TL Dates for the Neanderthal Site of the Amud Cave, Israel

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Age-estimates ranging from 50 to 70 ky were obtained for the Mousterian deposits of Amud Cave in Israel from thermoluminescence measurements performed on 19 burnt flints. The late dates obtained for the stratigraphic layers bearing hominin remains confirm the evidence for the late presence of Neanderthals in the Levant. The dates enable a more effective comparison of the lithic assemblages from Amud Cave with those of other contemporaneous sites and underline the variability within Mousterian lithic industries at the end of the Middle Palaeolithic in the Levant.

Keywords: THERMOLUMINESCENCE, DATING, AMUD, NEANDERTHAL, MOUSTERIAN.

Introduction

Amud Cave, first excavated in the 1960s (Suzuki & Takai, 1970), is one of the few Middle Palaeolithic sites in the Levant from which diagnostic human skeletal remains have been recovered, in addition to rich lithic and faunal assemblages. Initial age-estimates of the site, based on the alleged Middle–Upper Palaeolithic transitional characteristics of the lithic assemblages (Watanabe, 1965, 1970), placed it c. 30 ky ago (Suzuki, 1970a: 94). Similarly, the skeleton Amud I was assigned a transitional position between Neanderthals and modern humans (Suzuki, 1970b), due to its “advanced” anatomy in relation to European Neanderthals and the transitional context in which it was found. Such age-estimates were proven inaccurate when recent analyses challenged the interpretation of both the lithic and skeletal material. The Amud lithic assemblages were viewed as either an early “Tabun D phase” (Jelinek, 1982), or a late “Tabun B phase” industry (Meignen & Bar-Yosef, 1989; Ohnuma, 1992). Following Copeland’s (1975) suggestion that the technological stages seen in the Tabun sequence be used as the chrono-technological model for the Levantine Mousterian, these determinations imply different chronologies for Amud I, who has...
been acknowledged as a full Neanderthal (e.g., Trinkaus, 1983; Day, 1986; Tillier et al., 1988; Lavi, 1994).

The recent excavations at the site, conducted in 1991–1994 (Hovers, Rak & Kimbel, 1991), confirmed the Middle Palaeolithic affinities of the lithic assemblages (Goder, 1997; Hovers, 1998). Likewise, hominin remains recovered in the course of the new excavations exhibit several derived Neanderthal traits (Hovers et al., 1995; Rak, Kimbel & Hovel, 1994, 1996). These new data suggest that accurate dating of the cultural and skeletal remains from the site is essential for evaluating models explaining population dynamics during the Levantine Middle Palaeolithic. Radiometric dating of the various stratigraphic units of the site was therefore one of the major goals of renewed field work.

In the course of four field seasons we concentrated on obtaining appropriate materials for absolute dating by several methods such as thermoluminescence (TL) and electron spin resonance (Schwarz & Rink, 1998). Here we report the results of the TL dating.

The Site

Amud Cave is located on the margins of the Dead Sea Rift, about 5 km north-west of the Sea of Galilee. Perched in a rocky cliff face some 30 m above the bed of Wadi Amud, at an elevation of 110 m below mean sea level, the cave consists of a large (20 × 26 m) terrace, which is a remnant of a once-closed chamber (see below), and a smaller (10 × 5 m) inner chamber. Several niches which occur in the western wall of the cave, their openings situated 2–7 m above the chambers’ fill, are devoid of anthropogenic deposits. The large terrace is divided into two roughly equal-sized depressions in the bedrock, separated by a rocky ridge projecting from the cave’s western wall.

The original excavation revealed a two-unit stratigraphic sequence. The upper unit A consists of pottery sherds and flint implements in a matrix of redeposited soils and clays (A1), and a few historical pits (A2), sometimes walled with river cobbles, which disturbed the underlying Unit B. The latter encompasses four layers, three of which (B1, B2 and B4) are comprised of alternating bands of “calcareous concretions” and “black soils” and contain lithic artefacts and faunal remains. Layer B3 is archaeologically sterile and is composed of limestone gravels (Chinzei, 1970).

