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ALEXANDER YEVTUSHENKO
VICTOR CHABAI

KARABAI I, THE PALAEOLITHIC SITE IN EASTERN CRIMEA

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А. И. ЕВТУШЕНКО
В. П. ЧАБАЙ

КАРАБАЙ I, ПАЛЕОЛИТИЧЕСКАЯ СТОЯНКА В ВОСТОЧНОМ КРЫМУ

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Коллективная монография посвящена комплексному анализу материалов палеолитической стоянки Карабай I, Крым, Украина. Публикуются новые археологические коллекции, а также данные по палеогеографии и хронологии позднего плейстоцена. Издание рассчитано на специалистов: археологов, историков и палеогеографов.

This monograph devoted to the publication of the materials from Palaeolithic site of Karabai I, Crimea, Ukraine. Artefacts, chronological and paleogeographical data has been analysed. The monograph is count on specialists in archaeology, history and paleogeography.

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Александр Иванович Евтушенко
09.06.1959 – 10.02.2009

AVANT PROPOS

Huit années (1999-2006) de complexes travaux interdisciplinaires menés par une expédition paléolithique internationale en Crimée (Crimean International Paleolithic Expedition) ont été clôturées par les fouilles du site de Karabaï I. Ces recherches furent conduites dans le cadre du projet "*Funktionale Variabilität im späten Mittelpaläolithikum auf der Halbinsel Krim, Ukraine*" (RI 936/3-3, RI 936/3-4), financé par *Deutsche Forschungsgemeinschaft*. En 2001, dans le cadre de prospections systématiques dans le ravin de Karabaï Kuba, Alexander Ivanovitch Yevtushenko a découvert le nouveau site paléolithique de Karabaï I (Fig. A). Entre 2004 et 2006, A. I. Yevtushenko a dirigé la fouille de ce site. Ce chercheur n'a pas eu temps de terminer l'étude des matériaux obtenus: il est décédé le 10 février 2009. Sacha restera dans la mémoire de tous pour sa grande compétence scientifique et l'amitié dont il nous a toujours entourés.

La forme et la structure de ce volume furent planifiées par A. I. Yevtushenko et par V. P. Chabai, pendant les fouilles mêmes du site de Karabaï I. Le format choisi a d'abord été déterminé par l'intention de faire de ce volume le premier d'une série consacrée aux études menées dans le ravin de Karabaï Kuba. En 2005, A. I. Yevtushenko a découvert un autre site paléolithique – une grotte enfouie, Karabaï II, située à proximité de Karabaï I. La probabilité de découvrir de nouveaux sites paléolithiques y est relativement élevée et la nécessité de poursuivre des études scientifiques spécialisées sur les profils existants ne fait aucun doute.

La présence d'un complexe loess-sol relativement complet de couches du Pléistocène récent sur les pentes du ravin de Karabaï Kuba (Chapitre 1, A.I. Yevtushenko, V.P. Chabai), dont celles contemporaines avec l'accumulation des matériaux du Paléolithique supérieur (Chapitre 3, A.I. Yevtushenko, D.Yu. Nuzhnyi), ouvre de nouvelles perspectives dans l'étude du Paléolithique supérieur de Crimée. La stratigraphie culturelle du Paléolithique moyen du site de Karabaï I est représentée par les techno-complexes déjà bien connus sur le territoire de la péninsule: le Levalloiso-Moustérien (Chapitre 4, A.I. Yevtushenko, O.V. Ignatenko) et le Micoquien (Chapitres 5, 6, 7, A.I. Yevtushenko, V.P. Chabai). Nous ne pouvons pas exclure que les matériaux des couches inférieures peuvent contenir des industries encore inconnues dans le Paléolithique moyen de Crimée. La fonctionnalité des habitations paléolithiques du site du Karabaï I est directement liée à son emplacement à proximité des sources d'eau douce et de matière première. Malheureusement, l'absence de restes fauniques ne permet ni une reconstitution complète de type fonctionnel du site de Karabaï I ni une analyse de sa place dans le système des sites du Paléolithique moyen des contreforts des montagnes de Crimée. Malgré l'application de nouvelles méthodes de datations absolues pour les matériaux du Pléistocène de Crimée (Chapitre 2, Ch.I. Burbidge *et al.*), nous pouvons difficilement considérer le problème de la détermination de l'âge des complexes du Paléolithique moyen du site comme étant définitivement résolus. L'étude bio-stratigraphique joue un rôle déterminant dans le processus de datation des couches. Inachevée à ce jour, elle constitue une part prenante de l'étape suivante des études. En résumé, la première étape des études dans le ravin de Karabaï Kuba a mis au jour de nouvelles et parfois surprenantes perspectives pour les futures études multidisciplinaires du Paléolithique en Crimée.

Les dates OSL et TL ont été obtenues par R. Housley, D. Sanderson, K. Burbidge et D. Richter dans le cadre du projet *"Environmental Factors in the Chronology of Human Evolution and Dispersal*" financé par *UK's Natural Environment Research Council* (NERC). Les auteurs expriment leur gratitude la plus profonde à tous les amis et collègues qui ont participé aux fouilles et aux études en laboratoires des matériaux du site de Karabaï: I: Ph. Allsworth-Jones, G. Bataille, A.P. Veselsky, Yu. E. Demidenko, Ch. Kempcke-Richter, I. Kretschmer, M. Kurbjuhn, A. Maier, O.V. Mouzitchuk, J. Richter, D.G. Ovtcharov, Th. Uthmeier, N.V. Yatsishin , L.A. Yatsishina, ainsi qu'aux villageois Muhamed Memetov, Akim Memetov, Eric Chunakh, Yusuf Zerali, Aider Chalgasov, qui ont beaucoup aidé durant les fouilles. Nous adressons également nos remerciements à V.I. Usik pour la qualité remarquable des illustrations des artefacts et à Oliver Vogels pour la rédaction des textes anglais. Merci beaucoup à tout le monde!

Valéry Sitlivy
Victor Chabai

ВВЕДЕНИЕ

Раскопками палеолитической стоянки Карабай I завершились восьмилетние (1999-2006) комплексные междисциплинарные полевые исследования международной Крымской палеолитической экспедиции, которые проводились в рамках проекта “*Funktionale Variabilität im späten Mittelpaläolithikum auf der Halbinsel Krim, Ukraine*” (RI 936/3-3, RI 936/3-4), финансируемого фондом *Deutsche Forschungsgemeinschaft*. В 2001 году Александром Ивановичем Евтушенко в балке Карабай Куба, неподалеку от известных заскальненских стоянок, была открыта новая палеолитическая стоянка Карабай I (Рис. А). В 2004-2006 годах А.И. Евтушенко руководил комплексными исследованиями стоянки. Александр Иванович не успел завершить изучение материалов полученных в ходе полевых работ, он умер 10 февраля 2009 года.

Формат и структура данного тома были задуманы А.И. Евтушенко и В.П. Чабаём еще в ходе полевых работ на Карабай I. Выбранный формат обусловлен в первую очередь тем, что данное издание рассматривается как первый том публикаций посвященных исследованиям в балке Карабай Куба. В 2005 году А.И. Евтушенко открыл еще одну палеолитическую стоянку – погребенный грот Карабай II, которая расположена в непосредственной близости от Карабай I. Вероятность открытия новых палеолитических стоянок достаточно велика, а актуальность продолжения естественнонаучных исследований на имеющихся разрезах не вызывает сомнений.

Наличие относительно полной лессово-почвенной пачки позднеплейстоценовых отложений на склонах балки Карабай Куба (Раздел 1, А.И. Евтушенко, В.П. Чабай), в том числе, соответствующих времени аккумуляции верхнепалеолитических материалов (Розділ 3, О.І. Євтушенко, Д.Ю. Нужний), открывает новые перспективы в исследовании позднего палеолита Крыма. Культурная стратиграфия среднего палеолита в Карабае I представлена уже известными на территории нынешнего полуострова леваллуа-мустьерским (Раздел 4, А.И. Евтушенко, О.В. Игнатенко) и микокским технокомплексами (Разделы 5, 6, 7, А.И. Евтушенко, В.П. Чабай). Не исключено, что материалы нижних пачек отложений содержат новые индустриальные явления в среднем палеолите Крыма (Раздел 8, А.И. Евтушенко, В.П. Чабай). Функциональная направленность палеолитических поселений Карабая I во многом предопределена уникальным топографическим расположением стоянки, которая находится в непосредственной близости к источникам воды и практически рядом с выходами кремневого сырья. К сожалению, отсутствие фаунистических остатков не позволяет в полной мере реконструировать функциональный тип поселений Карабая I и проанализировать их место в системе среднепалеолитических поселений предгорий Крыма (Раздел 9, А.И. Евтушенко, В.П. Чабай). Несмотря на применения новых, как для крымских плейстоценовых материалов, методов абсолютного датирования (Раздел 2, К.И. Барбидж и др.), проблему определения возраста среднепалеолитических комплексов стоянки трудно признать окончательно решенной. Значительную роль в определении возраста отложений играют биостратиграфические исследования, которые к настоящему моменту еще не завершены и, вероятно, станут составной частью следующего этапа исследований. В целом, первый этап исследований в балке Карабай Куба открыл новые, подчас неожиданные перспективы для будущих междисциплинарных исследований палеолита Крыма.

