MICROMORPHOLOGY OF SELECTED SAMPLES FROM ÖKÜZINI CAVE

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INTRODUCTION

The sediments and stratigraphy from Öküzini Cave have been previously described by Otte *et al.* (1995) and in various chapters in this volume by Léotard *et al.*, and Pawlikowski,. In this chapter, we present a précis of our recent field descriptions and observations, and supplement them with micromorphological analyses of samples collected during the 1990, 1992, 1995 and 1996 seasons.

METHODS

Samples for micromorphological analysis (Table 1) were collected in the field and impregnated with either epoxy or polyester resin. The hardened blocks were sliced, and processed into petrographic thin sections either at the Geology Department, Université de Liège, Harvard University, and Spectrum Petrographics, Oregon. Thin sections were examined with a Nikon Labophot polarizing microscope in plane polarized (PPL) and cross polarized light (XPL). Nomenclature follows that of Bullock *et al.* (1985) and Courty *et al.* (1989).

Several samples were collected for mineralogical analysis using FTIR spectrometry at the Department of Structural Biology, Weizmann Institute, Rehovot, Israel. Samples were powdered and about 0.1 mg was pressed into KBr pellets and run with a FTIR spectrometer from the Midac Corporation, California, U.S.A. Details can be found in Schiegl *et al.* (1996).

FIELD CHARACTERISTICS AND DESCRIPTIONS

Overall, the Öküzini sediments are comprised of bright reddish brown clay, limestone roof fall, and culturally derived material, such as ashes, charcoal, and bone and lithic debris (Table 1). Two major lithostratigraphic units were recognized and are evident in the field, and the boundary between both corresponds roughly with the contact between Layers VI and V. Units XII through VI are comprised predominantly of bright reddish clays that are punctuated with lenses or zones of charcoal-rich, clayey, cultural sediments. The overlying Layers V through I are composed of browner, culturally rich clays that are rich in charcoal. Locally, particularly near the top (Layer II) there is an increase in angular stones derived from roof fall (details are presented in Table 2). Thus, the upper half of the profile exhibits much more of a cultural/anthropogenic aspect to it, a conclusion also reached by Pawlikowski (this volume) based on his mineralogical investigations.

MICROMORPHOLOGY

Thin section observations of the major lithological units, (i.e., ash-rich vs. clay rich), reveal similar micromorphological signatures. The clayier units, for example, typically consist of rounded aggregates of clay with inclusions of quartz silt (Figures 1a, 1b, 1c). This material, clearly is derived from the outside, representing ultimately terra rossa soil cover. However, its aggregated expression in thin section, including thin coatings of clay, suggests that it was colluvially emplaced in its present position. Although some of the clay was transported through bedrock joints of the cave roof (as envisioned by Pawlikowski, this volume), a considerable volume must have rolled into place from the entrance toward the rear of the cave. In fact, the apparent volume of clay decreases from a cone-like mass at the entrance-way. Also, it should be pointed out that thinly laminated clay or silt were not observed in the reddish clayey units.

The ash-rich layers in thin section (Figures 2a, 2b, 3a, 3b) are calcareous and tend to be enriched in rounded clay aggregates. Furthermore, the ashes are fairly massive, or at least show no layering or other internal structural organization, and are generally impoverished in charcoal. The heterogeneous character of most of the ashes examined by us suggest that most of the ashes are not the product of *in situ* burning, but rather the accumulation of dumped materials.

Mineralogically, both the micromorpho-logical and FTIR analyses show that the ashes are composed of calcite without any traces of diagenetic modifications, such as those found in other Mediterranean caves (e.g., Karkansas *et al.* 1999; Weiner *et al.* 1995) (Figures 2a and 2b). These observations are supported by the fact that snails from Layers 1 and 6B Sq. M6c (AH21) maintain their original aragonitic composition. Its presence demonstrates minimal chemical alteration at least from these layers.

