğlu 2017*). In southwestern Anatolia it is attested at Girmeler Cave (*Becks, Polat Becks 2013*), Tavabaşı Lower Cave (*Korkut* et al. *2017*), Karain Cave (*Seeher 1987*), Malkayası Cave (*Korkut* et al. *2017*), Beçin Kalesi (*Yıldız 2019*), Aşağı Bağbaşı, Kızılbel (*Eslick 1980; 1992*); in central-western Anatolia at Yeşilova phase III (*Derin, Caymaz 2017*), Liman Tepe phase VII (*Şahoğlu 2012*), Çine-Tepecik phase IV (*Günel 2021*), Dağdere (*Takaoğlu 2017*) and Kulaksızlar (*Yavşan 2022*); in northwestern Anatolia at Uğurlu (*Erdoğu 2014*), Gülpınar phase III (*Özdemir, Özdemir 2021*), Kumtepe, Beşik-Sivritepe, Alacalıgöl and Çıplak Köyü (*Gabriel 2014; Blum 2025*). The assemblages share form and decoration. Dark-faced burnished wares, uprising basket and mushroom handles, and channelled ornament tie them to the eastern Aegean islands, among them Emporio on Chios, Tigani on Samos, Vathy Cave on Kalymnos and Saliagos, while the channelled and pointillé decoration carries a further connection to the Balkans (*Blum 2014; 2025; Yavşan 2022*). The marble Kilia figurines and conical rhyta produced at Kulaksızlar and recovered across the region express the same relations as a movement of finished objects reaching from the Çanakkale area to Antalya (*Blum 2014; Takaoğlu, Özdemir 2017*). The distribution is shown in Figure 1.A.

The horizon is anchored by radiocarbon dating at several excavated sequences. In central-western Anatolia, determinations from Kulaksızlar, Yeşilova and Liman Tepe place occupation in the later fifth millennium cal BC (*Yavşan 2022*), and in the Troad the Kumtepe sequence provides the regional radiocarbon backbone against which the Beşik-Sivritepe horizon is fixed (*Blum 2014*). These determinations are compiled in Table 4. In southwestern Anatolia two sequences carry chronometric determinations, and neither has been published with a conventional age. At Tlos, a sounding in the stadium area returns a range of 5200 to 4850 cal BC, as reported by its excavators. At Tavabaşı Lower Cave, in the Eşen valley, a 0.6m culture layer resting on bedrock and bounded above and below by carbon accumulations yielded a dense Middle Chalcolithic assemblage, and two determinations bracket the layer between 4838 and 4459 cal BC, indicating continuous occupation over some 300 to 350 years (*Korkut* et al. *2017*). Tavabaşı is the closest the region comes to an absolute anchor for the horizon. Both ranges are entered in Table 4 as their excavators report them, and neither could be recalibrated here.

The horizon is characterized by short-lived occupations, and by a marked shift in where settlement is

placed. Takaoğlu, writing on Dağdere in the Akhisar plain, observes that Middle Chalcolithic settlement occurs in elevated terrain away from alluvial plains and from the lower slopes surrounding them, and that cave settlement is widespread in southwestern Anatolia (*Takaoğlu 2017*). Korkut, Takaoğlu and Sezgin draw the same conclusion from Tlos (*Korkut* et al. *2019*). The caves do not appear to have been seasonal camps. Yalçınkaya holds that the occupants of Karain were not semi-nomadic but lived in the caves (*Seeher 1987*), and Kartal, studying the chipped stone of Karain chamber B, finds that the microlithic technology of the Late Upper Palaeolithic continues into the Chalcolithic (*Kartal 2009*). Not all readings agree. French (*1965*) proposed that semi-nomadic pastoralists of the plateau wintered in Girmeler Cave, and Ralf Becks and B. Ayça Polat Becks (*2013*) argue from the Girmeler evidence that by the late seventh and early sixth millennia cal BC caves were no longer suitable dwellings for sedentary communities. Cave occupation in the Middle Chalcolithic thus appears to be a departure from the immediately preceding pattern rather than a continuation of it. One further feature of this pattern deserves notice. Cave and rock-shelter occupation, which recedes in the tell-

Site	Level	Lab code	Material	^{14}C BP	cal BC (2σ)	median
Tlos	stadium sounding	Beta-445402	bone	not published	5200–4850 (as published)	—
Tavabaşı Lower Cave	cave deposit	not reported	not reported	not published	4838–4459 (as published)	—
Kulaksızlar	Yapı C	TÜBİTAK-1341	animal bone	5609±31	4525–4354	4418
Kulaksızlar	Yapı A	TÜBİTAK-688	animal bone	5448±31	4349–4249	4288
Yeşilova	III	not reported	not reported	not published	4340–4230 (as published)	—
Liman Tepe	VIIb	not reported	not reported	not published	4600–4200 (as published)	—
Uğurlu	III	Beta-405650	bone	6590±30	5614–5479	5532
Uğurlu	III	Beta-405651	bone	6480±30	5479–5372	5420
Uğurlu	III	Beta-405649	bone	6470±30	5477–5372	5419
Uğurlu	III, Building 3	Beta-345836	bone	6410±30	5471–5317	5387
Uğurlu	III	UGAMS-25381	bone	6360±30	5466–5219	5333
Uğurlu	III	UGAMS-25382	bone	6260±30	5311–5076	5260
Uğurlu	III	Beta-405648	bone	6010±30	4992–4799	4898
Uğurlu	II, Building 1	Beta-362320	not reported	5500±30	4441–4262	4346
Beşik-Sivritepe	–41.95m	Hd-12154	animal bone	5829±62	4837–4537	4684
Beşik-Sivritepe	–42.13m	Hd-12088	animal bone	5760±37	4709–4502	4609
Beşik-Sivritepe	–42.16m	Hd-12087	animal bone	5675±35	4608–4373	4503
Beşik-Sivritepe	–42.42m	Hd-12153	animal bone	5629±51	4581–4349	4455
Beşik-Sivritepe	–42.49m	Hd-11366	shell	5925±79	not calibrated	—
Beşik-Sivritepe	–42.42m	Hd-11362	shell	5689±53	not calibrated	—
Beşik-Sivritepe	–42.79m	Hd-11348	shell	6567±84	not calibrated	—
Kumtepe	IA (KT A2/A3)	Hd-17705	charcoal	6239±170	5521–4734	5165
Kumtepe	IA1 (KT A1)	Hd-18919	human bone	5893±38	4880–4682	4761
Kumtepe	IA1 (KT A1)	Hd-19141	human bone	5880±41	4843–4615	4752
Gülpınar	III	E1–E9, B1/S1, B2/S2, S1–S4	pottery (OSL)	mean 7.03±0.81 ka	not calibrated	—