OSL и TL даты были получены Р. Хёсли, Д. Сандерсоном, К. Барбиджем, и Д. Рихтером в рамках проекта “*Environmental Factors in the Chronology of Human Evolution and Dispersal*” профинансированного *UK’s Natural Environment Research Council* (NERC). Авторы тома выражают искреннюю признательность всем друзьям и коллегам, принявшим участие в полевых и лабораторных исследованиях материалов Карабая I: Баталье Г., Весельскому А.П., Демиденко Ю.Э., Кемпке-Рихтер К., Крещтмер И., Курбюну М., Майеру А., Музычук О.В., Овчарову Д.Г., Рихтеру Ю., Утмайеру Т., Федорову К.Б., Элсворту-Джонсу Ф., Яцышину Н.В., Яцышиной Л.А., а также местным жителям Мухаммеду Меметову, Акиму Меметову, Эрику Чунаху, Юсуфу Зерали, Айдеру Чалгасову, оказавшим огромную помощь в раскопках стоянки. Отдельная благодарность В.И. Усику за превосходное качество иллюстраций артефактов и Оливеру Фогельсу за редактирование текстов на английском языке. Спасибо всем!

Валерий Ситливый
Виктор Чабай

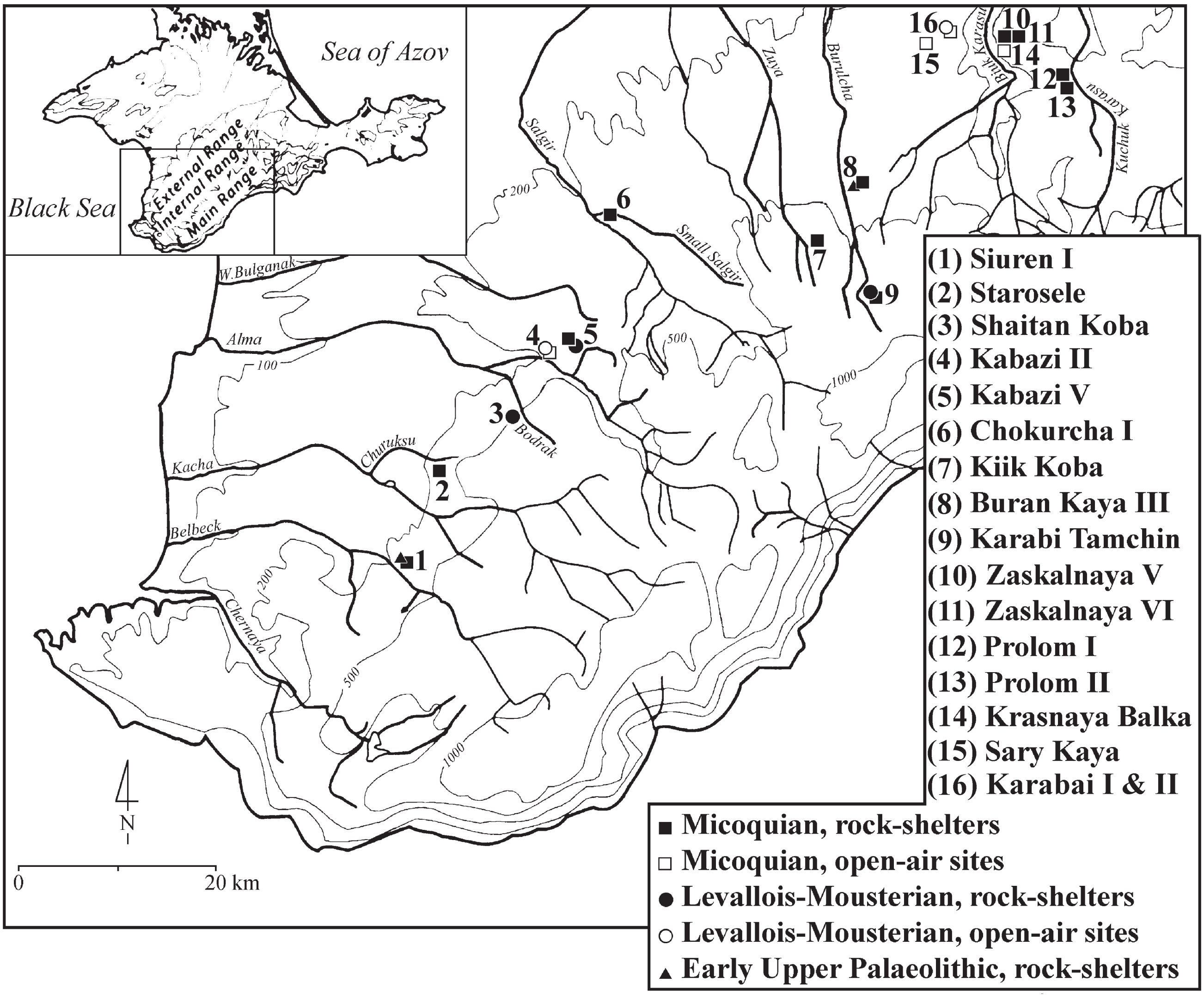

Fig. A. Crimea: map showing the main Middle Palaeolithic and Early Upper Palaeolithic sites
Рис. А. Крым: карта основных среднепалеолитических и ранних верхнепалеолитических памятников

Chapter 2

CHRIS I. BURBIDGE, DANIEL RICHTER,
DAVID C. W. SANDERSON &
RUPERT A. HOUSLEY

LUMINESCENCE ANALYSES (OSL AND TL) FROM KARABAI I

Karabai I was one of a number of Crimean Middle Palaeolithic sites included in the Natural Environment Research Council's EFCHED (Environmental Factors in the Chronology of Human Evolution and Dispersal) initiative (Housley *et al*. 2006). The site was visited in the summer of 2004 and a series of samples was taken for optically-stimulated luminescence (OSL) and thermoluminescence (TL) measurement. Analysis of the samples took place in 2005-2006. This paper reports the findings of these scientific analyses.

INTRODUCTION AND SAMPLING

The archaeological, stratigraphic and environmental contexts of this site have been outlined in chapters to this monograph by other contributors, and will not be reiterated here. Field assessment of the sediments suggested that they may be colluviated loessic in character. Since optical luminescence is most successful when applied to allochthonous sediments, which have undergone sufficient exposure to light during transportation that the luminescence signal is reset, determination whether this was the case at Karabai became a priority.

In 2004 seventeen small OSL profiling samples (in the sense of Burbidge *et al.* 2007) were taken from an exposed partly excavated vertical profile (Table 2-1). The stratigraphy of the sampling profile (section S, square K; Fig. 2-1) revealed a succession of archaeological horizons (I, IIA, II, III/1, III/2, IV/1, IV/2) separated by interleaved sterile layers. Sampling included both the archaeological horizons and the sterile layers, at *c.*10 cm vertical intervals in a column, such that each stratum was sampled at least once. Profiling samples were taken in 2 cm long by 1 cm diameter light-proof tubes, from which the light exposed sediment at each end was removed prior to processing for luminescence measurement. The purpose of the profiling samples was to survey the suitability of the sediments for full quantitative OSL analysis.

Given the many uncertainties that could potentially jeopardize the successful application of OSL in such a sedimentary setting, alternative dating strategies were considered. Within the cultural horizons other materials amenable to scientific dating were observed – including heated stones that were possibly suitable for thermoluminescence if of sufficient mass. Several lithic clasts, which appeared to have been heated, were selected from excavated material. Unfortunately only three potentially-heated flint clasts were present. Despite the poor size of this assemblage the clasts were taken on the understanding they could form a pilot study. Associated field dosimetry readings were made in selected localities in the exposed section in order to better understand the gamma dosimetry of the site.

Field sampling for quantitative OSL dating was also undertaken on the understanding that the samples were only to be dated if the results of the profiling indicated that conditions were right. Quantitative OSL sampling entailed the removal of larger steel tube samples (2 cm diameter, 20 cm length), coupled with a set of environmental dosimetry measurements from the sampling holes. The three large OSL samples came from a vertical section to the left of the profiling positions and sampled three archaeological horizons - cultural layers II, III/2 and IV/2 (Table 2-1).

Dating was undertaken in two separate geochronology laboratories: the OSL profiling and laboratory gamma dosimetry measurements were made in the SUERC at East Kilbride, Scotland; the TL analysis of the heated stones was undertaken in the Department of Human Evolution, Max-Planck-Institute in Leipzig.

LUMINESCENCE PROFILING

Methodology

A luminescence age is calculated by dividing the radiation dose absorbed by a sample during its burial, by the average dose rate to it during that time, so absorbed dose is a proxy for age. The absorbed dose is actually measured as the laboratory administered dose that produces a signal equivalent to the natural signal, hence the term equivalent dose (D_e). The term "luminescence sensitivity" is here used to mean the luminescence signal (I) measured per unit absorbed dose (D). This is a relative measure, since besides being a product of equipment, set-up, and type of measurement I varies as a function of D. The relationship can generally be approximated by a saturating exponential function, which is produced as the traps storing the latent luminescence signal become filled as the sample is exposed to more radiation. In the present study, infrared light (at a mean wavelength of 880 nm), blue light (at 470 nm), and heat were each used to stimulate luminescence signals (I) from the samples. Following convention, these signals are termed infrared stimulated luminescence (IRSL), optically stimulated luminescence (OSL), and thermoluminescence (TL) respectively.