CHRONOLOGY OF THE DEPOSITS AND ITS IMPLICATIONS

Fifty-nine radiocarbon dates were obtained from the Öküzini sediments and these are presented in Table 3 and Figure 4. The interesting aspects of these dates is not only what they reveal about the chronological development and timing of occupation in the cave, but also other aspects of site formation, such as artifact movement, as well as reflections about palaeoenvironments. In Table 3 the dates are arranged across the page according to location within the site, roughly from Sq. I8 in the eastern part of the site (left part of table), successively westward, from K5 (center of table) to L5 (right part). The samples were collected during excavation of the various squares and the archaeological horizons noted. In addition, adjacent to each date is the inferred geological horizon (in bold) as observed by the excavators, and the dates have been sorted primarily according to their geological unit designation. Evident in Table 3 is the fact that stratigraphic gaps appear in the record, which reflect not only sampling choices but periods when sediments do not appear to have accumulated. These are indicated with thick lines in Table 3. Such gaps appear between archaeological layers 21 and 24 (Figure 4), which corresponds to the contact between geological units VI and VII. This distinctiveness of this contact is striking in the field, and was both noted above and by Pawlikowski (this volume).

Another gap appears in the sequence of dates from the upper part of Square L5 where there is a discordance between the dates, the archaeological level and the geological unit. Many of these upper dates come from archaeological layers and above, which correspond to geological units Ia and Ib, post-date the Younger Dryas, and thus belong to the early Holocene occupation of the site by foragers. In any case, we have grouped units Ia and Ib together (Table 2), since they are similar lithologically. They also are characterized by excellent preservation as indicated by the fact that the land snails from these layers have kept their original aragonitic composition (determined by FTIR), and have not been transformed to calcite.

Aberrant dates in the upper part of the sequence include the following:

1) GIF A 92389 and LV-1985 are bone dates that possibly reflect a lack of sufficient amount of collagen.

2) Gx 16283 is a sample combined from a 20 cm thick unit, and homogenization of different aged materials is not surprising over such a vertical thickness.

3) ETH-8032 could easily point to intrusion by burrowing (Stiner *et al.* 2001) or possibly the use of older wood. In any case, it should be kept in mind that the upper parts are associated with heavy occupation, so that human trampling and bioturbation are not surprising.

In addition, Figure 4 clearly shows that dates obtained from bones (hollow symbols) tend to be younger that charcoal dates in the lower levels (e.g., levels 25 through 30, but also that from Sq. L5/17) but are slightly older than other dates in upper levels (e.g., level 5). Explanations for these irregular dates likely involve diagenetic alterations (possibly for the upper dates), and movement or intrusion of younger materials into older units. The occurrence of the latter has been recently documented for Hayonim Cave, in Israel (Stiner *et al.* 2001).

Finally, we note that Figure 4 reveals only two dates that fall within the range of the Younger Dryas interval. Whereas this could be related to issues of sampling, a realistic interpretation would be that the cave was less occupied during this time (see Pawlikowski this volume for an alternative viewpoint).