Tab. 4. Chronometric determinations for the Middle Chalcolithic horizon of western Anatolia, ordered from south to north. Conventional ages compiled from the 14SEA database (*Reingruber, Thissen 2016*) and the NERD database (*Palmisano *et al.* 2022*), and recalibrated here with IntCal20 (*Reimer *et al.* 2020*). Ranges are 2σ at 95.4 per cent; medians are of the calibrated probability distribution. All ages are cal BC. Determinations entered as published are those for which no conventional age has been reported, and the ranges given for them are those of their excavators. The Uğurlu sequence follows Erdoğu (*2014*); its phase III carries the transition from the Early to the Middle Chalcolithic and its phase II the Middle Chalcolithic proper. The Beşik-Sivritepe shell determinations are not calibrated here because no correction for a marine reservoir has been reported for them, and they are omitted from the NERD compilation. The Gülpınar luminescence measurements scatter from 5.83 to 8.64 ka, a spread of some 2800 years, and their dispersion exceeds their measurement errors (χ^2=102.7, 14 df), so that the set is entered as a summary and is not read as an independent age for the phase (*Kiyak *et al.* 2010*).

dominated Neolithic and Early Chalcolithic, becomes a recurrent component of Middle Chalcolithic settlement, and is most densely documented in the Antalya region, where the Taurus caves have the longest and most continuous history of excavation in southwestern Anatolia (*Kartal 2009; Atıcı 2011*). Whether this concentration records a real focus of Middle Chalcolithic cave use or the uneven distribution of cave excavation cannot be separated on present evidence, and the two are not exclusive. Either way it bears on the Lake District, whose own karstic systems, lying immediately north of the Antalya caves, have not been examined to the same standard.

The Elmalı plain lies at the southern edge of the Lake District and may almost be considered part of it. Its Middle Chalcolithic material, from Kızılbel, Aşağı Bağbaşı and the caves, is unpainted, coarse and poorly fired (*Eslick 1980; 1992; Seeher 1987; Korkut* et al. *2017; Aykurt, Ayengin 2022*). It stands outside the Late Neolithic and Early Chalcolithic tradition of the region, which is defined by the polychrome ceramics of Hacılar, and it shows no reported similarity to the Early Chalcolithic material of the Lake District, nor to the Late Chalcolithic material. On present evidence the Middle Chalcolithic of the regions immediately surrounding the Lake District neither descends from the Lake District sequence nor gives rise to it.

The horizon ends and, as Table 4 shows, the Middle Chalcolithic levels of the Lycia-to-Troad line terminate in the earlier centuries of the interval, on present radiocarbon evidence between approximately 4500 and 4200 cal BC (about 6450–6150 cal BP), across differences of altitude and topography, in caves and on plains alike. The latest Middle Chalcolithic is itself thinly attested even in the periphery, represented in the Troad chiefly by the transitional assemblage of Alacalıgöl, which already anticipates the Late Chalcolithic (*Blum 2014; 2025*). Few sequences show continuity across the interval, and settlement resumes, where it resumes, in the later phases of the Late Chalcolithic (*Blum 2014; Korkut* et al. *2017; Takaoğlu, Özdemir 2017*).

Discussion

The Gencali core provides the first continuous, high-resolution geochemical archive for the Lake District. It is interrupted by two short unrecovered intervals between about 8900 and 8000 cal BP, and it is fully continuous across the onset and the duration of the settlement hiatus under investigation. Its strengths are proximity, sensitivity and resolution. Its limitations are chronological, and they bear unevenly on what follows. The terminus of the Early Chalcolithic falls within the radiocarbon-controlled section. The clastic maximum does not. Where the record is weakest we ask least of it. The age model rests on two determinations and assumes a constant rate of sedimentation. Additional determinations from the upper part of the core, with a Bayesian age-depth model, would bring the clastic maximum under chronological control, and would permit the rate of sedimentation itself to be read as an environmental variable. It is the single most consequential improvement available to this record.

We take the three explanations in turn. The first is environmental, although Duru (*2016*) rejected it on archaeological grounds. The destruction deposits sealing the Hacılar, Kuruçay and Bademağacı sequences, he argued, record human agency rather than natural causes. The judgement was drawn from the settlement evidence alone, and it has stood untested. The Gencali record permits an independent test, and corroborates it. The corroboration is stronger than the mere absence of a signal. The onset of the gap falls within an interval of rising clastic input and falling Ca. If the environmental hypothesis were correct one would expect the settlements to end during or immediately after a deterioration. They end while conditions are improving.

A climatic reading of these events has been developed in full, and for this region. Clare *et al.* (*2008*) place the fortified enclosures at Hacılar IIA, IIB and I, at Kuruçay 11 and at Bademağacı ENII, together with the conflagrations that close several of these levels, within the interval of rapid climate change between 8600 and 8000 cal BP, and argue that colder winters and more extreme precipitation raised pressure on resources and led to armed conflict. The mechanism is indirect, and the account is the most fully developed one available for the region.

Two things follow from the Gencali record. The first is a limitation. The core cannot test the 8.2 ka window directly, because the unrecovered interval between 402 and 382cm falls at approximately 8290 to 7995 cal BP. The second bears on what is at issue here. The terminus of the Early Chalcolithic is later than that window. The youngest determination from the four excavated sequences, Hacılar IA, calibrates to 5990 to 5669 cal BC, that is to 7940 to 7619 cal BP, and its whole range post-dates 8000 cal BP. It falls within the

continuous and radiocarbon-controlled section of the core, where clastic delivery is rising and Ca is falling. The destructions with which Clare *et al.* (*2008*) are concerned may belong to the interval they assign them to. The abandonment that opens the two millennia of absence does not, and no deterioration accompanies it in the local record.

This is not a disagreement about chronology. Clare *et al.* (*2008*, Tab. 1) give medians of 7780 and 7900 cal BP for the two determinations from Hacılar level IA, and observe that fortification remained a feature of Early Chalcolithic settlement at Hacılar I and Kuruçay 11 into the sixth millennium cal BC. They also accept, following Schoop (*2005*), that a hiatus separates Hacılar II from Hacılar I. Eva Rosenstock (*2010*) has since questioned the fortified character of Hacılar I and proposed the order Hacılar VI, I, II in place of VI, II, I. On any of these readings the levels that close the Early Chalcolithic sequence lie after 8000 cal BP. What the Gencali record adds is a local environmental archive for those centuries, which was not available when the model was framed.