Luminescence profiling aims to rapidly produce a stratigraphically detailed survey of a site (Burbidge *et al.* 2007). The objectives are to assess the presence and suitability of

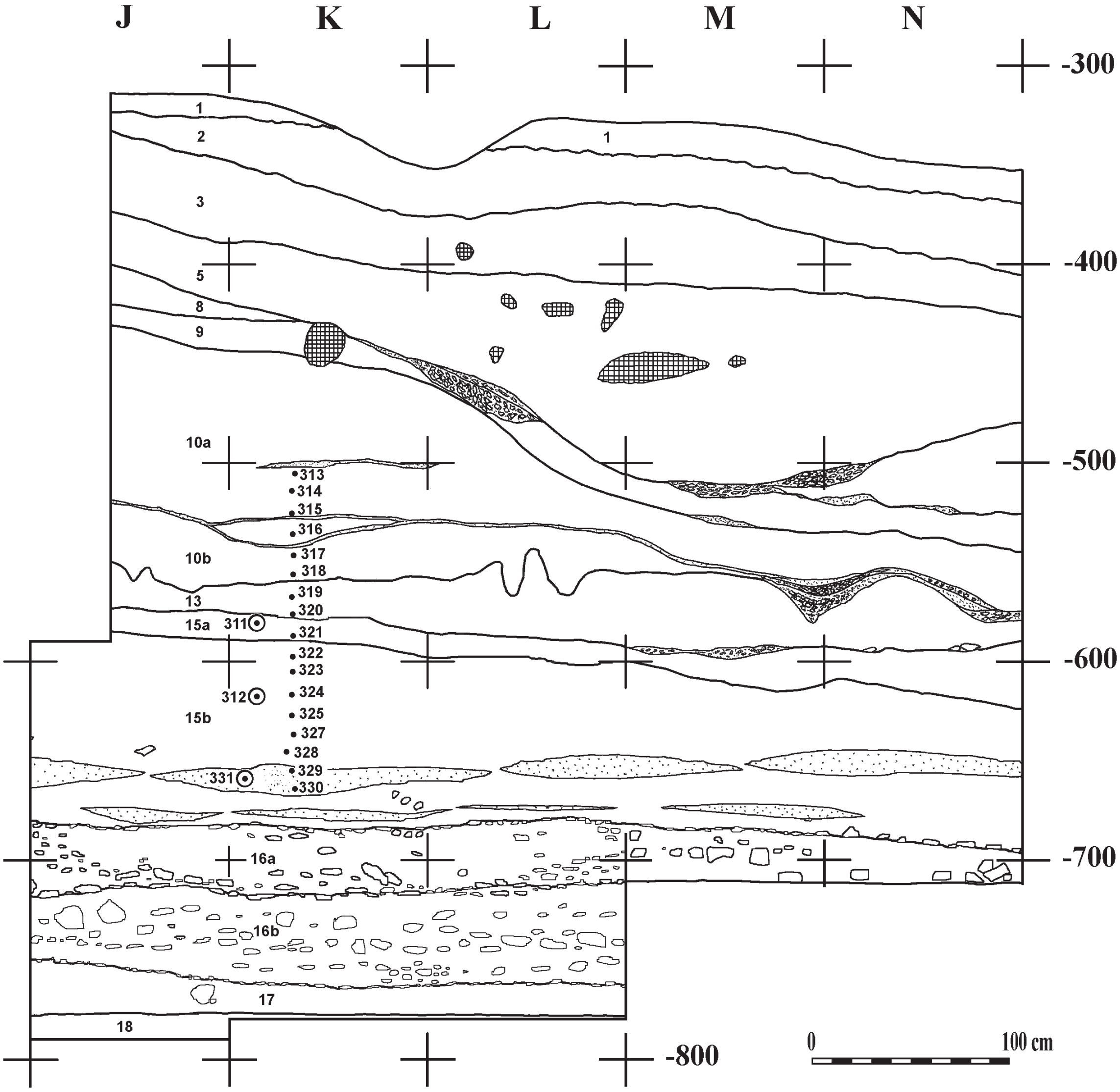

Figure 2-1: Section S, square K at Karabai I in 2004 showing position of OSL and TL samples.

Table 2-1: Luminescence samples from Karabai

Sample No.		Lab. No.	Arch. levels	Section, Square	Sample Type	Depth (cm)
EFD4L	311	SUTL 1685	2	section S, sq. K	OSL tube	-580
EFD4L	312	SUTL 1686	3-2	section S, sq. K	OSL tube	-621
EFD4L	313	SUTL 1683 a	1A	section S, sq. K	Profiling Tube	-505
EFD4L	314	SUTL 1683 b		section S, sq. K	Profiling Tube	-516
EFD4L	315	SUTL 1683 c	1	section S, sq. K	Profiling Tube	-526
EFD4L	316	SUTL 1683 d		section S, sq. K	Profiling Tube	-537
EFD4L	317	SUTL 1683 e	2A	section S, sq. K	Profiling Tube	-548
EFD4L	318	SUTL 1683 f	2A	section S, sq. K	Profiling Tube	-558
EFD4L	319	SUTL 1683 g		section S, sq. K	Profiling Tube	-569
EFD4L	320	SUTL 1683 h	2	section S, sq. K	Profiling Tube	-580
EFD4L	321	SUTL 1683 i	2	section S, sq. K	Profiling Tube	-589
EFD4L	322	SUTL 1683 j	3-1	section S, sq. K	Profiling Tube	-597
EFD4L	323	SUTL 1683 k		section S, sq. K	Profiling Tube	-606
EFD4L	324	SUTL 1683 l		section S, sq. K	Profiling Tube	-619
EFD4L	325	SUTL 1683 m	3-2	section S, sq. K	Profiling Tube	-630
EFD4L	326			modern ground surface	bag	
EFD4L	327	SUTL 1683 n		section S, sq. K	Profiling Tube	-637
EFD4L	328	SUTL 1683 o		section S, sq. K	Profiling Tube	-647
EFD4L	329	SUTL 1683 p	4-2	section S, sq. K	Profiling Tube	-656
EFD4L	330	SUTL 1683 q		section S, sq. K	Profiling Tube	-666
EFD4L	331	SUTL 1687	4-2 – 5	section S, sq. K	OSL tube	-659
EFD4L	332	SUTL 1689	2	sq. 4H	TL burnt flint	-623
EFD4L	333	SUTL 1690	2A	sq. 8G	TL burnt flint	-568
EFD4L	334	SUTL 1691	4-2	sq. 7J	TL translucent burnt flint	-667

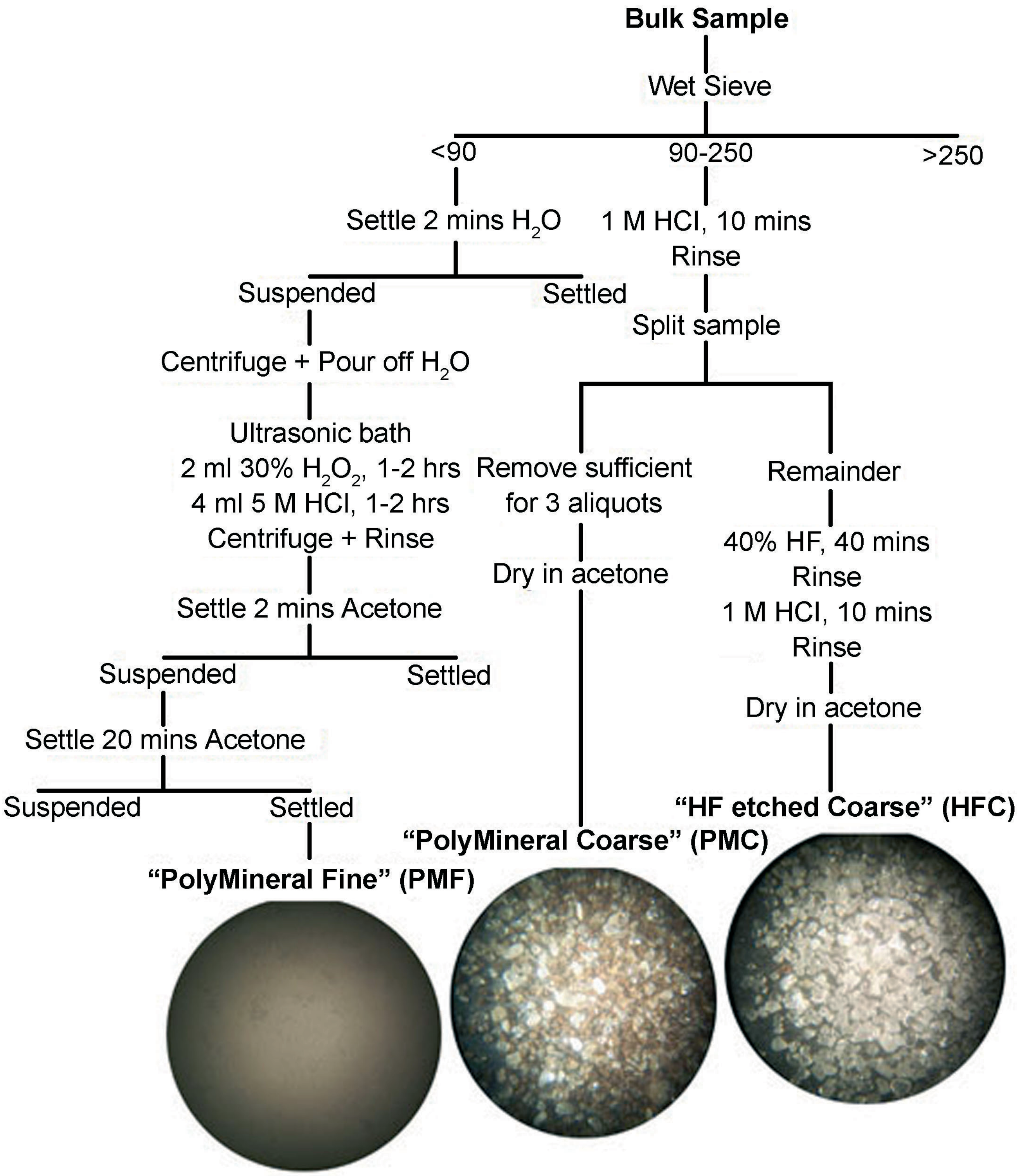

Figure 2-2: Preparation of "polymineral fine", "polymineral coarse" and "hydrofluoric etched coarse" mineral/grain-size fractions from profiling samples.

particular minerals/grain-sizes/signals for full luminescence dating measurements, and to provide a record of variations in luminescence and related characteristics that can be integrated with archaeological and sedimentological interpretations.

Preparation of the profiling samples produced three separate mineral/grain-size fractions that would be analysed for a number of properties:

1. Polymineral sand-sized fraction ("polymineral coarse", PMC)
2. Quartz enriched sand sized fraction ("hydrofluoric-etched coarse", HFC)
3. Polymineral silt-sized fraction ("polymineral fine", PMF).