During the 1991–1994 seasons the excavation extended north and south of the original trench (Figure 1). Because the excavation of this trench had severed the physical continuity among areas, the stratigraphic framework was devised separately for each of the three excavation areas. Layer B3, which could be traced continuously throughout the whole site, served as a stratigraphic marker bed and enabled the correlation of the stratigraphic units among areas. Our work confirmed the broad stratigraphic sequence described by the first excavators, while in some areas it allowed us to make finer distinctions within each layer. In Area A we recognized the existence of horizons 6–7 in layer B1, and of horizons 8–10 in layer B2, based on alterations in the frequencies of fine- and coarse-grained deposits, as well as of organic material contents. The individual layers differed in thickness from one square to another. Sub-divisions in the other areas are as yet tentative.

The “calcareous concretions”, which occur in all areas and in all the archaeological deposits, were identified by micromorphological and sedimentological work as horizons of cemented ashes in pristine mineralogical condition (Y. Goren & P. Goldberg, pers. comm.), whereas the “black soils” are unceremented burnt silts, showing no indication of pedological processes. It is these ashes that have yielded a considerable number of burnt flints, which were dated by TL.

Depositional history of the cave

The total depth of the Middle Palaeolithic deposits at Amud reaches some 4 m, but none of the preserved profiles exhibits the complete sequence (Chinzei, 1970: figure IV–13). This relatively short accumulation reflects several major events.

(1) The first episode of settlement in the Cave is represented by extensive deposition of anthropogenic ashy sediments (layer B4), originally associated with hearths. The thickness of layer B4 varies from sector to sector, remaining in most instances in the 30–50 cm range, except for square N-015 where it is 80 cm. Intact material is found in Area C, where the ashes retain the original oval or rounded shapes of the hearths, and in Area B as calcareous ash layers which were cemented shortly after they accumulated and thus escaped bioturbation. Gravels are infrequent in this layer. Accumulation of the ashes at the time of B4 occurred in a closed cave, as indicated by the practical absence of non-ashy external substances such as silts, clays, and soils.

(2) The deposition of layer B3 represents an occupational hiatus at Amud Cave, although its length cannot be estimated from the stratigraphic record. The angular rubble (up to 15 cm in size) which characterizes this layer was derived from the walls and roof of the cave by dissolution of brecciated bedrock and is sorted by size along the natural slope. Layer B3 thus attains a thickness of up to 15 cm in the western part of Area B and up to 70 cm in Area C. The deposition of this layer denotes the beginning of the collapse of the cave’s roof.

(3) Large blocks which had been detached from the roof and the walls were found incorporated in the silty ashes of layer B2, indicating that the process
of roof collapse continued during the deposition of this layer, while human occupation extended all over the cave. The sediment incorporates larger quantities of angular gravels, sometimes embedded as thin bands (3–7 cm thick) in the silty ash deposit. This particular layer was 1 m deep in

Figure 1. Schematic map of all excavated areas of Amud Cave. The three areas of excavation are designated as A, B, and C. Hominid remains recovered in the 1960s are marked by Roman numerals, those recovered in the recent excavation are marked by Arabic numerals. Size of the circles is relative to the completeness of the skeletons (for details see Hovers et al., 1995). □, old excavation 1961–1964; □ excavated 1991–1993; □ excavated 1993–1994.
Area A, but only about half as thick in Areas B and C.

(4) Deposits of layer B₁ were encountered only in the northern depression of the cave (Area A), where their thickness ranges from 70 to 80 cm. Cementation of the ashes close to the cave's wall was due to dripping water (P. Goldberg, pers. comm.)

(5) The deposition of layer B₁ was followed by a long period of erosional activity, that had removed an unknown volume of the Mousterian sediment. In Area B there is evidence for a channelling event which cut down the accumulated sediments of layer B₂, during either the time of B₁ or post-Middle Palaeolithic times, and concurrently with the final opening of the roof.

(6) A process of sediment deposition occurred during the Middle Bronze Age (2nd millennium BC), when some terracing and ephemeral occupation took place, and then again from c. 5th century BC, as attested by pottery sherds ranging in age from the Persian–Hellenistic to the Early Arab period (9th century AD). This resulted in the accumulation of c. 2 m of historical deposits by both natural agents (i.e., inflow of water and mud from the plateau above the cave, as indicated by the terra-rossa soil, basalt particles and clays) and human activity (namely, introduction of river cobbles and their use in building pits, or terracing activities intended to level out the erosional Mousterian surface).

(7) The last episode of considerable channelling occurred after the 1960s excavation, when a new local erosional base was formed (namely, the bottom of the test trench) and sediments from both the fill of Unit A and the in situ material of Unit B collapsed into the trench.