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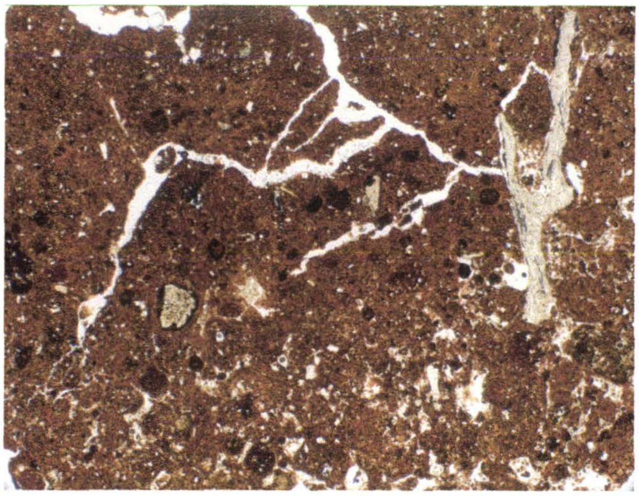
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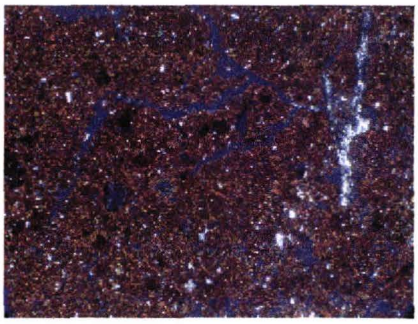
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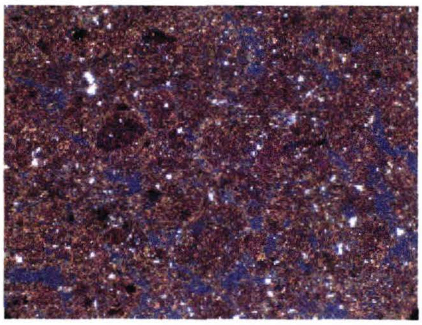
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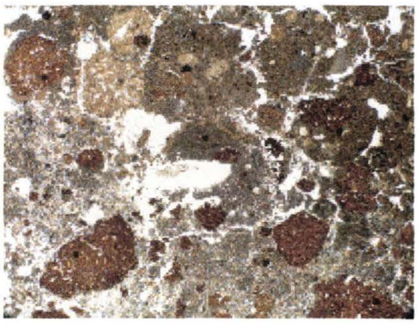
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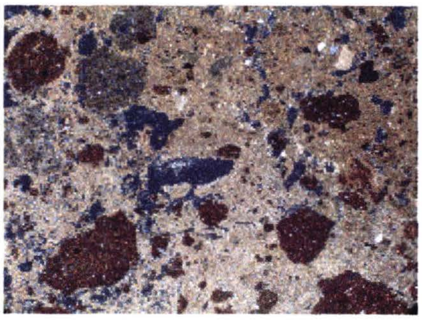
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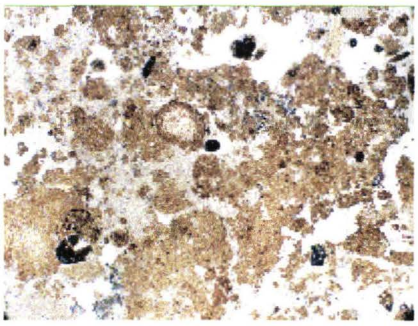
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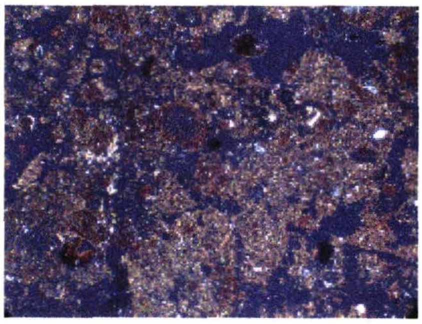
3b

Figure 1a.

Photomicrograph of sample 4, reddish brown sediment from Layer II (formerly Ia/Ib). The heterogeneity of the sediment is visible here, including the vertically oriented bone fragment in the upper right-hand part of the photograph. Plane polarized light (PPL); width of field ca. 3.3 mm.

Figure 1b.

Same as Figure 1a but in cross polarized light (XPL). The aggregated nature of the clays shows up better in this view, as does the oriented clay around them. The presence of quartz silt – derived with the terra rossa but ultimately of aeolian origin - is also more visible in this view. XPL; width of field ca. 3.3 mm.

Figure 1c.

Detail of figure 1b showing rounded nature of individual aggregates and the oriented clay around them. XPL; width of view ca. 1.6 mm.

Figure 2a.

Sample OK-92-7 from Layer Ia showing rounded terra rossa aggregates mixed within a mass of calcareous ash, also in aggregated form. Such textures are indicative of dumping and not *in situ* burning. PPL; width of field ca. 3.3 mm.

Figure 2b.

Same as Figure 2a but in XPL. The bright, calcareous nature of the ashiness of this sample is more evident in this view. XPL; width of field ca. 3.3 mm.

Figure 3a.

Sample 1 from Layer II. Although somewhat broken during transport, the heterogeneous nature of the sediment is visible here as a mixture of reddish clay aggregates and lighter colored ash. PPL; width of field ca. 3.3 mm.

Figure 3b.

Same as figure 4a but in XPL. Rounded clay aggregates with oriented clay are visible, as the brighter colored, calcareous matrix. The latter is in part due to the presence of recrystallized calcitic ash. XPL; width of field ca. 3.3 mm.