To produce these fractions preparatory treatments were

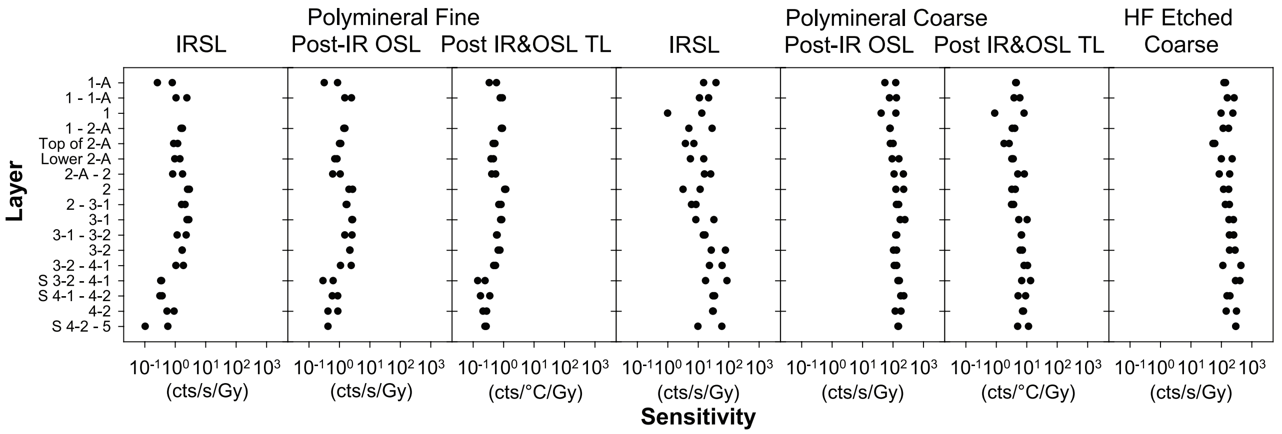

Figure 2-3a: Luminescence profiling results from Karabai I, showing the sensitivity of the samples to luminescence. Samples are plotted in stratigraphic order.

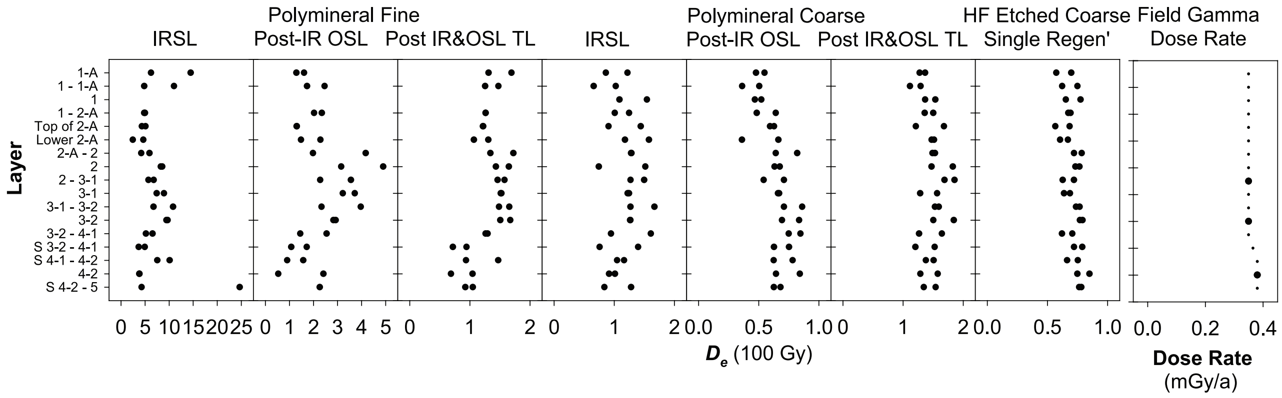

Figure 2-3b: Luminescence profiling results from Karabai I, with field dosimetry results. Samples are plotted in stratigraphic order. Note changes in D_e scale with mineral/grain size fraction. Smaller points in the plot of field gamma dose rate are interpolated values.

applied to approximately 5 g of bulk sample (for details of the procedures see Fig. 2-2). The samples were initially wet sieved, to reduce the chance of contamination by geological grains from limestone clasts. Carbonates were then removed from the 90-250 μm fraction using HCl acid, and after thorough rinsing in water to clean the grains, sufficient of the polymineral coarse material was removed to make up three aliquots. The remaining material was HF etched to produce a quartz-rich fraction. The less than 90 μm fraction was settled in water for 2 minutes and the suspended (less can c.20 μm) fraction collected and centrifuged out for further processing. Approximately 2 ml of this was treated in H_2O_2 and HCl acid to remove organics and carbonates, and the undissolved material settled in acetone to isolate the 4-11 μm fraction, which was itself settled onto steel discs in acetone.

Two aliquots from each fraction were subjected to simple regenerative D_e determinations, using IRSL, post IR OSL, and post IR & OSL TL for the polymineral fractions, and sensitivity corrected OSL for the HF etched fraction. This rapidly produced large matrices of luminescence sensitivity and D_e values from top to base of the section, including paired reproducibility assessment.

Results

The results, plotted in stratigraphic order, are displayed in Fig. 2-3a; 2-3b, together with the field gamma spectrometry which shows change in dose rate down profile. Individual sample determinations are summarised in Tables 2-2a & 2-2b.

The polymineral fine fraction exhibits low sensitivity, which generally decreases with depth. The polymineral coarse fraction shows orders of magnitude higher sensitivity than the fine fractions. The OSL of the HF etched coarse fraction had similar sensitivity to the post IR OSL of the polymineral coarse fraction.

The polymineral fine fraction exhibits large differences in D_e values between IRSL (400-1000 Gy), post IR OSL (100-500 Gy) and post IR & OSL TL (100-200 Gy) data. These high IRSL values may indicate that sample sensitivity change during measurement differentially affects the different signals. Although different in magnitude, the D_e value for each stimulation type shows increase with depth, but are then replaced by lower values in archaeological horizons IV/1 – V, which lie at the level of the present day water table.

D_e values from the polymineral coarse fraction are scat-

Table 2-2a: Equivalent dose estimates for polymineral, polymineral coarse and etched (quartz) fractions from Karabai I, in Grays (Gy)

Sample				**Equivalent Dose**						
				Polymineral Fine			Polymineral Coarse			HFE Coarse
SUTL	Field No EFD4L#	Archaeological Context	Ali	IRSL (Gy)	Post IR OSL (Gy)	Post IR & (Gy)	IRSL (Gy)	Post IR OSL (Gy)	Post IR & (Gy)	OSL (Gy)
1683 a	313	Layer 1A	1	625 ± 94	129 ± 34	131 ± 6	122 ± 3	55 ± 1	137 ± 3	70 ± 2
			2	1447 ± 607	161 ± 100	169 ± 11	86 ± 2	48 ± 1	128 ± 3	57 ± 2
b	314	Layers 1 – 1A	1	1102 ± 136	247 ± 38	148 ± 6	103 ± 3	51 ± 1	129 ± 3	75 ± 2
			2	483 ± 31	173 ± 19	125 ± 4	66 ± 2	36 ± 1	112 ± 2	62 ± 1
c	315	Layer 1	1		not measured		154 ± 21	47 ± 1	154 ± 5	65 ± 2
			2		not measured		109 ± 3	52 ± 2	137 ± 3	78 ± 3
d	316	Layers 1 – 2A	1	500 ± 45	203 ± 35	126 ± 4	125 ± 6	48 ± 1	150 ± 3	69 ± 2
			2	483 ± 40	235 ± 37	127 ± 5	101 ± 2	64 ± 1	136 ± 3	67 ± 2
e	317	Layer top of 2A	1	436 ± 46	131 ± 28	122 ± 6	91 ± 3	59 ± 1	121 ± 3	69 ± 3
			2	511 ± 71	130 ± 29	122 ± 7	144 ± 7	63 ± 1	168 ± 4	57 ± 2
f	318	Layer lower 2A	1	465 ± 58	229 ± 67	131 ± 8	118 ± 5	66 ± 1	152 ± 3	61 ± 2
			2	247 ± 23	148 ± 37	107 ± 6	158 ± 4	36 ± 1	147 ± 3	67 ± 2
g	319	Layers 2A – 2	1	592 ± 86	198 ± 40	172 ± 10	128 ± 3	64 ± 1	149 ± 3	79 ± 2
			2	423 ± 34	417 ± 148	134 ± 7	129 ± 3	82 ± 2	153 ± 3	72 ± 3
h	320	Layer 2	1	827 ± 48	316 ± 30	165 ± 5	74 ± 2	63 ± 1	147 ± 3	73 ± 2
			2	858 ± 55	490 ± 61	143 ± 4	152 ± 9	68 ± 1	183 ± 4	77 ± 2
I	321	Layer 2 – level 3-1	1	572 ± 41	356 ± 52	146 ± 5	127 ± 4	71 ± 1	169 ± 4	72 ± 2
			2	680 ± 59	228 ± 31	158 ± 6	150 ± 6	54 ± 1	186 ± 4	63 ± 2
j	322	Level 3-1	1	894 ± 56	372 ± 38	153 ± 6	122 ± 4	67 ± 1	157 ± 3	64 ± 2
			2	741 ± 43	322 ± 32	151 ± 5	125 ± 3	66 ± 1	128 ± 2	69 ± 2
k	323	Levels 3-1 – 3-2	1	1083 ± 120	397 ± 60	148 ± 7	127 ± 3	71 ± 1	160 ± 3	77 ± 2
			2	676 ± 46	234 ± 24	166 ± 7	167 ± 5	86 ± 2	153 ± 3	74 ± 2
l	324	Level 3-2	1	970 ± 79	293 ± 32	151 ± 6	126 ± 3	69 ± 1	184 ± 4	77 ± 2
			2	946 ± 78	283 ± 32	167 ± 7	127 ± 2	84 ± 2	150 ± 3	79 ± 2
m	325	Levels 3-2 – 4-1	1	655 ± 80	254 ± 50	129 ± 7	95 ± 2	85 ± 2	127 ± 2	71 ± 2
			2	517 ± 39	145 ± 15	126 ± 6	161 ± 3	75 ± 2	165 ± 3	62 ± 1
n	327	Sterile between 3-2 & 4-1	1	368 ± 111	108 ± 35	94 ± 14	76 ± 1	75 ± 1	120 ± 2	72 ± 2
			2	495 ± 159	172 ± 112	72 ± 7	140 ± 4	63 ± 1	153 ± 3	79 ± 2
o	328	Sterile between 4-1 & 4-2	1	1011 ± 292	91 ± 24	94 ± 6	105 ± 2	63 ± 1	151 ± 3	75 ± 2
			2	753 ± 240	158 ± 54	147 ± 18	116 ± 3	78 ± 2	138 ± 3	66 ± 2
p	329	Level 4-2	1	382 ± 80	54 ± 16	69 ± 8	91 ± 2	84 ± 2	129 ± 2	85 ± 2
			2	385 ± 49	241 ± 110	105 ± 9	101 ± 2	64 ± 1	158 ± 3	75 ± 2
q	330	Sterile between 4-2 & 5	1	428 ± 81	-702 ± 980	105 ± 9	128 ± 4	63 ± 1	154 ± 3	78 ± 2
			2	2468 ± 2437	226 ± 103	93 ± 8	84 ± 2	68 ± 1	135 ± 2	76 ± 2