The lithic assemblages

Several authors have assigned the lithic assemblages of Amud to the “Tabun B phase”. This technological phase is characterized by monotonous and standardized production of Levallois points, obtained by convergent and (normally) recurrent flaking strategy, and thin levallois flakes detached from one-axis or radially-prepared cores (Copeland, 1975). The lithic assemblages derived from the three archaeological layers at Amud exhibit some variability. The assemblage of layer B₁ comprises a high laminar index and a paucity of short and broad-based specimens among the Levallois points, although the unipolar convergent Levallois flaking method is the prevalent one (Goder, 1997). Samples from the older layers, analysed by Ohnuma (1992; Ohnuma & Akazawa, 1988) are characterized by low blade frequencies and high frequencies of centripetal Levallois flaking, although the frequencies of points are similar to those observed in layer B₁. Hence, none of the three samples can be argued to be a close parallel of any of the Kebara assemblages (Bar-Yosef et al., 1992) or of Tabun B as described by Copeland (1975), although its highest resemblance is with industries assigned to this phase of the Levantine Mousterian.

Hominid remains

Of the remains of 18 individuals recovered at the Amud Cave, 15 were derived from unambiguous Middle Palaeolithic contexts, all of them located in the northern area of the excavation (Hovers et al., 1995). The stratigraphic distribution of these remains encompasses layers B₁ and B₂, with only a single specimen derived from layer B₄ (Sakura, 1970). Three individuals bear diagnostic characteristics which define them as Neanderthals. Amud I, the skeleton of an adult male was found at the top of layer B₁, while the partial skeleton of the baby Amud 7 (Rak, Kimbet & Hovers, 1994) was recovered from the top of layer B₂, just under the contact with the base of layer B₁. Amud II, represented by a fragment of the right maxilla, was excavated from layer B₂.

TL Dating

Materials and Methods

The TL method, which has been used successfully to date several Middle Palaeolithic sites of the Near East (Valladas et al., 1987, 1988; Mercier et al., 1993, 1995), has been applied to flints that behave as dosimeters and record the radiation energy received from internal and external sources. Flint that has been heated to a sufficiently high temperature (c. 450°C) will faithfully store all the radiation energy received since the last heating (Valladas, 1992). If the annual radiation dose received by such a flint can be determined, a measurement of the total accumulated dose (palaeodose) will make it possible to estimate how many years have elapsed since a hearth, for example, into which the flint had fallen, was abandoned.

We examined about 50 flints that showed signs of having been heated. Of these only 19 were sufficiently heated to be dated by TL: nine from squares K₃–L₃, six from O₁₄–O₁₅–N₁₅, and four from the central square P₉ (Figure 2). In terms of vertical distribution 14 came from the upper layers B₁–B₂ and five from the lower layer B₄. Each flint was treated according to the procedure described by Valladas (1992).

The palaeodose of each sample was determined by the additive-dose technique with the added doses coming from a Cs-137 gamma-ray source delivering 1.48 Gy/min (Valladas, 1978). The supralinearity correction was measured from a TL curve regenerated after the original powder was reheated for 1.5 h at 350°C. It has been demonstrated (Mercier, Valladas & Valladas, 1992) that the reheating conditions do not
modify to any significant degree the shape of the TL growth curve. The TL emission was measured on an automatic apparatus (Valladas, Mercier & Létuvé, 1994) using a heating rate of 5/s with a Thorn EMI 9635QB photomultiplier equipped with a MTO 380 nm optical filter that selected the blue component of the emission spectrum. Figure 3 shows the TL glow curves (natural TL and natural+artificial TL) of two typical burnt flints (AM26 and AM52) accompanied by the values of the accumulated doses deduced as a function of the temperature (plateau test). The palaeodose was obtained by integrating the 380°C peak from 340°C to 400°C, where the plateau test was satisfied (Aitken, 1985).

The external dose-rate was measured between 1991 and 1995 with the aid of 12 CaSO4:Dy dosimeters, each planted in the sediment profiles for 1 year (Figure 2). Dose-rates recorded within any one sector remained relatively constant but varied from 310 μGy/year near limestone walls (squares K3–L3) to 470 μGy/year in the centre of the cave (squares O14–O15, N15, and P9). The difference is attributable to the relative proportions of more-radioactive clays and less-radioactive limestone fragments. The cited dose-rates include the cosmic components which were measured with a portable multichannel analyser and found to have values of 105 and 140 μGy/year near the limestone wall and in the centre of the cave, respectively. Analyses of sediment samples with a high-purity Ge detector in the laboratory showed no evidence of disequilibrium in the U and Th series. Thus, it appears that the U and Th contents of the Amud sediments did not undergo any significant changes during the time of flint burial. Moreover, only small amounts of secondary minerals have been detected by FTIR spectroscopic measurements (S. Weiner, pers. comm.) indicating a negligible geochemical evolution.