One point of agreement should be recorded. Clare *et al.* (*2008*) expect the regional expression of the interval to involve heavy rainfall and snowfall rather than drought alone. The later excursion recorded here is one of enhanced runoff and erosion, not of aridity, and is consistent with that expectation. They also urge that attribution to a distant signal be made with caution, and that regional patterns be documented directly (*Clare, Weninger 2010*). This record is the first continuous, high-resolution geochemical archive from within the settled landscape against which propositions of this kind can be checked.

Two qualifications are needed here. The destruction deposits invoked by Duru are evidence of a kind the Gencali record cannot address. Burning is not a climate signal, but neither is it necessarily an invasion signal. And the negative result is bounded. A subtler stress, such as soil exhaustion, a shift in seasonality, or a change in the lake margin affecting water access, would not necessarily appear in these proxies. We claim only that no perturbation of the kind this core is capable of recording accompanies the onset of the gap.

The second explanation is a failure of detection, and it has real content. Middle Chalcolithic deposits are thin. The plains have accumulated alluvium throughout the Holocene. Surveys have been directed at tells, plains and lake margins, while the uplands and karstic massifs have not been examined to a comparable standard. The excavated sites of the horizon show why such a record would be faint. They are thin, single-period and easily destroyed. Kulaksızlar, a single-period flat settlement whose cultural layer lay 20 to 50cm below the plough zone over sterile soil, survived only in the patches that ploughing and looting had spared, and was recognized as a Middle Chalcolithic settlement only through rescue excavation (*Yavşan 2022*). Alacalıgöl, buried beneath colluvium on a low ridge and lacking any topsoil, was located not by archaeological survey but by geomorphological exploration of the Kesik plain (*Blum 2014*). The properties that make such sites archaeologically faint are low relief, thin deposits, and placement away from the tells and plains that surveys have targeted. They are the properties the Middle Chalcolithic of the region displays as a rule.

Nonetheless, two considerations weigh against it. The region has been intensively investigated for over a century, and four tells have been excavated to sterile soil. Every survey conducted since the 1970s has recovered material of the periods on either side in quantity, and none has recovered Middle Chalcolithic material. An absence that survives a century of looking is not the same kind of absence as one that has never been tested. The gap is also confined to the Lake District. Figure 4 sets the dated occupation of the region beside that of its neighbours on a single calendar axis. The determinations of the Lake District cease with Hacılar IA and do not resume for the better part of two millennia. Those of the periphery run through that emptiness. A detection failure severe enough to erase 2000 years of settlement would have to operate here and nowhere adjacent, and no reason has been offered why it should.

The third explanation is the most interesting, because the period supplies a mechanism for it. Middle Chalcolithic settlement in the surrounding regions is not where Early Chalcolithic settlement was. It lies in caves and on elevated ground, away from the tells and the alluvial plains, and it is recovered there when caves and uplands are the settings investigated. A shift of that kind, had it occurred in the Lake District, would remove the population from precisely the settings that a century of survey has searched, and it would leave the record the region now presents. The hypothesis is therefore not idle, and it is the periphery that makes it plausible.