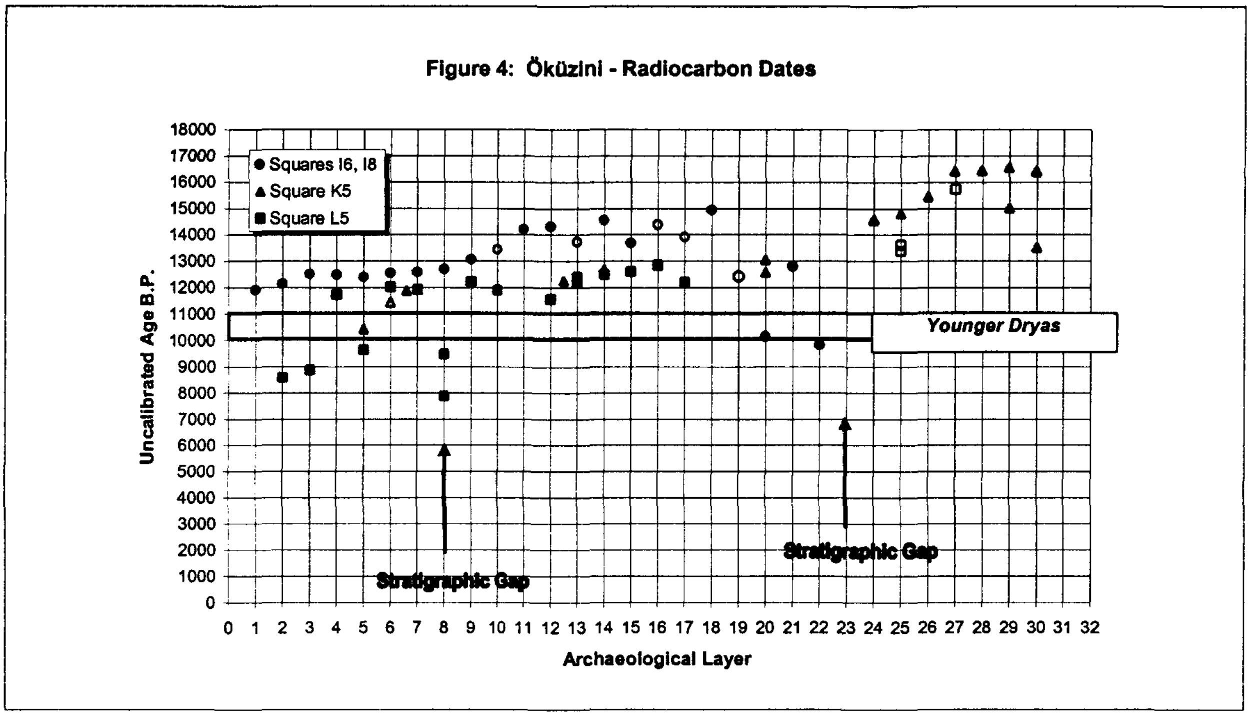

Figure 4. Radiocarbon dates from Öküzini Cave (cf. Table 3).
Hollow symbols refer to dates obtained from bones. Arrows signify gaps in the record (see text).

Sample No.	Square	Depth	AH	Geo Layer
90-1				
90-3				
90-4				
92-3	L5	391		VIb
92-5	L5	325		IV
92-7	M5	237		Ib,1
92-8	M5	252		Ib,2
94-1	M5a	·355-365	18	Upper VI
94-3	N8a	350-358	18	VI?
94-4	M7b	367-375	19	VI?
94-5	M6a	430-440	26	VIII-IX

Table 1. List of samples used in micromorphological analyses from Öküzini Cave.