The internal dose-rate of each flint was computed from its U-238, Th-232, and K-40 contents measured by neutron activation analysis at the Pierre Sue Laboratory, Saclay (Joron, 1974) and from its alphasensitivity (Valladas & Valladas, 1982). The latter was determined by comparing the TL induced in each flint by the alpha-rays from a Pu-238 source (flux: 2.46 × 106 alpha/cm²/s) with the TL induced by beta-rays from a Sr/Y-90 source (dose-rate: 9.2 Gy/min), after the specimen had been heated for 1.5 h at 350°C. Depending on the characteristics of each flint (radioisotopic content and alpha sensitivity), the internal dose-rates ranged from 105 ± 10 to 1060 ± 90 μGy/year, and consequently could account for as little as 25% to as much as 71% of the total annual dose.

Results
All the age-estimates and the data from which they were deduced are presented in Table 1.

The 14 specimens from layers B₁ and B₂ yielded ages ranging from 44 to 70 ky, but 70% of the flints in question fell into the 50–60 ky age bracket. The five specimens from the lower level B₄ yielded age estimates ranging from 55 to 76 ky, but for four of the five flints the range could be narrowed down to 65–76 ky. While on the whole the age-estimates increase with depth, the spread of values within any one layer is quite appreciable, particularly in B₁/6 and B₄, where it exceeds the statistical uncertainty associated with the computed age of any of the dated flints (10–12% on the average). Such a spread is never observed when TL dating is done on flints buried in a homogeneous sediment. A prominent factor influencing the dispersed results is probably attributable to the environmental heterogeneity produced by the mixture of fine-grained silts and limestone gravels of a wide size range (cf.
Schwarcz, 1994). The latter are often randomly distributed throughout the sediments. Such a heterogeneous mix of silt and limestone can produce significant variations in the relative gamma-radiation doses received by the flints. This anisotropy may have escaped detection since the dosimeters were not placed at the exact provenience of the burnt flints, but at a distance of 0.3–1 m from the find spot. The dosimetry was conducted after the excavations with the dosimeters planted in unexcavated sections adjacent to those which yielded the dated flints.

However, the sediment heterogeneity in itself cannot explain some of the outlying age-estimates. Other factors to be considered are the dynamic depositional processes at the site, which may have caused changes in the environment of the heated flints after their initial

Figure 3. (a) TL glow curves of two typical burnt flints (AM26 and AM52): natural TL and natural plus artificial TL induced, respectively, by the added doses of 29, 58 and 87 Gy (AM26) and 44, 87 and 131 Gy (AM 52). (b) Plateau test plots computed from the linear growth of the TL signal as a function of applied dose. (c) TL growth curves obtained, respectively, at the first and second heatings in the TL oven.
Table 1. Thermoluminescence age-estimates and radioactivity data for the flints from Amud Cave. Following Atkén’s recommendations (Atkén, 1985) the statistical and systematic errors were calculated separately for each flint. Each of the tabulated over all errors represents the mean square average of the two errors of each flint date were dealt with separately. The statistical and systematic errors of each flint date were dealt with separately. The statistical and systematic errors calculated separately for each flint. Each of the tabulated over all errors represents the mean square average of the two