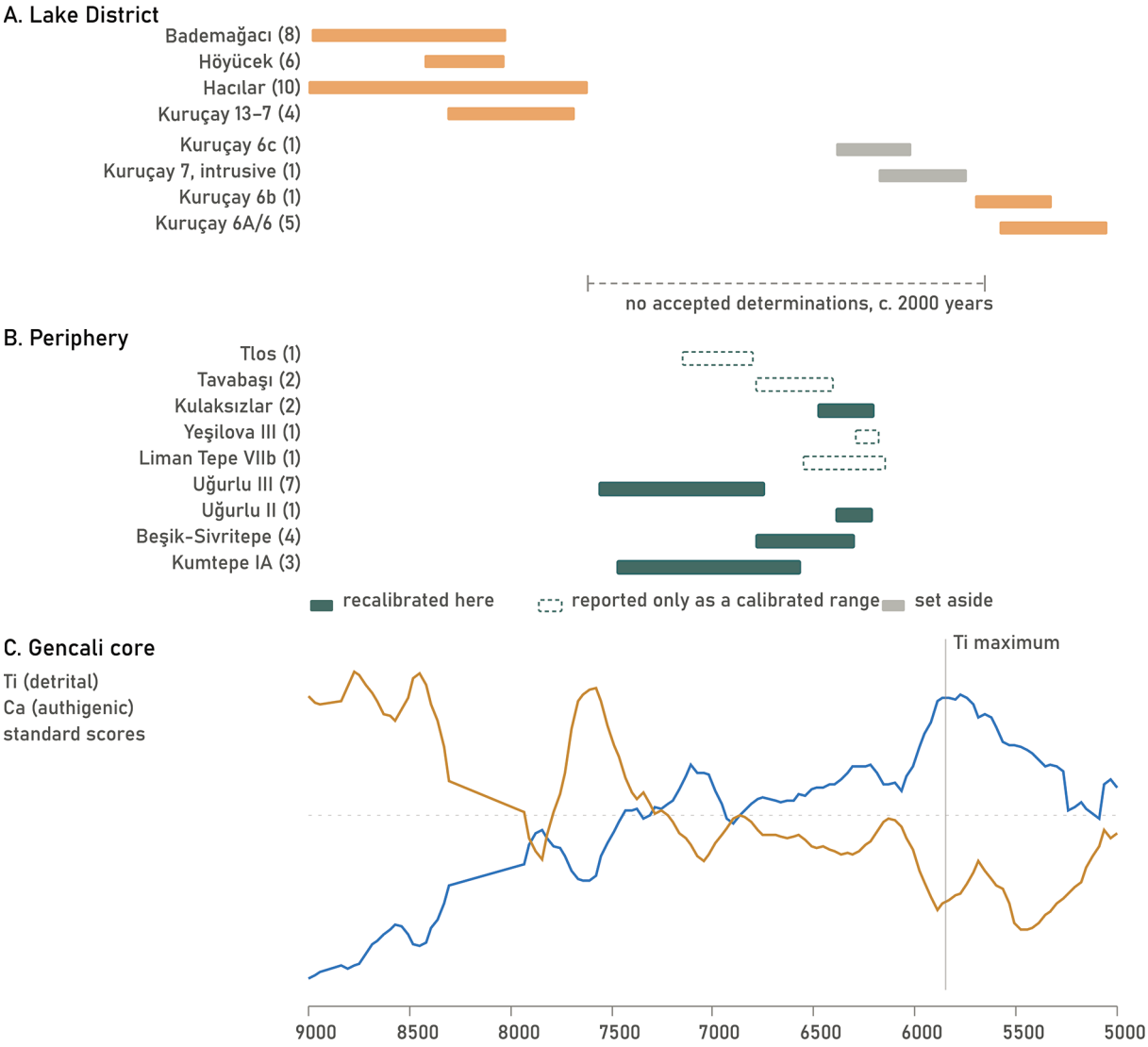


Fig. 4. The dated occupation of the Lake District and of the western Anatolian periphery, set against the elemental record of the Gencali core. Panel* A *gives the span of the calibrated radiocarbon determinations for each block of dated occupation in the Lake District, and panel* B *gives the same for the periphery. The number of determinations in each block is given in brackets. Solid bars are determinations recalibrated here with IntCal20 from a reported conventional age. Open bars are determinations for which no conventional age has been published, and are entered as their excavators report them. Grey bars are the two Kuruçay determinations set aside in the text. Panel C gives Ti and Ca from the core as standard scores, smoothed with a running mean of 51 points. The broken vertical line marks the uppermost radiocarbon determination in the core, and the record to the right of it lies in the extrapolated section of the age model. The upper axis gives cal BC and the lower axis cal BP. The aceramic determination from Hacılar falls outside the axis. Determinations are those of Tables 3 and 4.

The periphery is also what speaks against it. The Middle Chalcolithic of the adjacent regions is, on present evidence, culturally distinct from the Lake District sequence on both sides of the gap. It derives from the Balkans and the Aegean islands, and it is not a continuation of the Hacılar tradition. Had the population of the Lake District persisted in less visible positions, one might expect the material they left to bear some relation to what preceded them. The material recovered at Elmalı, some 40km away, has not been reported to bear any. And a shift in preference relocates a population, it does not silence it. The uplands of the Lake District have been searched less closely than its plains, but they have not gone unvisited, and they have produced nothing of the period in any setting.

The detection and displacement hypotheses remain testable, and should be tested. A systematic survey of

the uplands and karstic systems of the Lake District, conducted with the recognition criteria developed at Karain and Tavabaşı, would settle both, although we know of no such examination. On the evidence presently available, the gap appears more plausibly a cultural fact than an archaeological one. The region was not emptied by climate, and it does not appear to have been emptied by our failure to look. It appears to have been emptied.

One further observation follows from the record, and we offer it as an observation rather than as an answer to the question posed here. The Lake District was already without archaeologically visible settlement when the later interval of pronounced environmental variability recorded in the Gencali core began. It is for that reason that the cultural consequences of this interval cannot be read there, while its environmental expression can be examined. The radiocarbon-dated occupations of the periphery end between approximately 4500 and 4200 cal BC, which is to say between about 6450 and 6200 cal BP. That range falls within the rising limb of the excursion recorded in the core, which begins at *c.* 6600 cal BP and culminates at *c.* 5850 cal BP. Across that interval the core registers the largest change in clastic delivery of its Holocene section, and its culmination follows the terminations. The configuration is not that of a drought. Aridity in this basin would reduce clastic delivery, and clastic delivery reaches its Holocene maximum. The fall in Ca across the same horizon is consistent with that reading. The environmental variability that is not legible in the empty Lake District as a cultural signal is nevertheless recorded there as an environmental one, recorded in the same landscape and the same moisture regime that the peripheral settlements occupied.

We advance the coincidence carefully, and with several reservations. The chronology of the Middle Chalcolithic horizon is anchored by radiocarbon dating at several sites, though unevenly across the region, and remains typological where determinations are lacking. The interval lies above the uppermost radiocarbon determination in the core, in the extrapolated section of the age model. Gencali is a small closed basin, which speaks in the first instance for its own catchment rather than for western Anatolia. A comparison with other Anatolian Holocene archives would convert an internal calibration into an external validation. The proxies establish a rise in clastic input relative to carbonate. They do not establish which term drove it. A larger detrital flux, a reduction in authigenic carbonate production, or both together would produce the same signal. Dry bulk density, together with the additional determinations called for above, would convert the ratio into a sediment flux. Isotopic or palynological work on the same core would be needed to separate a higher mean precipitation from a shift toward more seasonal and more erosive rainfall. And the maximum the core records falls some centuries after the terminations it is set against. It is suggestive. It is not demonstrated.

What can be said is that the two archives are complementary in a way that has not previously been exploited. The Lake District holds a continuous environmental record across an interval when it held no population. Its neighbours held populations across the same interval, and no environmental record. Neither region answers the question alone. Read together, the two archives permit a proposition that further work could test: the environmental instability recorded at Gencali between *c.* 6600 and *c.* 5850 cal BP may have been expressed in southwestern Anatolia not as drought but as enhanced runoff and erosion. If that proves to be so, the relationship between climate and settlement in this landscape is not one of cause and collapse but one of threshold. The Early Chalcolithic settlements of the Lake District, large, sedentary and agriculturally anchored, ended in an interval of improving climate. The Middle Chalcolithic communities of the periphery, small, mobile and dispersed across caves and uplands, may have ended during an interval of enhanced erosion. The more robust settlement system would then have fallen to a social cause, in a favourable climate. The more fragile one would have fallen to an environmental cause that was not a drought. This is the reverse of what environmental determinism predicts, and it is a possibility worth taking seriously.

Conclusions

The Chalcolithic of the Lake District contains a gap of some 2000 years. Four excavated tells terminate at the close of the Early Chalcolithic, three of them beneath destruction debris. Survey of the islands and lake shores recovers five Early Chalcolithic sites and five Late Chalcolithic sites, and no site carrying both. A century of investigation has produced no Middle Chalcolithic deposit and no securely assigned Middle Chalcolithic assemblage. In the regional chronology the interval is left unnamed.

We have presented the first continuous, high-resolution geochemical record for the region, and have used

it to weigh the three explanations the gap admits. The record shows that the gap opens during an interval of rising effective moisture. The environmental explanation for the end of Early Chalcolithic settlement is not supported, and the archaeological judgement of Duru (*2016*) is independently corroborated. Nor does the gap appear to be an artefact of detection. The region has been examined more closely than most of Anatolia, and every survey conducted in it has recovered material of the periods on either side in quantity. Nor does it appear to record a shift in where the population lived. Such a shift is the pattern of the Middle Chalcolithic elsewhere in western Anatolia, and it would have carried a population out of the settings that survey has searched. But the material of those regions has not been reported to bear any relation to the Lake District sequence on either side of the gap, and nothing of the period has been recovered in the region in any setting. On present evidence the region was emptied, and it was not emptied by climate. This is the principal result offered here.

