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NEW AMS ^{14}C DATES FROM THE EARLY UPPER PALEOLITHIC SEQUENCE OF RAQEFET CAVE, MOUNT CARMEL, ISRAEL

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INTRODUCTION

Raqefet Cave (35°04′21″N, 32°39′17″W) is situated in the southeastern side of Mount Carmel in Israel (Figure 1) on the left bank of wadi Raqefet (230 m asl), ~50 m above the wadi bed. It is 50 m long with an area of ~500 m^2 (Figure 2). Eric Higgs of Cambridge University and Tamar Noy of the Israel Museum conducted excavations at the site between 1970 and 1972 (Higgs et al. 1975). New excavations at the cave began in 2004 (Lengyel et al. 2005).

Studies on the lithic archaeological remains from the 1970–1972 stratigraphic units assign Late Mousterian or Middle to Upper Paleolithic transition (layers VIII-VI in squares B-G/18-23), indeterminate early Upper Paleolithic (layer IV in squares B-G/18-23), Levantine Aurignacian (layers IV, III, and II in squares B-G/18-23), indeterminate late Upper Paleolithic (layer II in area B-G/18-23), Late Kebaran (layer I in squares B-G/18-23), Geometric Kebaran (layer VII in squares J-M/24-28), Late Natufian (layers IV-VI in squares A-H/7-17), Neolithic (I-IV in squares J-M/24-28), and Bronze Age (pits in squares A-H/7-17 and B-G/18-23) occupations (Higgs et al. 1975; Lengyel 2003, 2005; Lengyel and Bocquentin 2005; Lengyel et al. 2005; Noy and Higgs 1971; Sarel 2004; Ziffer 1978a,b).

SAMPLES FOR AMS RADIOCARBON DATING

The samples for AMS dating of layers III and IV (from 1970–1972 excavations) are wood charcoals. The charcoals were collected by Eric Higgs and Tamar Noy during the 1970–1972 excavations and stored at the University of Cambridge, Department of Archaeology. The charcoal samples have been kept in tightly sealed nylon bags. The charcoals are in a good state of preservation; some of the pieces are 1–2 cm large. The weight of the collected samples ranged between 0.6 and 22 grams. Each sample consisted of several species of wood, among which *Amygdalus* sp. af *A. korchinsky* was the most common.

RADIOCARBON DATING

From each sample, a single piece of *Amygdalus* sp. af *A. korchinsky* was used for dating. The samples were submitted to the Radiocarbon Laboratory of the Weizmann Institute of Science in Israel and were all measured by accelerator mass spectrometry (AMS). Samples were pretreated using the acid-base-acid protocol in order to remove the environmental contaminants and obtain pure charcoal for dating (Alon et al. 2002; Yizhaq et al. 2005). The pure charcoal content of the samples ranged between 60–80%, which is characteristic of well-preserved charcoal. All calculated ^{14}C ages were corrected for fractionation in order to compare results with the standard δ^{13}C value of –25‰ (wood).