Table 2-2b: Luminescence sensitivities, in photon counts per second or degree Celsius per Gray from polymineral and etched quartz fractions from Karabai I

Sample				**Sensitivity**						
				Polymineral Fine			Polymineral Coarse			HFE Coarse
SUTL	Field No EFD4L#	Archaeological Context	Ali	IRSL (cps/Gy)	Post IR OSL (cps/Gy)	Post IR & (cp°C/Gy)	IRSL (cps/Gy)	Post IR OSL (cps/Gy)	Post IR & (cp°C/Gy)	OSL (cps/Gy)
1683 a	313	Layer 1A	1	0.80 ± 0.12	0.87 ± 0.21	0.58 ± 0.02	15.1 ± 0.4	54 ± 1	4.3 ± 0.1	138 ± 2
			2	0.26 ± 0.11	0.32 ± 0.19	0.34 ± 0.02	38.3 ± 0.8	123 ± 2	4.5 ± 0.1	123 ± 2
b	314	Layers 1 – 1A	1	1.07 ± 0.13	1.50 ± 0.22	0.78 ± 0.03	11.0 ± 0.3	77 ± 2	3.8 ± 0.1	158 ± 3
			2	2.41 ± 0.15	2.49 ± 0.25	0.90 ± 0.03	21.9 ± 0.5	131 ± 2	5.9 ± 0.1	264 ± 5
c	315	Layer 1	1		not measured		1.0 ± 0.1	125 ± 2	0.9 ± 0.0	240 ± 4
			2		not measured		13.1 ± 0.3	41 ± 1	8.2 ± 0.2	98 ± 2
d	316	Layers 1 – 2A	1	1.55 ± 0.14	1.40 ± 0.23	0.92 ± 0.03	4.9 ± 0.2	81 ± 2	3.3 ± 0.1	174 ± 3
			2	1.72 ± 0.14	1.52 ± 0.23	0.85 ± 0.03	28.6 ± 0.6	80 ± 2	4.1 ± 0.1	115 ± 2
e	317	Layer top of 2A	1	1.21 ± 0.13	1.10 ± 0.21	0.52 ± 0.02	7.3 ± 0.2	82 ± 2	2.6 ± 0.1	53 ± 1
			2	0.89 ± 0.12	1.01 ± 0.20	0.45 ± 0.02	3.8 ± 0.2	102 ± 2	1.8 ± 0.0	61 ± 1
f	318	Layer lower 2A	1	0.97 ± 0.12	0.70 ± 0.20	0.39 ± 0.02	5.6 ± 0.2	94 ± 2	3.3 ± 0.1	100 ± 2
			2	1.42 ± 0.13	0.83 ± 0.19	0.46 ± 0.02	15.3 ± 0.4	158 ± 3	3.6 ± 0.1	227 ± 4
g	319	Layers 2A – 2	1	0.83 ± 0.12	1.07 ± 0.20	0.41 ± 0.02	16.0 ± 0.4	109 ± 2	5.1 ± 0.1	188 ± 3
			2	1.73 ± 0.14	0.60 ± 0.21	0.55 ± 0.02	25.9 ± 0.6	221 ± 4	8.4 ± 0.2	85 ± 2
h	320	Layer 2	1	2.92 ± 0.17	2.72 ± 0.25	1.08 ± 0.03	11.6 ± 0.3	226 ± 4	4.2 ± 0.1	119 ± 2
			2	2.55 ± 0.16	2.07 ± 0.25	1.19 ± 0.03	3.2 ± 0.2	126 ± 2	3.2 ± 0.1	175 ± 3
I	321	Layer 2 – level 3-1	1	2.10 ± 0.15	1.67 ± 0.24	0.82 ± 0.03	8.5 ± 0.3	130 ± 2	3.7 ± 0.1	185 ± 3
			2	1.62 ± 0.14	1.76 ± 0.22	0.70 ± 0.03	6.0 ± 0.2	154 ± 3	3.2 ± 0.1	135 ± 2
j	322	Level 3-1	1	2.44 ± 0.15	2.56 ± 0.25	0.80 ± 0.03	8.3 ± 0.3	174 ± 3	5.5 ± 0.1	178 ± 3
			2	2.79 ± 0.16	2.73 ± 0.26	0.87 ± 0.03	32.8 ± 0.7	248 ± 4	10.4 ± 0.2	250 ± 4
k	323	Levels 3-1 – 3-2	1	1.16 ± 0.13	1.51 ± 0.22	0.59 ± 0.02	16.8 ± 0.4	133 ± 3	6.8 ± 0.1	256 ± 4
			2	2.29 ± 0.15	2.59 ± 0.25	0.61 ± 0.03	14.8 ± 0.4	124 ± 2	6.6 ± 0.1	185 ± 3
l	324	Level 3-2	1	1.69 ± 0.14	2.22 ± 0.23	0.76 ± 0.03	26.9 ± 0.6	132 ± 2	7.2 ± 0.1	285 ± 5
			2	1.68 ± 0.14	2.20 ± 0.24	0.66 ± 0.03	78.9 ± 1.5	105 ± 2	6.1 ± 0.1	186 ± 3
m	325	Levels 3-2 – 4-1	1	1.06 ± 0.13	1.08 ± 0.20	0.47 ± 0.02	23.5 ± 0.5	134 ± 3	10.6 ± 0.2	113 ± 2
			2	1.86 ± 0.14	2.44 ± 0.23	0.54 ± 0.02	61.4 ± 1.2	110 ± 2	8.2 ± 0.2	443 ± 8
n	327	Sterile between 3-2 & 4-1	1	0.36 ± 0.11	0.62 ± 0.18	0.14 ± 0.02	88.0 ± 1.6	162 ± 3	13.5 ± 0.2	412 ± 7
			2	0.33 ± 0.11	0.29 ± 0.18	0.25 ± 0.02	17.4 ± 0.4	146 ± 3	6.9 ± 0.1	294 ± 5
o	328	Sterile between 4-1 & 4-2	1	0.37 ± 0.11	0.88 ± 0.19	0.35 ± 0.02	30.4 ± 0.6	228 ± 4	5.2 ± 0.1	154 ± 3
			2	0.31 ± 0.10	0.58 ± 0.19	0.17 ± 0.02	34.8 ± 0.7	181 ± 3	9.2 ± 0.2	192 ± 3
p	329	Level 4-2	1	0.54 ± 0.11	0.89 ± 0.19	0.21 ± 0.02	29.8 ± 0.6	119 ± 2	7.9 ± 0.1	317 ± 5
			2	0.92 ± 0.11	0.42 ± 0.19	0.28 ± 0.02	31.1 ± 0.7	185 ± 3	7.3 ± 0.1	145 ± 3
q	330	Sterile between 4-2 & 5	1	0.57 ± 0.11	-0.13 ± -0.18	0.24 ± 0.02	9.8 ± 0.3	153 ± 3	5.0 ± 0.1	298 ± 5
			2	0.10 ± 0.10	0.42 ± 0.19	0.27 ± 0.02	59.7 ± 1.1	146 ± 3	11.5 ± 0.2	300 ± 5

Table 2-3: Field and High resolution gamma spectrometry results associated with OSL sampling tubes: gamma dose rates based on measurements, and modelling of potential variations in radon retention

	Field Gamma Dosimetry Results			Water Content	Laboratory Gamma Dosimetry Results			
					Gamma Dose Rate. Water Content Corrected (mGy/a)			
Sample	Reference	Geometry (pi)	Measured Gamma Dose Rate (mGy/a)	(%)	Full Series Concentrations = ^{234}Th [1]	Pre ^{222}Rn Concentrations = ^{234}Th Measured. Post ^{222}Rn Concentrations = 0 [2]	Full Series Concentrations = Wt Mean Measured [1.3]	% Error
Modern Topsoil	EFD4G075	~2	0.30 ± 0.02					
SUTL 1685	EFD4G106	~4	0.35 ± 0.01	21	0.71 ± 0.04	0.40 ± 0.01	0.57 ± 0.15	27
SUTL 1686	EFD4G107	~4	0.35 ± 0.02	20	0.59 ± 0.01	0.37 ± 0.01	0.52 ± 0.11	21
SUTL 1687	EFD4G108	4	0.38 ± 0.02	21	0.62 ± 0.02	0.39 ± 0.01	0.55 ± 0.12	21