A second observation follows from the record, and it is not an answer to the same question. In its extrapolated upper section the core registers a sustained rise in clastic delivery between approximately 6600 and 5850 cal BP, culminating in the highest values of the Holocene. It is within that interval, from Lycia to the Troad, that the Middle Chalcolithic horizon appears to come to an end. The Lake District, empty, holds the environmental signal. Its neighbours, populated, hold what may be the response. Neither archive answers the question alone, and their complementarity has not previously been exploited. If the correlation holds, then the more robust settlement system of the region, sedentary and agricultural, ended for social reasons in a favourable climate, while the more dispersed system that followed it ended during a period of enhanced erosion that was not a drought. The correlation is suggestive, but has not been demonstrated.

What is required to test these propositions is specifiable. Radiocarbon control is needed on both sides of the comparison, and part of the Middle Chalcolithic evidence of western Anatolia has never been published with a conventional age. A second lacustrine sequence would convert an internal calibration into an external validation. And a systematic survey of the uplands and karstic systems, conducted with the recognition criteria developed where the Middle Chalcolithic is known, would settle the two hypotheses this study can only weigh. The lacustrine sequence continues above the interval examined here and remains unbroken to the base of the agricultural soil. With the additional determinations required to bring the upper part of the core under chronological control, it would become available for the later Holocene.

Acknowledgment
We thank Assoc. Prof. Dr Orhan Kurt (Department of Geomatics Engineering, Kocaeli University) for writing the code used in the Fast Fourier Transform filtering of the XRF data. Core storage, splitting and ITRAX scanning were carried out at the EMCOL laboratory of Istanbul Technical University, and we thank its staff for their assistance. The radiocarbon determinations were measured at the Illinois State Geological Survey. This research received no specific grant from any funding agency.

Data Availability
*The raw ITRAX XRF data underlying this study, together with the derived elemental ratios, are openly available at Zenodo (*Konak 2026*) under a CC BY 4.0 licence. The radiocarbon determinations are reported in full in Tables 2 and 3. No further restrictions apply.*

Declaration on the Use of AI
*When preparing this article, the authors used two AI-assisted tools between 15 and 17 July 2026, in both cases for language editing of the English text only. Pooltext was used for proofreading and copy-editing. The tool does not operate through user prompts, and no instructions were supplied to it. Claude (Anthropic) was used for copy-editing and style feedback, with the following prompt: "*Edit the following section of an academic manuscript for grammar, clarity and consistency. Use British spelling. Keep sentences short and finite. Avoid em-dashes and minimise semicolons. Do not add, remove or reinterpret any content, and do not introduce citations or factual claims.*" Neither tool was used to generate content, to analyse data, or to produce citations. The authors subsequently reviewed and edited all output and accept full responsibility for the content and integrity of the publication.*

References

Angelucci D. E., Soares A. M., Almeida L., Brito R., and Leitão V. 2007. Neolithic occupation and mid-Holocene soil formation at Encosta de Sant'Ana (Lisbon, Portugal): a geoarchaeological approach. *Journal of Archaeological Science 34: 1641–1648*. https://doi.org/10.1016/j.jas.2006.12.002

Atıcı L. A. 2011. Epipaleolithic Archaeology in Turkey. In H. Taşkıran, M. Kartal, K. Özçelik, M. Kösem Beray, and G. Kartal (eds.), *Işın Yalçınkaya'ya Armağan*. Bilgin Kültür Sanat. Ankara: 27–46.

Aykurt A., Ayengin N. 2022. Middle Chalcolithic Period Ceramic from Karain Cave. *Belleten 86: 1–37*. https://doi.org/10.37879/belleten.2022.001

Becks R. 2013. Prehistoric Island and Lake-Shore Settlements in the Lake District of Southwest Anatolia. *Adalya 16: 15–30*.

Becks R., Polat Becks B. A. 2013. Girmeler Mağarasi – Lykia'da Bir Kalkolitik Dönem Yerleşimi. *Mehmet Akif Ersoy Üniversitesi Sosyal Bilimler Enstitüsü Dergisi 5: 166–183*.

Birmingham J. 1964. Recent Archaeological Research in Turkey: Surface Finds From Various Sites. *Anatolian Studies 14: 21–37*. https://doi.org/10.2307/3642465

Bittel K. 1942. *Kleinasiatische Studien*. Universum Druckerei. İstanbul.

Blum S. W. E. 2014. The Middle Chalcolithic Cultural Sequence of the Troad (Northwest Anatolia): Chronological and Interregional Assessment. In B. Horejs, M. Mehofer (eds.), *Western Anatolia before Troy. Proto-Urbanisation in the 4th Millennium BC? Proceedings of the International Symposium held at the Kunsthistorisces Museum Wien, Vienna, Austria, 21–24 November, 2012*. Austrian Academy of Sciences Press. Vienna: 125–156.

2025. *Alacalıgöl: Archäologisch-chronologische Untersuchungen zur Besiedlung der Troas an der Schnittstelle zwischen mittlerem und späten Chalkolithikum*. Studia Troica Monographien 13. Verlag Dr. Rudolf Habelt GmbH. Bonn.

Bronk Ramsey C. 2009. Bayesian Analysis of Radiocarbon Dates. *Radiocarbon 51: 337–360*. https://doi.org/10.1017/S0033822200033865

Çayır Tığlı Ü. 2025. Batı Anadolu Kalkolitik Dönem Oluk Bezeme Tekniği: Çine-Tepecik Höyük Bağlamında Bir Değerlendirme. *Arkhaia Anatolika Anadolu Arkeolojisi Araştırmaları Dergisi*. https://doi.org/10.32949/Arkhaia.2025.74

Chen Y., Zhang W., Sun Q., Liu Y., Snowball I., Almqvist B., Yan C., and Wang H. 2023. Rapid hydroclimate fluctuation in eastern China coastal plain restrain Neolithic cultures development: A mineral magnetic study. *CATENA 233: 107442*. https://doi.org/10.1016/j.catena.2023.107442

Clare L., Rohling E. J., Weninger B., and Hilpert J. 2008. Warfare in Late Neolithic/Early Chalcolithic Pisidia, southwestern Turkey. Climate induced social unrest in the late 7th millennium calBC. *Documenta Praehistorica 35: 65–92*. https://doi.org/10.4312/dp.35.6

Clare L., Weninger B. 2010. Social and biophysical vulnerability of prehistoric societies to Rapid Climate Change. *Documenta Praehistorica 37: 283–292*. https://doi.org/10.4312/dp.37.24