Layer	Colour	Texture	Upper Contact	Thick.	Arch. Hor.	Micro. Sample
I [ex. Layer 0]	Brown [7.5YR5/4]	Brown, mixed crumbly stony silty clay, biologically reworked (worm/insect casts?). Abuts against the major rock fall and is cemented in Square J5. In squares H 5-10, a series of Chalcolithic burials (dated by sherds) is set into this deposit. Overall, Layer I is not lithologically different from Layers III and IV, except for the extensive degree of reworking.	NA	ca. 25 cm	???	
II [ex. Layers Ia and Ib]	Reddish brown [5YR5/3]	Complex unit showing marked lateral variability. • In Sq. K, it displays blocky, angular, cm size fragments of limestone mixed with land snail fragments within a brown silty clay matrix rich in charcoal and bright red aggregates; overall it resembles a cultural midden. • In Sq. J5 it is weakly to moderately cemented by calcium carbonate derived from the overhang. From the middle of Sq. K, cementation decreases and disappears to the W. • In Section C, this entire complex is covered by two large boulders of rock fall. • Hearths in M/N represent an upward continuation of burned layers as those in Layers III and IV, and reflect the same general usage of this area of the cave.	Sharp	ca 70 cm	5-10	• Sample 1 • 4
III	Brown [7.5YR5/4]	Very anthropogenic unit composed of silty clay ashy deposits with distinct hearths (only the white ashes visible). Quite stony in the central part of L-K 9. Concentrations of land snails. Laterally in Section B, Layer III contains hearths that are visible in I7.	Distinct. [includes basal few cm of silty clay of former Layer II]	13 cm (E) to 26 cm (W)	12, 11	
IV	Brown [7.5YR4/4]	Clay with scattered stones, charcoal and hearths, both small and large (e.g., M6: 60 cm wide by 9 cm thick). In J5, bright red clay aggregates occur. Marks the first appearance of large land snails. Like Layer V, this layer is very homogenous and with no apparent bedding.	Gradual	25 cm	15, 14, 13	
V	Dark reddish brown [5YR3/4]	Generally homogenous and similar to Layer VIa, but with greater abundance of small rocks, and charcoal seems to be smaller and more fragmentary. Remains of reddened ashy hearths at the base and in M6, are white ashes of hearth ca. 4 cm thick. In this area (M6 and N6), large rocks (50-30 cm) and a boulder of roof fall were observed.	Grades into Layer IV	ca. 15 cm	16	
VIa	Dark reddish brown [5YR3/3]	Variegated silty clay, with many pieces of cm size charcoal and a few angular rock fragments. Many sand size bright red aggregates.	Forms transition between generally red clayey sediments below (VIb) to more yellow brown, culturally rich sediment above; grades into Layer V	20-18 cm	18 (mostly), 17	Sample 3, 5
VIb	Yellowish red [5YR4/6]	Generally massive clay with scattered pieces of angular rocks. Locally are a few ash lenses and pockets (J5 and K5). Laterally to the E it is less clayey and richer in pieces of scattered charcoal, i.e., is more cultural. The same is true towards the W (L, M); some bright red clay aggregates.	Grades into overlying Layer VIa which is transitional to overlying units	0-30 cm [pinches out in Section C]	22-18-17	
VII	Variable: yellowish red [5YR4/6] in L5 and dark reddish brown [5YR3/3] in K5	Predominantly clay, but locally in K5 where numerous burned areas occur, it is much stonier. Overall, many flecks of charcoal. This layer is more reddish and resembles terra rosa, and seems to be clayier than below. Layer VII dips to the West as it rests on large bouldery rock fall.	Very irregular and locally indistinguishable from Layer VI which is of similar texture	17-26 cm	25, 24	
VIII	Yellowish red [5YR4/6]	Band of gritty clay, quite distinct and visible across the entire section. Includes charcoal, a few small angular stones 2-11 cm across; many clay aggregates. The southern half of the profile exhibits an ash lens about 7 cm thick and ca. 70 cm long and whose base is reddened by fire.	In S part grades into Layer VII with strong cultural aspect. In Sq. L5, the contact is sharper.	ca. 18 cm	27, 26	
IX, X	Dark reddish brown [5YR3/3]	Very similar to Layer XI: silty clay with rock fall and many blackish mottles which appear to be manganese (Mn).	Irregular and gradual;	X + IX, ca. 20 cm; exposed over 2.5 m	29, 28?	
XI	Reddish brown [5YR4/3]	Very humid, greasy silty clay with abundant pieces of charcoal, a few bright red (fired) clay aggregates, bone fragments, and angular rocks about 6-12 cm in size.	Grades imperceptibly into Layer X	15-20 cm	29, 28	
XII	Yellowish red [5YR5/8]	Silty clay with many angular rock fragments that range in size over several cm. Layer is exposed just above a series of boulders.	Sharp, slightly irregular	ca. 30 cm over ca. 2.5 m long	33, 32, 31, 30	

Table 2. Summary of geological field characteristics of sediments from Section A, Öküzini Cave.