<table>
<thead>
<tr>
<th>Flint no.</th>
<th>U* (ppm)</th>
<th>Th* (ppm)</th>
<th>K* (%)</th>
<th>S-alpha† (µGy/1n/cm²)</th>
<th>Doses (µGy/year)</th>
<th>Palaeodose (Gy)</th>
<th>Age (ky)</th>
<th>Square</th>
<th>Layer with (Z)</th>
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<td>0·025</td>
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<td>310 ± 30</td>
<td>790 ± 80</td>
<td>38·7 ± 2·2</td>
<td>K3a</td>
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<td>26</td>
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<td>0·034</td>
<td>0·038</td>
<td>16·14</td>
<td>233 ± 20</td>
<td>310 ± 30</td>
<td>543 ± 70</td>
<td>32·5 ± 1·7</td>
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<td>0·037</td>
<td>0·049</td>
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<td>334 ± 20</td>
<td>310 ± 30</td>
<td>644 ± 70</td>
<td>33·6 ± 1·4</td>
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<td>0·020</td>
<td>0·032</td>
<td>16·61</td>
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<td>310 ± 30</td>
<td>670 ± 70</td>
<td>47·3 ± 2·9</td>
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<td>0·082</td>
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<td>440 ± 40</td>
<td>970 ± 80</td>
<td>51·5 ± 3·2</td>
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<td>0·026</td>
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<td>440 ± 40</td>
<td>651 ± 70</td>
<td>49·2 ± 1·5</td>
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<td>14·91</td>
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<td>19·02</td>
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<td>470 ± 40</td>
<td>910 ± 60</td>
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<td>720 ± 60</td>
<td>48·0 ± 1·0</td>
<td>B2 (521–528)</td>
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*The U, Th and K contents were measured by neutron activation analysis and each have an error of ± 10%.
†The S-alpha value is the dose delivered per 1 alpha/cm² (Valladas & Valladas, 1982). The uncertainties associated with the values listed above are in the range 3–8%.
‡The internal dose-rates were computed from U, Th and K using published values of specific dose rates (Liritzis & Kokkoris, 1992).
§The external dose-rate includes a cosmic contribution ranging from 100 to 140 µGy/year.

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samples not included in calculation of weighted mean ages in Table 2.

burial. One of these processes is the post-depositional bioturbation, which was observed in some parts of the cave (most notably in Area A). This process is known to have displaced flints both laterally and vertically (Y. Goren & P. Goldberg, pers. comm.). Hence some of the flints sampled in a specific stratigraphic horizon might not have been originally embedded in it and exhibit deviant TL ages when compared to the majority of samples from this layer.

The history of depositional events in the cave is another factor contributing to deviant TL results. It appears that Area B must be considered less satisfactory for dating compared to other areas of the cave for the following reasons. (1) In some sections of this zone, the historical fill directly overlies the top of the Mousterian. One suspects that layer B2 was much thicker before it was eroded and the historical sediment deposited on top of it. Radiation intensity must have varied in a complex manner for an uncertain length of time, depending on the changing thickness of the overburden. Consequently, the modern external dose-rate might differ somewhat from that of the past. For instance, one of the burnt flints from square O15 (AM64), was found just underneath the contact between the Mousterian B2 layer and the overlying historical sediments of Unit A1. This might explain why this sample yielded a TL age-estimate 25% younger than the sample AM10 recovered in the same square. (2) Moreover, the 1994 excavation in the same area revealed the limits of a large Hellenistic pit (roughly dated to 400–50 years bc). This pit (Figure 2) had cut through the sediments of layer B3, already eroded by channelling, and into the upper part of B4 sediments in the northern half of square O14, less than 30 cm away from flints AM13, AM62 and AM63. The existence of the channel and of the historical pit may have changed to a certain extent the amount of external dose absorbed by the flint in square O14. Consequently, while flints from squares O14 and O15 attest to the antiquity of the archaeological layer, the numerical values of the age-estimates cannot be taken with the same confidence as those of flints from other squares.

In view of the aforementioned problems, we feel that one is justified in excluding the age-estimates of flints from the most disturbed squares (O14 and O15). When this is done, one gets the results shown in Figure 4.

Having assumed that flints from a given layer were contemporaneous we computed the mean age of a layer from the weighted averages of individual flints originating in this layer. The statistical and systematic errors of each flint date were dealt with separately. The mean weighted ages at one sigma level for the upper
layers B₁/6 and B₁/7, B₂ and for the lower layer B₄ are listed in Table 2.

**Discussion**

TL age-estimates for the various stratigraphic layers at Amud Cave suggest an occupation of the cave from 70 to 50 ky BP with a hiatus of several thousand years, possibly, between the time of layer B₄ and that of layers B₂–B₁. This pattern is in agreement with the stratigraphic evidence, where the occupational gap is reflected in the accumulation of the sterile layer B₃. While the TL dates obtained for the archaeological layers of Amud suggest that layer B₁ was deposited under changing climatic conditions (from oxygen isotope stage 4 to oxygen isotope stage 3), this must be considered very tentative, as a detailed climatic reconstruction for the time span 65–59 ky BP in the Levant is not yet available (but cf. Bar-Matthews, Ayalon & Kaufman, in press).

The sedimentological similarities between layers B₁ and B₂ (see Chinzei, 1970; Y. Goren, pers. comm.) are in accordance with their respective TL age-estimates, which indicate a rapid and continuous deposition.