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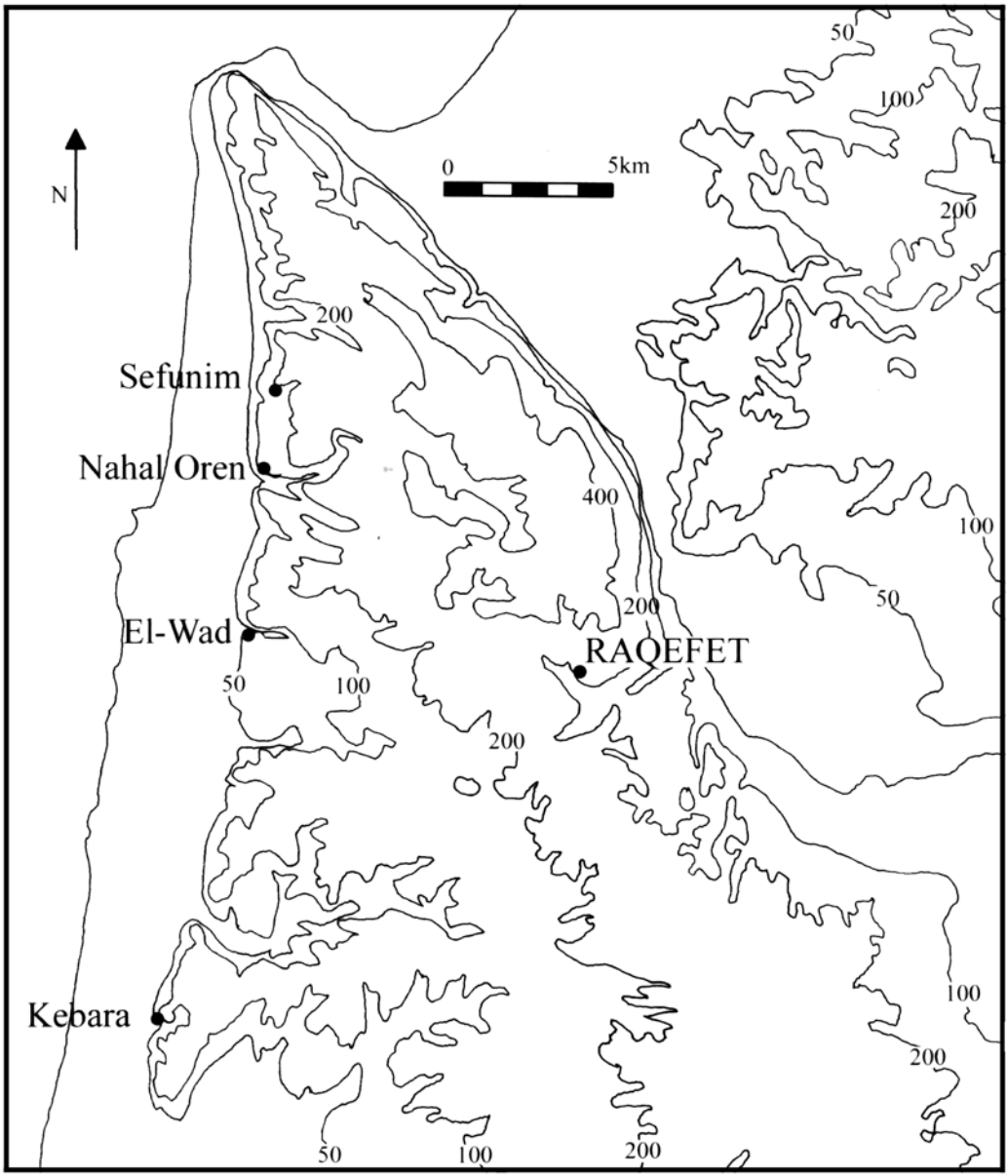

Figure 1 Location of Raqefet Cave in the Mount Carmel region

Layer III

RTT-4945 **30,540 ± 440**

Raqefet, layer III base, square B19 $\delta^{13}C = 24.2‰$

This sample provides a date in ^{14}C yr for the layer III base, ~170 cm below the surface. Layer III (Figure 3) is a 10–20-cm-thick, silver/grey, slightly brecciated deposit. It is finely laminated by organic rich ~1–3-mm-thick bands, horizontally running as irregular waves in the section. The base of the layer in squares B-C/18-20 was reddish in color and varied in thickness from 1–5 cm. In situ anthropogenic structures, such as hearths, are distorted throughout the entire layer. Charcoals are