[1] U Full Series: 0.1149 mGy/a/ppmU (Aitken. 1983)

[2] U Pre ^{222}Rn Only: 0.0044 mGy/a/ppmU (Adamiec and Aitken. 1998)

[3] Error = 'Full SeriesConcentrations = ^{234}Th' minus 'Pre ^{222}Rn Concentrations = ^{234}Th Measured, Post ^{222}Rn Concentrations = 0' divided by 2

Table 2-4: High resolution gamma spectrometry results from bulk samples associated with OSL sampling tubes: parent concentrations

	Potassium (%)	Thorium (ppm)	Uranium Apparent Concentration (ppm)					
Sample			Full Series[1]	From ^{234}Th[1]	From ^{226}Ra (^{235}U)	From ^{214}Pb [1]	From ^{214}Bi [1]	From ^{210}Pb
SUTL 1685	0.82 ± 0.03	5.60 ± 0.11	1.91 ± 0.06	3.42 ± 0.36	1.51 ± 0.33	1.83 ± 0.02	1.87 ± 0.06	2.93 ± 0.62
SUTL 1686	0.76 ± 0.03	5.00 ± 0.10	1.76 ± 0.05	2.45 ± 0.08	3.19 ± 0.37	1.65 ± 0.05	1.71 ± 0.11	2.51 ± 0.62
SUTL 1687	0.78 ± 0.03	5.45 ± 0.10	1.83 ± 0.06	2.57 ± 0.12	2.61 ± 0.35	1.75 ± 0.06	1.77 ± 0.08	1.54 ± 0.59
Mean	0.79	5.35	1.83	2.82	2.44	1.74	1.79	2.33
SD	0.03	0.31	0.07	0.53	0.85	0.09	0.08	0.71

[1] Weighted mean and external error of results from measured emission peaks

Table 2-5: High resolution gamma spectrometry results from bulk samples associated with OSL sampling tubes: measured and modelled gamma dose rate contributions

	Laboratory High Resolution Gamma Spectrometry: Gamma Dosimetry Results				
	Potassium (mGy/a)	Thorium (mGy/a)	Uranium Apparent Dose Rate (mGy/a)		
Sample			Full Series Concentrations = Measured	Full SeriesConcentrations = ^{234}Th	Pre ^{222}Rn Concentrations = ^{234}Th Measured, Post ^{222}Rn Concentrations = 0
SUTL 1685	0.198 ± 0.006	0.288 ± 0.005	0.219 ± 0.007	0.393 ± 0.042	0.015 ± 0.002
SUTL 1686	0.183 ± 0.006	0.257 ± 0.005	0.203 ± 0.006	0.282 ± 0.009	0.011 ± 0.000
SUTL 1687	0.187 ± 0.006	0.280 ± 0.005	0.210 ± 0.006	0.296 ± 0.014	0.011 ± 0.001

tered, and measurements from the optically stimulated ones are much lower than the fines (IRSL: 80-180 Gy, post IR OSL: 40-80 Gy, post IR & OSL TL: 120-200 Gy). The same trend with depth is, however, evident.

OSL on the HF etched coarse fraction yields reproducible D_e values in the range 60-90 Gy. These exhibit a slight overall increase with depth, but while the sequence contained minor fluctuations, it does not exhibit the lower values observed in the lowermost layers by the other fractions.

Using dose rates derived from laboratory gamma spectrometry, with correction for in-situ water content and the addition of an approximate cosmic ray dose rate of 0.15 mGy/a, OSL and post IR OSL measurements on coarse material yields apparent ages in the range 30-60 ka. However, since the OSL and post IR OSL measurements exhibit a saturating quartz signal, these are likely to be underestimating the true age. IRSL and postIR&OSL TL from the polymineral coarse fraction indicate ages in the range 60-115 ka. However, accurate determination of average dose rates at Karabai is complicated by the presence of the water table in the lower part of the section, and by indications of disequilibrium in the laboratory gamma spectrometry.

The similarity of IRSL and post IR & OSL TL results indicate that relatively low residuals are present in the Karabai samples. There is a slight gradual increase in D_e values with depth until the water table is reached (water absorbs radiation and hence reduces D_e). The lack of large fluctuations indicates that the luminescence signals probably have been zeroed at the time of deposition, however the scatter in the IRSL results suggests completeness of zeroing is questionable.

Field Dosimetry Measurements

Gamma dose rates were recorded on site using a 2x2" NaI scintillation probe and portable gamma spectrometer (Health Physics Instruments Rainbow MCA). Spectra were collected for 600s periods from eight measurement locations and were converted to dose rates using standard SUERC procedures. The instrument had been checked and calibrated using the doped concrete calibration pads at

SUERC before commencement of fieldwork in July 2004, and was re-checked in September 2004 on conclusion of the fieldwork. Dose rates were estimated using three conversion methods (integral count rates >450 keV, integral count rates >1350 keV and an energy integration method) and corrected for field geometry. The results are tabulated in Table 2-3. Readings EFD4G 106-108 were recorded in 4π geometry in the sample holes used to collect tube samples for possible luminescence dating. Reading EFD4G 075 was made on the surface of the modern topsoil behind the excavated section. From Table 2-3 it can be seen that the gamma ray does rates inferred from 4 pi in-situ measurements are very similar to each other with a mean value of 0.36 mGy a^{-1}, while the measurement on the ground surface behind the excavation indicates a much higher dose rate of around 0.6 mGy a^{-1} when converted to 4 pi equivalent. The instrument calibration is believed to be accurate with a systematic uncertainty of approximately 10%, which should be taken into account in age estimation based on these data.

Laboratory Gamma Spectrometry

Bulk samples of sediments associated with OSL tube sampling were dried, ground, and analysed by high resolution gamma spectrometry at SUERC. From Karabai I the three OSL tube sampling positions have been examined in this manner. Samples were sealed for >3 weeks (note: actually 15 months) after drying and grinding to allow Radon daughters to equilibriate, and then measured for 80 ks each in a shielded Ortec GMX detector of 50% relative efficiency. Gamma ray lines associated with ^{40}K and nuclides from the ^{238}U and ^{232}Th decay series were quantified and used to estimate radionuclide concentrations, scaled relative to an internal Shap Granite standard presented in similar form. Table 2-4 summarises the radionuclide parent concentrations. For the ^{40}K this was based on the gamma emission at 1462 keV; for the Th decay series on the weighted mean results from lines from ^{228}Ac, ^{212}Pb, ^{212}Bi, and ^{208}Tl; and for the U decay series