The TL ages obtained for the Amud sequence are similar to those of the Mousterian occupation of Kebara Cave (Valladas et al., 1987; Schwarcz et al., 1989). The ages of layers B₁ and B₂ make the two most diagnostic Neanderthal specimens from the Amud Cave (Amud I and Amud 7), only slightly younger than the Kebara 2 Neanderthal dated to c. 60 ky BP. Although practically contemporaneous, hominin specimens from these two sites exhibit variation in their anatomical traits. The new dates for Amud support the conclusion, derived from anatomical analyses (Lavi, 1994; Hovers et al., 1995), that the morphological diversity seen among Neanderthals in the Levant should be attributed to normal intra-species variation rather than to temporal change, as previously suggested (e.g., Trinkaus, 1983).

The Amud dates confirm the presence of Neanderthals in the region towards the end of the Middle Palaeolithic period. However, these data, by themselves, can not tell us whether this population arrived in the Near East during isotope stages 4 (Bar-Yosef, 1988, 1994), 5 (Vandermeersch, 1982) or even earlier. Consequently, the duration of coexistence of Neanderthals and Modern Humans remains equivocal, not the least so because of the ambiguous stratigraphic provenance of the Tabun I Neanderthal skeleton in either layer C or B (Garrod & Bate, 1937: 64), and hence its uncertain age (Mercier et al., 1995).

An intriguing implication of the TL chronology for Amud concerns the character of the lithic assemblages at the site and their relation to other contemporaneous sites. As discussed above, although broadly assigned to the “Tabun B phase” the three lithic assemblages of Amud differ slightly from each other as well as from the assemblages known from the type locality and from Kebara. While units XII–XI in Kebara are slightly more laminar than the overlying units (Meignen & Bar-Yosef, 1992) the laminar index is not as high as at Amud B₁, whereas in none of the Kebara units is there as high an emphasis on centripetal Levallois flaking as reported by Ohnuma (1992) for Amud B₂ and B₄. Another contemporaneous site, Quneitra (Ziaei et al., 1990), contains an altogether different assemblage from both typological and technological points of view (Goren-Inbar, 1990). In Tor Faraj, dated to the same time span (Henry & Miller, 1992; Mercier & Valladas, in press), the end products of the reduction sequence are similar to those from Amud, but they appear to have been obtained from somewhat different reduction sequences.

The comparisons among sites dated to the latest phase of the Mousterian in the Levant suggests a high degree of technological variability during this time (Hovers, 1998). Although there are overall similarities between the Mousterian assemblages produced at 70–50 ky BP when compared to earlier ones, reduction strategies are neither homogeneous nor rigid in any one assemblage and reflect a high degree of technological flexibility (Meignen & Bar-Yosef, 1992; Meignen, 1995; Goren-Inbar & Belfer-Cohen, 1998; Hovers, 1998).

**Table 2. Mean weighted dates of the stratigraphic layers at Amud Cave**

<table>
<thead>
<tr>
<th>Layers</th>
<th>Age-estimate (ky)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B₁/6–B₁/7</td>
<td>57.6 ± 3.7</td>
</tr>
<tr>
<td>B₂</td>
<td>56.5 ± 3.5</td>
</tr>
<tr>
<td>B₄</td>
<td>68.5 ± 3.4</td>
</tr>
</tbody>
</table>

Figure 4. Age-estimates of individual flints plotted as a function of their recovery depth.
Conclusions

The new TL dates from Amud Cave agree with the view that Neanderthals were present in the Levant at a late stage of the Middle Palaeolithic. The late age-estimates for the Amud Neanderthals raise again the (as yet) untestable questions about the place of the Levantine Neanderthals in the process of the Middle–Upper Palaeolithic transition in this region, and the mechanisms of their demise in this part of the world.

A comparison of the Amud lithic assemblages with those from radiometrically dated contemporaneous sites reveals that Late Mousterian assemblages are highly variable from a technological point of view, and that their assignation to a well-defined technological stage of the Levantine Mousterian is possible in only a generalized, broad manner. The existence of such flexibility in the very last stages of the Middle Palaeolithic period begs the question as to its role in adopting new lithic reduction strategies and in bringing about Upper Palaeolithic traditions (Hovers, 1998) at c. 45 ky ago at Boker Tachtit (Bar-Yosef et al., 1996), not long after the site of Amud was occupied for the last time.

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