Sq./Arch Lev.	Laboratory No.	Uncal. Date, yrs B.P.	Geol. Layer	Sq./Arch Lev.	Laboratory No.	Uncal. Date, yrs B.P.	Geol. Layer	Sq./Arch Lev.	Laboratory No.	Uncal. Date, yrs B.P.	Geol. Layer
H7b/3	RT 3892	4465±55									
H7b/4	RT 3891	4745±55									
I5c/3	RT3889	5430±40									
								L5/2	HD-14363-13884	8,595±90	1b1
								L5/3	ETH-8031	8,880±80	1b1
I6a/3	RT3894	9825±55						L5/5	HD-14364-13887	9,650±50	1ab1
I6/5	*GIF A.-92389 (b)*	*12,410±140*	1a1	K5c/5	RT-1441	10,440±115	1a2	L5/4	ETH-8032	11,730±90	1a2
I8b/8	OxA-5213	10,150±90	1a1	*K5c/6*	*Lv-1895 (b)*	*11,440±100*	1a2	L5/8	HD-13345-12983	7,880±80	1b1
				K5c/6-7	Gx-16283	11,880±530	1a2	L5/8	ETH-8029	9,480±80	1b1
								L5/6	ETH-8026	12,020±90	2
								L5/7	HD-13334-13211	11,920±190	2
								L5/9	ETH-8033	12,210±90	3
								L5/10	ETH-8030	11,900±90	3
J6a/13	Lv-1998 (b)	12,810±180	4/5	K5c/11-14	RT-1442	12,260±90	4	L5/12	HD-13347-13341	11,565±110	4
								L5/13	HD-13348-12984	12,420±80	4
				J5c/14	*Lv-1997 (b)*	*12,680±210*	5/6a				
I8b/9	RT-2335	11,900±75	6a								
I8b/9	OxA-5214	12,130±100	6a					L5/13	HD-13349-13373	12,190±120	6a
I8b/10	OxA-5215	12,500±110	6a					L5/14	HD-13351-12985	12,500±75	6a
I8b/11	Lv-2078	12,480±160	6a					L5/15	HD-13352-13343	12,610±180	6a
I8b/12	OxA-5216	12,390±110	6a					L5/16	HD-13353-13381	12,850±310	6a
I8B/13	OxA-5217	12,540±110	6b					L5/17	HD-13354-12989	12,190±270	6b
I8b/14	OxA-5218	12,580±110	6b								
I8b/15	OxA-5219	12,700±110	6b								
I8b/16	OxA-5220	13,060±120	6b								
I8d/16	*Lv-2079 (b)*	*13,430±180*	6b								
I8b/18	OxA-5222	14,200±130	6b	K5c/17-20	Gx-16284	12,585±280	6b				
I8b/19	OxA-5223	14,320±130	6b	*K5c/20*	*Lv-1896 (b)*	*13,060±360*	6b				
I8d/19	*Lv-2080 (b)*	*13,740±200*	7	*K5d/24*	*Lv-2074 (b)*	*14,570±150*	7				
I8b/20	OxA-5224	14,550±130	7	K5d/24	OxA-5175	14,610±150	7				
I8	RT-2334	13,670±175	8	K5d/25	OxA-5176	14,820±150	8	*L5c/25*	*Lv-1999 (b)*	*13,620±280*	8
I7d/21	*Lv-2077 (b)*	*14,380±190*	8								
I8d/21	*Lv-2081 (b)*	*13,910±120*	8								
I8b/22	OxA-5225	14,940±140	8								
				K5d/26	OxA-5177	15,460±160	8/9	*L5d/25*	*Lv-2000 (b)*	*13,380±190*	8/9
				K5d/27	OxA-5178	16,420±180	9	*L5c/d/27*	*Lv-2057 (b)*	*15,740±290*	9/10
				K5c/28	OxA-5180	16,440±240	10				
				K5c/29	OxA-5181	16,560±180	11				
				K5d/29	*Lv-2075 (b)*	*15,020±550*	11				
				K5d/30	OxA-5179	16,440±160	11				
				K5c/30	OxA-5182	16,400±160	11				
				K5d/30	*Lv-2076 (b)*	*13,520±640*	11/12				

Radiocarbon Laboratories

Gif - Gif-sur-Yvette, France
Gx - Krueger Enterprises, Cambridge, USA
ETH, Zurich
HD - Heidelberg, Germany
Lv - Louvain, Belgium
OxA - Oxford, UK
RT - Weizmann Institute, Israel

(b)=bone sample

Table 3. The vertical spread of uncalibrated radiocarbon dates at Öküzini.