Cohen A. S. 2003. *Paleolimnology*. Oxford University Press. Oxford. https://doi.org/10.1093/oso/9780195133530.001.0001

Constantin S., Bojar A.-V., Lauritzen S.-E., and Lundberg J. 2007. Holocene and Late Pleistocene climate in the sub-Mediterranean continental environment: A speleothem record from Poleva Cave (Southern Carpathians, Romania). *Palaeogeography, Palaeoclimatology, Palaeoecology 243(3–4): 322–338*. https://doi.org/10.1016/j.palaeo.2006.08.001

Croudace I. W., Rindby A., and Rothwell R. G. 2006. ITRAX: description and evaluation of a new multi-function X-ray core scanner. In R. G. Rothwell (ed.), *New techniques in sediment core analysis*. Geological Society. Special Publication 267. Geological Society of London. London: 51–63. https://doi.org/10.1144/GSL.SP.2006.267.01.04

Davraz A., Çakmak M. 2016. Yarışlı Gölü (Burdur) Sulak Alanının Hidrojeoloji ve Hidrojeokimyasal İncelemesi. *The Journal of Graduate School of Natural and Applied Sciences of Mehmet Akif Ersoy University 7: 102–115*.

deMenocal P., Ortiz J., Guilderson T., Adkins J., Sarnthein M., Baker L., and Yarusinsky M. 2000. Abrupt onset and termination of the African Humid Period. *Quaternary Science Reviews 19: 347–361*. https://doi.org/10.1016/S0277-3791(99)00081-5

Derin Z., Caymaz T. 2017. The Chalcolithic period at Yeşilova Höyük. In S. Dietz, F. Mavridis, Ž. Tankosić, and T. Takaoğlu (eds.), *Communities in Transition*. Oxbow Books. Oxford: 499–505. https://doi.org/10.2307/j.ctvh1dtp5.58

Düring B. S. 2010. *The Prehistory of Asia Minor*. Cambridge University Press. Cambridge. https://doi.org/10.1017/CBO9780511778926

Duru G. 2011. Göller Bölgesi Neolitik Yerleşmeleri Üzerine Bir Deneme. In H. Şahin, E. Konyar, and G. Ergin (eds.), *Özsait Armağını: Mehmet ve Nesrin Özsait Onuruna Sunu-*

lan Makaleler. Suna-İnan Kıraç Akdeniz Medeniyetleri Araştırma Enstitüsü. İstanbul: 157–176.

Duru R. 1992. Höyücek Kazıları – 1989. *Belleten 56: 551–566*. https://doi.org/10.37879/belleten.1992.551

1996. *Kuruçay Höyük 1 : 1978–1988 Kazılarının Sonuçları Neolitik ve Erken Kalkolitik Çağ Yerleşmeleri – 1994*. Türk Tarih Kurumu. Ankara.

2008. *From 8000 BC to 2000 BC: Six Thousand Years of the Burdur-Antalya Region*. Suna & İnan Kıraç Research Center for Mediterranean Civilizations (AKMED). İstanbul.

2013. Burdur Bölgesi Prehistorik Kültür Dönemlerinin İsimlendirilmesiyle İlgili Bazı Düşünceler. *Adalya 16: 1–14*.

2016. *Tarım'dan Yazı'ya Burdur Yöresi ve Yakın Çevresinin Altınbin Yılı (8000-2000)*. Batı Akdeniz Kalkınma Ajansı. Antalya.

Duru R., Umurtak G. 2005. *Höyücek: 1989-1992 Yılları Arasında Yapılan Kazıların Sonuçları*. Türk Tarih Kurumu Yayınları. Ankara.

2019. *Bademağacı Höyüğü Kazıları Neolitik Ve Erken Kalkolitik Çağ Yerleşmeleri*. Ege Yayınları. İstanbul.

Dypvik H., Harris N. B. 2001. Geochemical facies analysis of fine-grained siliciclastics using Th/U, Zr/Rb and (Zr+Rb)/Sr ratios. *Chemical Geology 181: 131–146*. https://doi.org/10.1016/S0009-2541(01)00278-9

Eastwood W. J., Roberts N., Lamb H. F., and Tibby J. C. 1999. Holocene environmental change in southwest Turkey: a palaeoecological record of lake and catchment-related changes. *Quaternary Science Reviews 18: 671–695*. https://doi.org/10.1016/S0277-3791(98)00104-8

Eastwood W. J., Leng M. J., Roberts N., and Davis B. 2007. Holocene climate change in the eastern Mediterranean region: a comparison of stable isotope and pollen data from Lake Gölhisar, southwest Turkey. *Journal of Quaternary Science 22: 327–341*. https://doi.org/10.1002/jqs.1062

Erdoğu B. 2014. Gökçeada Uğurlu Archaeological Project: A Preliminary Report from the 2011–2013 Field Season. *Anatolica 40: 157–178*.

Eslick C. 1980. Middle Chalcolithic Pottery from Southwestern Anatolia. *American Journal of Archaeology 84: 5–14*. https://doi.org/10.2307/504390

1992. *Elmalı-Karataş I: Neolithic and Chalcolithic Periods: Bagbasi and Other Sites*. Bryn Mawr College. Pensilvanya.

Florescu G., Brown K. J., Carter V. A., Kuneš P., Veski S., and Feurdean A. 2019. Holocene rapid climate changes and ice-rafting debris events reflected in high-resolution European charcoal records. *Quaternary Science Reviews 222: 105877*. https://doi.org/10.1016/j.quascirev.2019.105877

Francus P., Lamb H., Nakagawa T., Marshall M., and Brown E. 2009. The potential of high-resolution X-ray fluorescence core scanning: Applications in paleolimnology. *PAGES news 17: 93–95*. https://doi.org/10.22498/pages.17.3.93

French D. 1965. Recent Archaeological Research in Turkey. *Anatolian Studies 15: 23–39*. https://doi.org/10.2307/3642499

Gabriel U. 2014. *Die Keramik der troadischen Fundorte Kumtepe IA, Beşik-Sivritepe und Çıplak Köyü im Kontext ihrer überregionalen Vergleichsfunde*. STUDIA TROICA. Monographien 5. Eberhard Karls Universität Tübingen. Dr. Rudolf Habelt GmbH. Bonn.