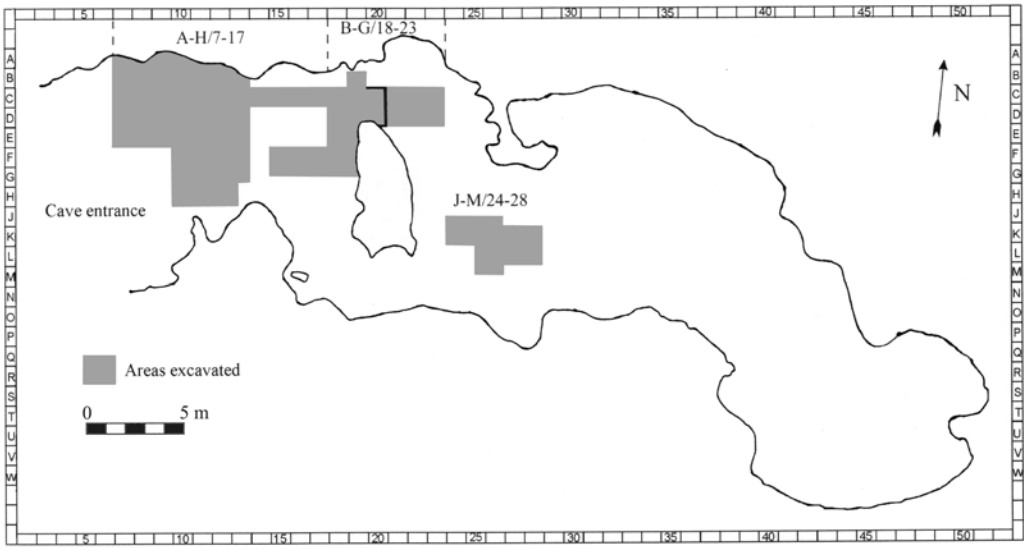

Figure 2 Raqefet Cave floor plan showing excavated areas. The solid black line in excavated area B-G/18-23 indicates the location of the section presented in Figure 3.

abundant in 2 dark bands a few cm in width. The sample dated derives from scattered charcoal locations in the reddish part of layer III.

Comment: This date is associated with Levantine Aurignacian artifacts (Lengyel 2003, 2005; Lengyel et al. 2005). This radiocarbon date closely resembles the oldest AMS date from Hayonim Cave (Galilee, Israel) layer D, Levantine Aurignacian, 29,980 ± 720 (OxA-2805), obtained on charred bone (Bar-Yosef 1991; Housley 1994). All other Levantine Aurignacian AMS dates on charcoal are older: Ksar 'Aqil layers 10i, 11bm, and 12m, Lebanon, dated to ~31–32 kyr BP (Mellars and Tixier 1989); Kebara Cave units I-II, Mount Carmel, Israel, dated to ~32–36 kyr BP (Bar-Yosef et al. 1996); Umm el-Tlel layer II2b, Syria, dated to 32,000 ± 580 (Gif A-93212) (Ploux and Soriano 2003). The date also falls within the range of the Early Ahmarian AMS dates on charcoal from Qafzeh Cave layer 11, Galilee, Israel, dated to ~29–32 kyr BP (Bar-Yosef and Belfer-Cohen 2004).

Layer IV

RTT-4940 **30,610 ± 400**
Raqefet, layer IV, level 1, squares C-D/20 $\delta^{13}C = -24.8‰$

RTT-4942 **31,340 ± 480**
Raqefet, layer IV, level 2, square C/20 $\delta^{13}C = -24.3‰$

RTT-4944 **31,800 ± 470**
Raqefet, layer IV, level 2, squares C-D/20 $\delta^{13}C = -24.3‰$

RTT-4941 **32,100 ± 450**
Raqefet, layer IV, level 3, square E/19 $\delta^{13}C = -24.5‰$

RTT-4939 **31,070 ± 430**
Raqefet, layer IV, level 4, square C/20 east $\delta^{13}C = -24.5‰$

RTT-4938 **32,560 ± 520**
Raqefet, layer IV, level 4, square E/19 $\delta^{13}C = -25.3‰$

RTT-4943 **31,920 ± 480**
Raqefet, layer IV, level 5, square C/20 west $\delta^{13}C = -25.2‰$

RTT-4937 **33,040 ± 550**
Raqefet, layer IV, level 6, square D/20 west $\delta^{13}C = -24.6‰$

These dates provide a time frame in ^{14}C yr for layer IV (Figure 3). Layer IV is a 20–40-cm-thick, light-grayish, soft, laminated deposit with gley features and scattered charcoal and discontinuous dark charcoal strips ~1 cm thick at their lower boundary. In situ anthropogenic structures, such as hearths, are distorted throughout the entire layer.