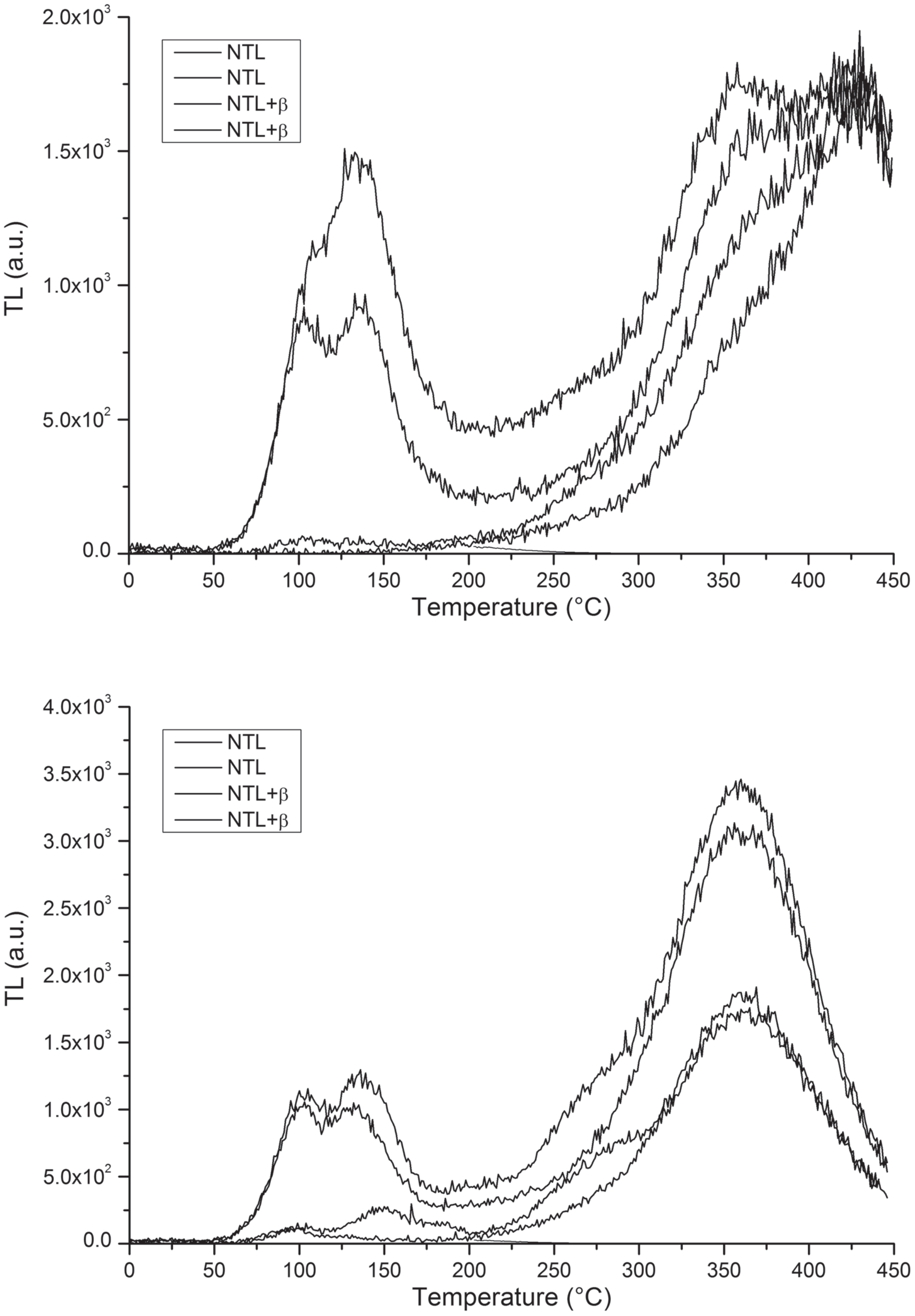

Fig 2-4a & 2-4b: TL glow curves of test measurements for heated rock samples EFD4L 332 & 333 (NTL and NTL+β) on analysis of lines from ^{234}Th, ^{226}Ra (and ^{235}U), ^{214}Bi, ^{214}Pb, and ^{210}Pb. Results in Table 2-4 from the Th decay series are expressed as Th elemental concentrations based on full-series radioactive equilibrium. The K and Th concentrations are on average 0.8 % and 5.4 ppm respectively. For the Uranium series apparent parent concentrations are also tabulated inferred from the full series weighted according to the relative gamma ray emission intensities of all nuclides analysed, and from each of the radionuclides analysed. Uncertainties associated with the determinations from the pre-radon nuclides (lines from ^{234}Th and ^{226}Ra) and ^{210}Pb are large, but the apparent concentrations are commonly higher than those inferred from the mid-series post radon nuclides, ^{214}Pb and ^{214}Bi.

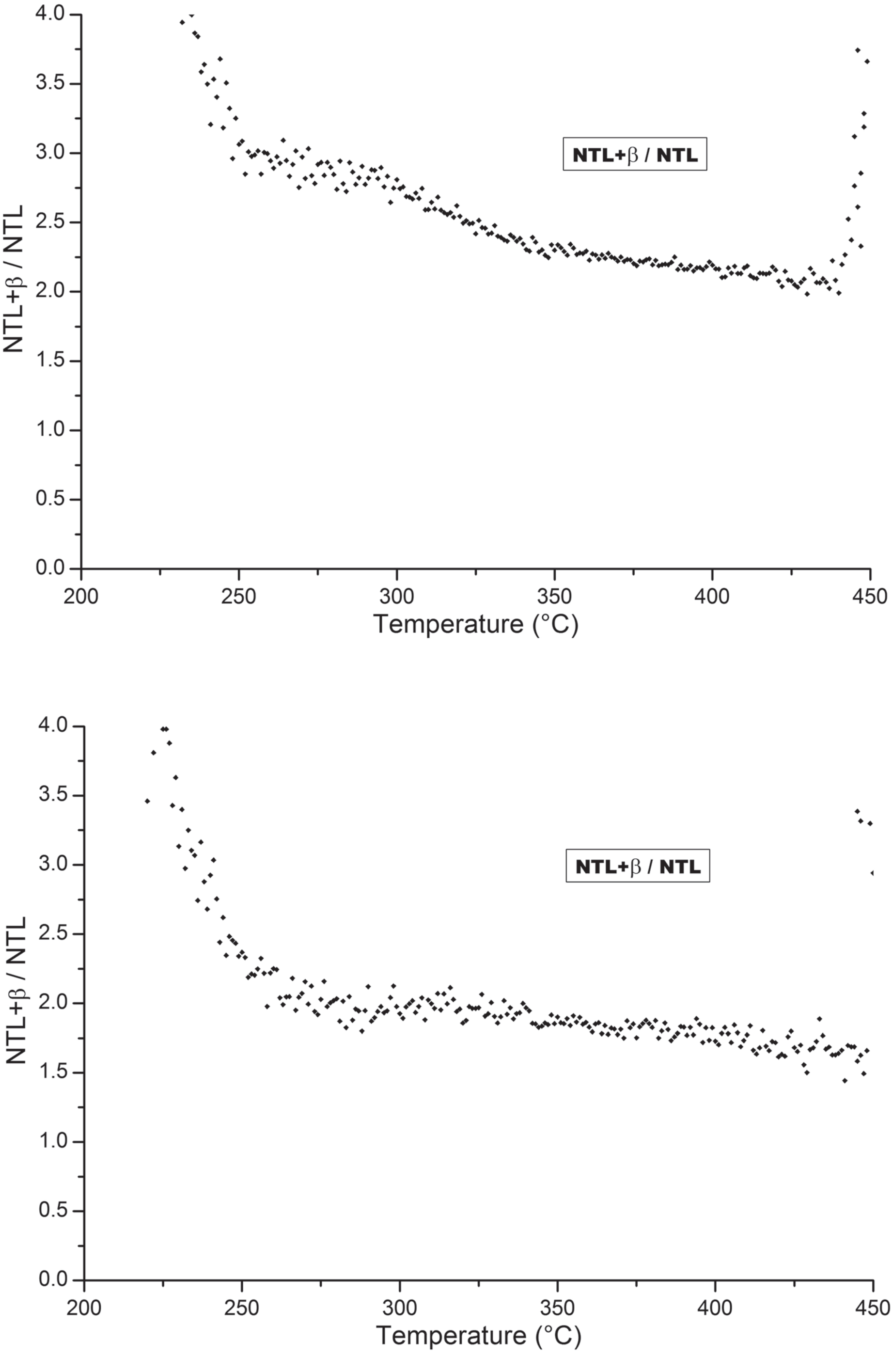

Fig. 2-5a & 2-5b: Heating plateau test (ratio NTL+β̃ NTL) for the test analysis – samples EFD4L 332 & 333.

Table 2-5 shows the gamma dose rate contributions from K, Th and U series for each sample, including U series apparent concentrations based on different scenarios relating to radon escape from the samples. The first (Full series as measured) assumes that differences between the apparent concentrations derived from different nuclides are statistical and uses the weighted mean result. The second (Full series concentrations = ^{234}Th) assumes that radon is escaping from the sample in the laboratory but was not escaping while it was buried. The third (Pre ^{222}Rn Concentrations = ^{234}Th Measured, Post ^{222}Rn Concentrations = 0) assumes complete radon escape during burial. The average Uranium contribution to the gamma dose rate varies between 0.01 and 0.3 mGy/a in these models.

Table 2-5 shows total gamma dose rates derived from laboratory measurements for each radon escape scenario, allowing for the water content of the sediment at the time of sampling. Dose rate conversion factors were based on those of Aitken (1983) and Adamiec and Aitken (1998) and the water content correction formula of Zimmerman (1971). Total radon escape in the field (scenario 3) yields an average gamma dose rate of 0.39 mGy/a: this is similar to the in situ measurements at the OSL sampling points. No radon escape in the field, but some radon escape in the laboratory (scenario 2) produces an average gamma dose rate of 0.64 mGy/a: this is similar to the field result from the modern ground surface when the latter is converted to 4 pi geometry. To account for dosimetric variability implied by scenarios 2 and 3, the scenario 1 value has been used, but with uncertainty described by the average deviation of the scenario 2 and 3 values. This produces an average uncertainty in the gamma dose rate of 23%.

Total effective dose rates to fractions of interest for the luminescence dating of sediments are presented in Table 2-6, using alpha, beta and gamma dose rates calculated using the models described. Overall uncertainties are around 10 %.

THERMOLUMINESCENCE

Sampling

Three heated rock samples from the site of Karabai I (Table 2-1) were submitted for dating by thermoluminescent methods to the luminescence laboratory at the Department of Human Evolution at the Max-Planck-Institute for Evolutionary Anthropology, Leipzig. The macroscopic features used to infer possible alteration by fire were: (i) the presence of 'potlid' structures (observable in all 3 samples), (ii) red surface coloration (only in sample EFD4L 333), and (iii) cracking of the surface (present in samples EFD4L 333 & 334).

One of the heated rock samples (EFD4L 334) was thin and had a translucent appearance. In such circumstances it is believed that bleaching during and after excavation may lead to a reduction in the natural TL signal. This, combined with the fact the sample mass was below the threshold for standard routine methodology, meant no further analyses were undertaken.

Testing for sufficiency of heating for TL-dating

In general prehistoric heating temperatures in excess of about 400°C (Melcher & Zimmerman 1977) are necessary for a successful application of the TL-dating method to heated flint samples. To ascertain that this had happened, a small sub-sample was removed from the edges of the clast. Crushed, sieved and treated with HCl the resulting grains were mounted on a set of four discs to test for the sufficiency of heating for TL analysis before the entire sample was

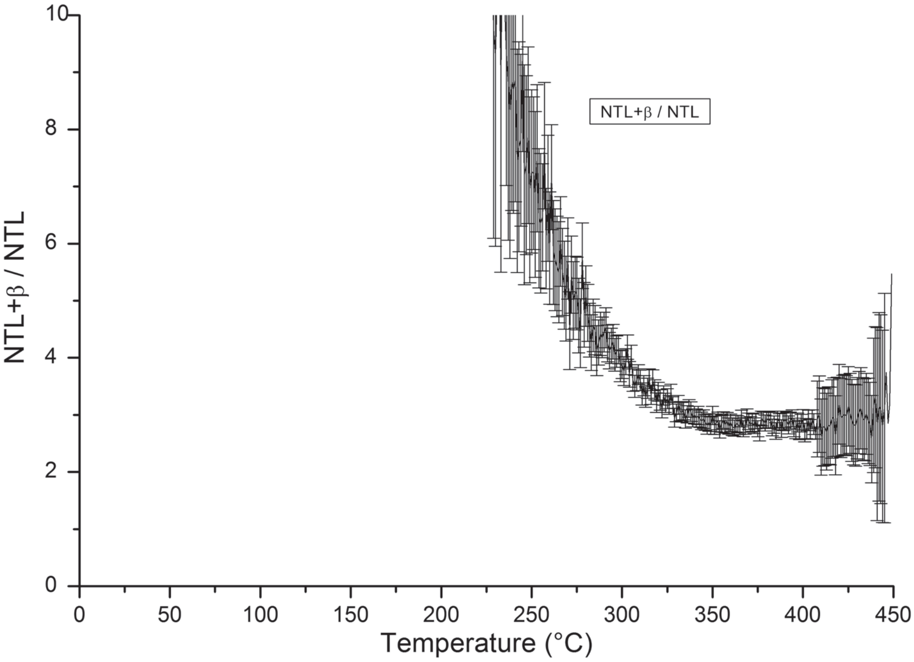

Figure 2-6: 2nd heating plateau test (ratio NTL+β̃ NTL) for the interior of the flint sample EFD4L 332.