Gasse F., Van Campo E. 1994. Abrupt post-glacial climate events in West Asia and North Africa monsoon domains. *Earth and Planetary Science Letters 126: 435–456*. https://doi.org/10.1016/0012-821X(94)90123-6

Günel S. 2021. Çine-Tepecik'in Kültürel Gelişiminde Kentleşme Sürecini Anlamak. *Anadolu Araştırmaları/Anatolian Research 24: 117–144*. https://doi.org/10.26650/anar.2021.24.945531

Jahn B., Donner B., Müller P. J., Röhl U., Schneider R. R., and Wefer G. 2003. Pleistocene variations in dust input and marine productivity in the northern Benguela Current: Evidence of evolution of global glacial–interglacial cycles. *Palaeogeography, Palaeoclimatology, Palaeoecology 193: 515–533*. https://doi.org/10.1016/S0031-0182(03)00264-5

Jones B., Manning D. A. C. 1994. Comparison of geochemical indices used for the interpretation of palaeoredox conditions in ancient mudstones. *Chemical Geology 111: 111–129*. https://doi.org/10.1016/0009-2541(94)90085-X

Kansu A. Ş. 1945. Isparta Burdur İlleri Çevresinde T.T.K. Adına 1944 Haziranında Yapılan Prehistorya Araştırmalarına Dair İlk Rapor. *Belleten 9(34): 277–288*. https://dergipark.org.tr/en/pub/ttkbelleten/article/1371280

Kartal M. 2003. Anatolian Epi-Paleolithic Period Assemblages: Problems, Suggestions, Evaluations and Various Approaches. *Anadolu/Anatolia 24: 45–63*.

2009. *Konar Göçerlikten Yerleşik Yaşama Geçiş: Epi-Paleolitik Dönem Türkiye'de Son Avcı Toplayıcılar*. Arkeoloji ve Sanat Yayınları. İstanbul.

Kiyak N. G., Takaoğlu T., Erginal A. E., and Ozcan H. 2010. Luminescence Dating of Prehistoric Site of Smintheion (Gulpi-

nar) in NW Turkey. *Mediterranean Archaeology and Archaeometry 2010: 35–42*.

Kökten İ. K. 1952. Anadolu'da Prehistorik Yerleşme Yerlerinin Dağılışı Üzerine Bir Araştırma. *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi 10: 167–188*.

Konak A. 2018. *Göller Bölgesi ve Trakya'daki neolitik yerleşmelerin çevre koşullarına G.Ö. 8200 olayının olası etkileri*. İstanbul University. İstanbul.

2026. *High-Resolution ITRAX XRF Core Scanning Data and Palaeoclimatic Proxies from Gencali Palaeolake, Southwestern Anatolia* (Data set). Zenodo. https://doi.org/10.5281/zenodo.21415547

Konak A., Yalçın M. N. 2021. Arkeoloji Araştırmalarına Paleoiklim ve Paleoçevre Arşivi Olarak Göllerin Katkıları. In O. Dumankaya (ed.), *Çağlar Boyunca Nehirler, Denizler ve Göller*. Doruk Yayınları. İstanbul: 29–74.

Korkut T., Işın G., and Takaoğlu T. 2017. Cave habitations in Chalcolithic Lycia. In S. Dietz, F. Mavridis, Ž. Tankosić, and T. Takaoğlu (eds.), *Communities in Transition*. Oxbow Books. Oxford: 548–555. https://doi.org/10.2307/j.ctvh1dtp5.63

Korkut T., Takaoğlu T., and Sezgin K. 2019. Pre-Classical Habitation at Tlos, Lycia. *Adalya 22: 25–44*.

Litt T., Krastel S., Sturm M., Kipfer R., Örcen S., Heumann G., Franz S. O., Ülgen U. B., and Niessen F. 2009. 'PALEOVAN', International Continental Scientific Drilling Program (ICDP): site survey results and perspectives. *Quaternary Science Reviews 28: 1555–1567*. https://doi.org/10.1016/j.quascirev.2009.03.002

Lloyd S., Mellaart J. 1962. *Beycesultan 1. The Chalcolithic and Early Bronze Age Levels*. British Institute at Ankara. Ankara.

Marks L., Salem A., Welc F., +10 authors, and Jiang J. 2018. Holocene lake sediments from the Faiyum Oasis in Egypt: a record of environmental and climate change. *Boreas 47: 62–79*. https://doi.org/10.1111/bor.12251

Mellaart J. 1954. Preliminary Report on a Survey of Pre-Classical Remains in Southern Turkey. *Anatolian Studies 4: 175–240*.

1958. Excavations at Hacılar. First Preliminary Report. *Anatolian Studies 8: 127–156*.

1960. Anatolia and the Balkans. *Antiquity 34(136): 270–278*. https://doi.org/10.1017/S0003598X00035560

1970. *Excavations at Hacılar 1*. Edinburgh University Press. Edinburgh.

Mudelsee M. 2014. *Climate Time Series Analysis*. Springer International Publishing. Cham. https://doi.org/10.1007/978-3-319-04450-7

Ormerod H. A. 1912. Prehistoric Remains in South-Western Asia Minor. III. *The Annual of the British School at Athens 19: 48–60*.

Özdemir A., Özdemir A. 2021. Technological Marks On Pot Bases from Chalcolithic Gülpınar. *Arkeoloji Dergisi 1: 47–64*. https://doi.org/10.51493/egearkeoloji.820660

Özsait M. 1976. Pisidya Bölgesinde Yeni Prehistorik İskan Yerleri (I). *Anadolu Araştırmaları 4: 71–184*.

1984a. Pisidya Bölgesinde Yeni Prehistorik İskan Yerleri (II). *Anadolu Araştırmaları 9: 133–167*.

1984b. Pisidya Bölgesinde Yeni Prehistorik İskan Yerleri (III). *Anadolu Araştırmaları 10: 73–99*.

1989. *Pisidya Bölgesinde Yeni Prehistorik İskan Yerleri (IV)*. Edebiyat Fakültesi Basımevi. İstanbul.

1991. Nouveaux sites contemporains de Hacılar en Pisidie occidentale. *Anatolia Antiqua 1: 59–118*. https://doi.org/10.3406/anata.1991.1144

Palmisano A., Bevan A., Lawrence D., and Shennan S. 2022. The NERD Dataset: Near East Radiocarbon Dates between 15,000 and 1,500 cal. yr. BP. *Journal of Open Archaeology Data 10(2): 1–9*. https://doi.org/10.5334/joad.90

Reimer P. J., Austin W. E. N., Bard E., +38 authors, and Talamo S. 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon 62: 725–757*. https://doi.org/10.1017/RDC.2020.41

Reingruber A., Thissen L. 2016. *The 14SEA Project. A ^{14}C database for Southeast Europe and Anatolia (10,000–3,000 cal BC)*. http://www.14sea.org/

Riquier L., Tribovillard N., Averbuch O., Devleeschouwer X., and Riboulleau A. 2006. The Late Frasnian Kellwasser horizons of the Harz Mountains (Germany): Two oxygen-deficient periods resulting from different mechanisms. *Chemical Geology 233: 137–155*. https://doi.org/10.1016/j.chemgeo.2006.02.021

Rosenstock E. 2010. Die "Festung" von Hacılar I. Ein Dekonstruktionsversuch. In J. Šuteková, P. Pavúk, P. Kalábková, and B. Kovár (eds.), *Panta Rhei. Studies on the Chronology and Cultural Development of South-Eastern and Central Europe in Earlier Prehistory Presented to Juraj Pavúk on the Occasion of his 75th Birthday*. Studia Archaeologica et Mediaevalia XI. Comenius University in Bratislava and Archaeological centre Olomuc. Bratislava: 21–34.