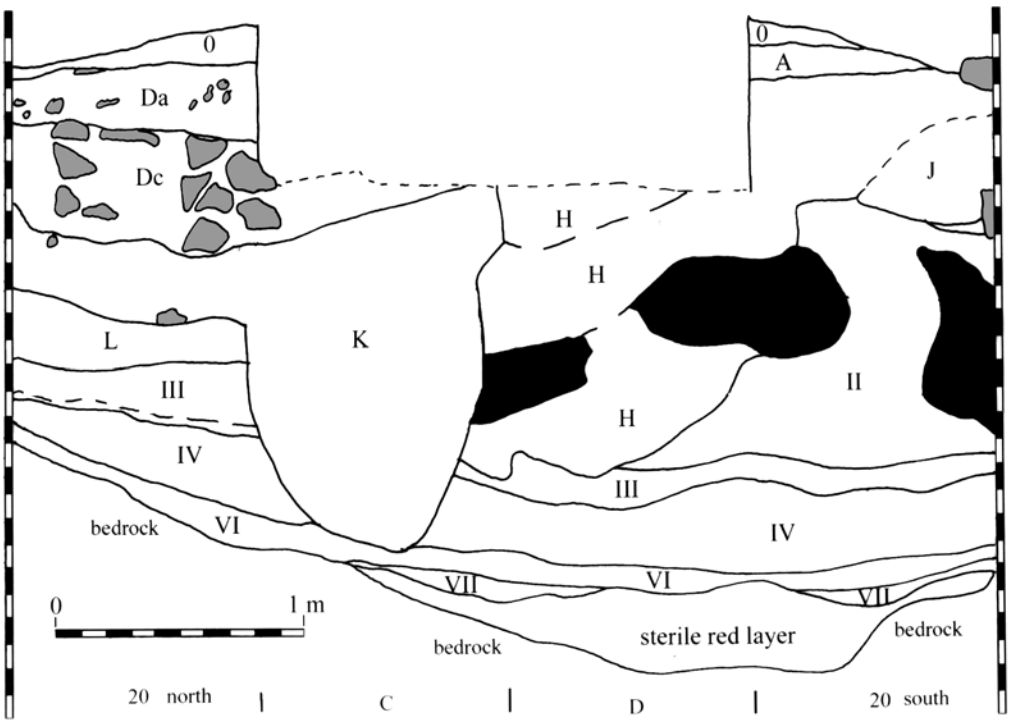

Figure 3 Stratigraphy of squares C-D/20. Grey shading marks stones and black shading marks animal burrows. Capital letters indicate pits and Roman numerals indicate layers.

This series of dates starts at 180 cm below the surface and goes down to 220 cm. The dates have been obtained from 6 successive levels of 5–10 cm marked by laminations. The samples labeled C-D/20 derive from both squares C/20 and D/20. Thus, the dated samples may have derived from either square C/20 or D/20. A single sample from layer IV level 3 from squares C-D/20 resulted in no date (RTT-4946).

All the dates obtained for layer IV are all very close and most likely represent the same event. Although there is a great agreement between the stratigraphy and the sequence of ^{14}C dates, 2 dates from the lower levels—31,070 ± 430 (RTT-4939) from level 4 and 31,920 ± 480 (RTT-4943) from level 5—are slightly younger than expected. This might be due to downward movement of charcoal

pieces from the upper levels. Also, some sample contamination, especially in square C/20, from the post-Natufian pit K cutting through layers III and IV in square C/20 (Figure 3) cannot be excluded.

Comment: Layer IV levels 1–2 in square D/20 yielded Levantine Aurignacian artifacts. Since one level 1 date (30,610 ± 400, RTT-4940) and one level 2 date (31,800 ± 470, RTT-4944) are associated with both squares C/20 and D/20, there is no apparent link between dates and Aurignacian lithics in layer IV. Dates from level 2 in square C/20 and from levels 3–6 in all squares are associated with a lithic industry characterized by blade and bladelet production and general Upper Paleolithic tool types, such as end-scrapers, retouched blades, and burins. In the absence of diagnostic tool types, this lithic industry is provisionally denominated as "indeterminate early Upper Paleolithic" (Lengyel 2005; Lengyel et al. 2005).

Most ^{14}C yr AMS results on charcoal samples similar those of Raqefet layer IV in the Levant were obtained from Levantine Aurignacian sites such as Kebara Cave units I-II, Mount Carmel, Israel, dated to ~32–36 kyr BP (Bar-Yosef et al. 1996); Umm el-Tlel layer II2b, Syria, dated to 32,000 ± 580 (Gif A-93212) (Ploux and Soriano 2003); and Ksar 'Aqil layers 10i, 11bm and 12m, Lebanon, dated to ~31–32 kyr BP (Mellars and Tixier 1989). Other similar AMS dates are known from the Early Ahmarian site of Üçaizli Cave layer B, Turkey, dated to 32,670 ± 760 (AA-38201) on shell aragonite (Kuhn et al. 2003) and of Qafzeh Cave layer 11, Galilee, Israel, dated to 31,520 ± 490 (GifA-97338) on charcoal (Bar-Yosef and Belfer-Cohen 2004).

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