Rothwell R. G., Rack F. R. 2006. New techniques in sediment core analysis: an introduction. In R.G. Rothwell (ed.), *New techniques in sediment core analysis.* Geological Society. Special Publication 267. Geological Society of London. London: 1-29. https://doi.org/10.1144/GSL.SP.2006.267.01.01

Sagona A., Zimansky P. 2015. *Ancient Turkey*. Routledge. London. https://doi.org/10.4324/9780203880463

Şahoğlu V. 2012. Lıman Tepe (1992–). In O. Bingöl, A. Öztan, and H. Taşkıran (eds.), *DTCF Arkeoloji Bölümü Tarihçesi ve Kazıları (1936-2011)*. Ankara University. Ankara: 219–230.

Schneider W., Salameh E. 2015. The Last 15,000 Years: Climate-Controlled and "Rare-Event"-Triggered/Rise and Fall of Holocene Cultures in the Near/Middle East and in Central Europe—Evidence and Background. *Open Journal of Geology 05: 743–769*. https://doi.org/10.4236/ojg.2015.511065

Schoop U. D. 2005. *Das anatolische Chalkolithikum: Eine chronologische Untersuchung zur vorbronzezeitlichen Kultursequenz im nördlichen Zentralanatolien und den angrenzenden Gebieten*. Verlag Bernhard Albert Greiner. Remshalden.

Seeher J. 1987. Antalya Yakınlarında Karain Mağarasındaki Kalkolitik Çağ Buluntuları. *V. Araştırma Sonuçları Toplantısı*. T. C. Kültür ve Turizm Bakanlığı Eski Eserler ve Müzeler Genel Müdürlüğü. Ankara: 221–238.

Solecki R. S. 1965. An Archaeological Reconnaissance in the Beyşehir-Suğla Area of South Western Turkey. *Türk Arkeoloji Dergisi 13: 129–148*.

Takaoğlu T. 2017. Middle Chalcolithic finds from Dağdere in the Akhisar/Manisa Region. *Anadolu (Anatolia) 43: 1–13*. https://doi.org/10.1501/Andl_0000000437

Takaoğlu T., Özdemir A. 2017. The Middle Chalcolithic period in the Troad. In In S. Dietz, F. Mavridis, Ž. Tankosić, and T. Takaoğlu (eds.), *Communities in Transition*. Oxbow Books. Oxford: 479–490. https://doi.org/10.2307/j.ctvh1dtp5.56

Todd I. 1980. *The Prehistory of Central Anatolia I: The Neolithic Period*. Paul Ĺströms. Göteborg.

Tribovillard N., Algeo T. J., Lyons T., and Riboulleau A. 2006. Trace metals as paleoredox and paleoproductivity proxies: An update. *Chemical Geology 232: 12–32*. https://doi.org/10.1016/j.chemgeo.2006.02.012

Tuncel R., Şahoğlu V. 2017. The Chalcolithic of Coastal Western Anatolia. In In S. Dietz, F. Mavridis, Ž. Tankosić, and T. Takaoğlu (eds.), *Communities in Transition*. Oxbow Books. Oxford: 513–529. https://doi.org/10.2307/j.ctvh1dtp5.60

Türkteki S. Ü. 2021. Hacılar Kronoloji Sorunu ve Farklı Bir Yaklaşım Gereksinimi. *Anadolu/Anatolia 47: 115–136*.

Umurtak G. 2005. A study of the dating of new groups of pottery from Bademağacı Höyük and some reflections on the Late Chalcolithic cultures of southwestern Anatolia. *Anatolia Antiqua 13: 53–69*. https://doi.org/10.3406/anata.2005.1037

Umurtak G., Dönmez S., and Yurtsever A. 2007. *Refik Duru'ya armağan*. Ege Yayınları. İstanbul.

van Zeist W., Woldring H., and Stapert D. 1975. Late Quaternary vegetation and climate of southwestern Turkey. *Palaeohistoria 17: 53–143*.

Wanner H., Solomina O., Grosjean M., Ritz S. P., and Jetel M. 2011. Structure and origin of Holocene cold events. *Quaternary Science Reviews 30: 3109–3123*. https://doi.org/10.1016/j.quascirev.2011.07.010

Weninger B., Clare L., Rohling E. J., +15 authors, and Zielhofer C. 2009. The Impact of Rapid Climate Change on Prehistoric Societies during the Holocene in the Eastern Mediterranean. *Documenta Praehistorica 36*: 7–59. https://doi.org/10.4312/dp.36.2

Yakar J. 2014. *Eski Anadolu Topluluklarının Arkeolojideki Yansımaları*. Homer Kitabevi. İstanbul.

Yalçın M. N., Bulkan Ö., Algan A. O., and Konak A. 2015. A Holocene aged swamp area in Yenikapı-Istanbul and it's relation with the neighboring Neolithic settlement. *İstanbul and Water, Ancient Near Eastern Studies*. Peeters Publishers. Leuven-Paris-Bristol: 31–46.

Yavşan Ç. 2022. An Assesment of Middle Chalcolithic Pottery from the Kulaksızlar Excavations in Central-Western Anatolia. *Arkeoloji Dergisi 1: 23–42*. https://doi.org/10.51493/egearkeoloji.1071006

Yıldız M. 2019. Beçin Kalesi. In O. Henry, K. Konuk (eds.), *Karia Arkhaia. La Carie, des origines à la période pré-hékatomnide*. Institut français d'études anatoliennes. İstanbul: 375–385. https://doi.org/10.4000/14ulu

Zielhofer C., Faust D., and Linstädter J. 2008. Late Pleistocene and Holocene alluvial archives in the Southwestern Mediterranean: Changes in fluvial dynamics and past human response. *Quaternary International 181: 39–54*. https://doi.org/10.1016/j.quaint.2007.09.016