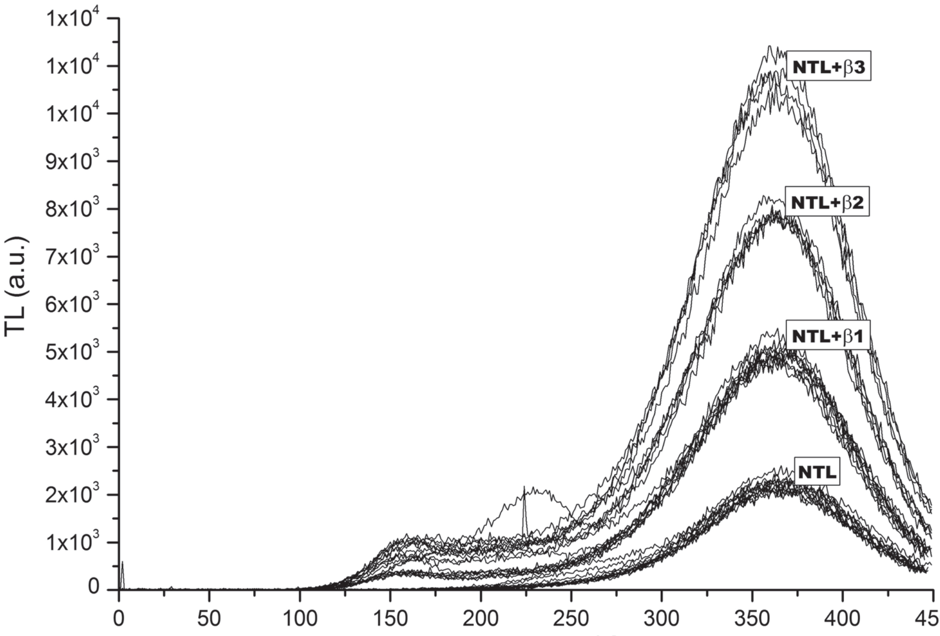

Figure 2-7: TL curves for sample EFD4L 332.

subjected to the rather time consuming (and destructive) full dating procedure. Two of the sets of four discs received a β-dose and the resulting TL glow curve of all the discs from samples EFD4L 332 & 333 are shown in Fig. 2-4a; 2-4b.

For TL dating only signals above approximately 300°C are of interest. This is because the stability of the signal below this temperature is not sufficiently good to be applied to samples from this time period. Sample EFD4L 332 showed a natural TL peak (NTL) at around 370 °C. Additional β-irradiation increases the TL signal proportionally over the temperature range of the peak, thus providing a heating plateau (ratio of NTL+β / NTL) over the TL-peak (Fig. 2-5a). This feature shows that the sample had undergone sufficient ancient heating for the TL-signal to be zeroed making it suitable for TL dating. The heating plateaus include the NTL peak and produced values in the order of about 340 - 410 °C. This is in contrast to sample EFD4L 333, where an additional peak at about 430°C indicates the presence of geological TL, which has not been erased by prehistoric heating. The 360°C peak used for dating is 'masked' by this higher temperature peak, thus producing (in Fig 5b) no heating plateau. It can be concluded that this sample is only partially heated and therefore EFD4L 333 has to be excluded from further analysis.

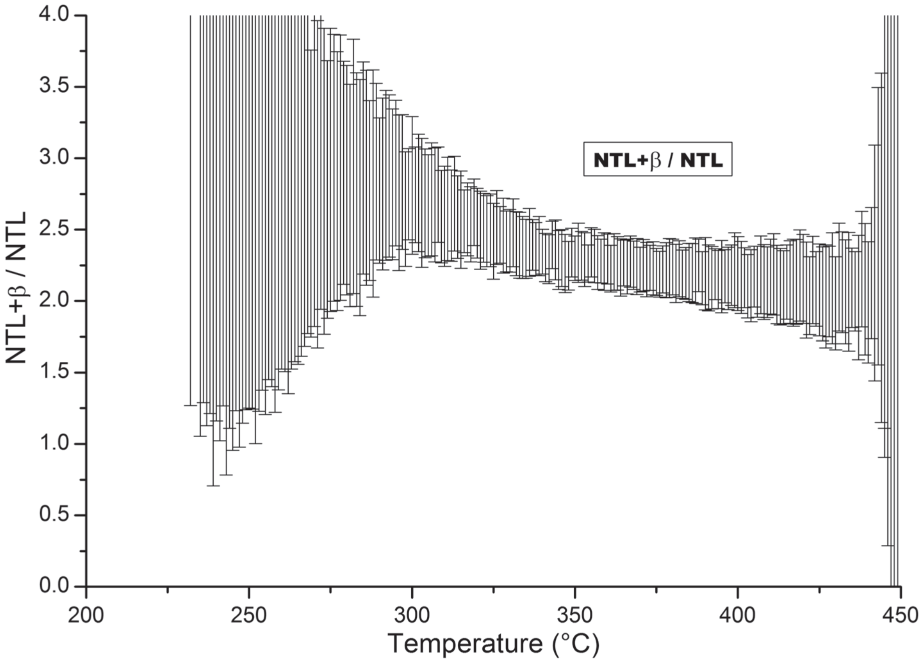

Figure 2-8: Heating plateau for sample EFD4L 332 (345-435°C).

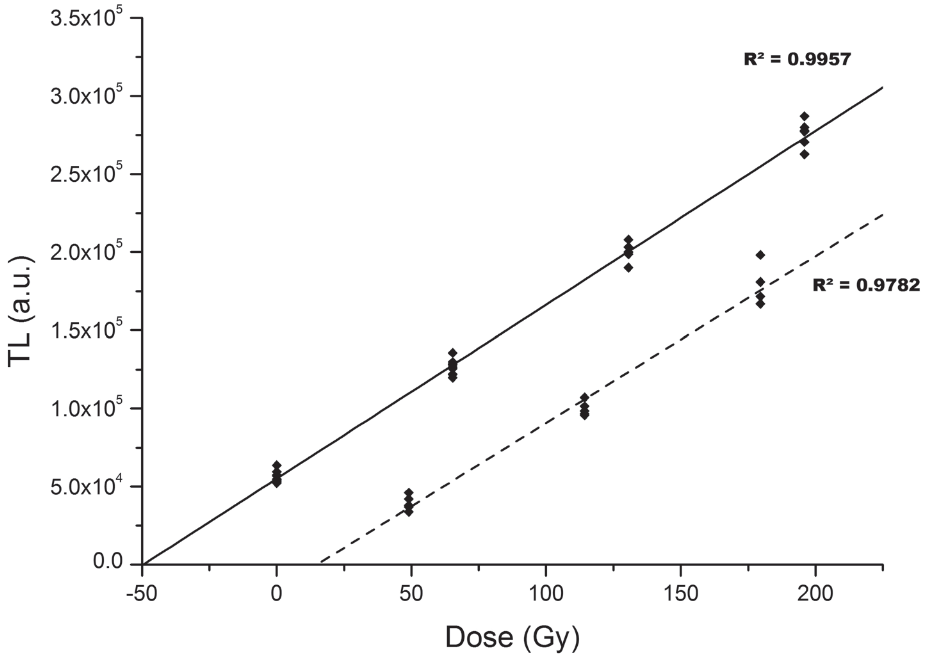

Figure 2-9: TL growth curves for sample EFD4L 332. The additive growth curve is marked by the solid line and the regeneration curve by the dotted line. The x-axis intercepts of the linear regression give the D_E for the additive growth curve and the supralinearity correction D_I for the regeneration growth curve.

Sample Preparation

Sample EFD4L 332 was prepared for TL-dating by stripping off the outer 2 mm layer with a low speed water cooled diamond saw. This removes parts which might have been bleached and all parts of the sample which had been exposed to α and β-radiation from the surrounding sediment. These radiations thus can be excluded from the age calculation, which improves the precision of the resulting ages. The remaining material was gently crushed in a hydraulic steel mortar. About 200 mg of powder were used for measurements of radioactive element concentrations by ICP-MS (Inductively-Coupled-Plasma Mass-Spectrometry) and INAA (Instrumental Neutron Activation Analysis). The grain fraction of 90-160 μm for the determination of the palaeodose was then obtained by sieving, while the fine grain of 4-11 μm material for alpha sensitivity

Table 2-6: Total effective dose rates to sediment fractions of interest for luminescence dating, based on measurements and modelling of potential variations in radon retention

	Total Effective Dose Rates At The Time of Sampling[1]	
Sample	4-11 micron Polymineral[2]	200 micron Etched Quartz[3]
SUTL 1685	2.15 ± 0.24	1.49 ± 0.18
SUTL 1686	2.00 ± 0.18	1.39 ± 0.13
SUTL 1687	2.08 ± 0.18	1.44 ± 0.14
Mean	2.08	1.44
SD	0.08	0.05

[1] Based on HGRS results + Cosmic Dose Rate of 0.15 ± 0.01

[2] Alpha effectiveness (keff) = 0.07 (Burbidge et al., In Prep)

[3] Etching assumed to remove all Alpha and 14% Beta (Mejdahl. 1979)

measurements was prepared after Zimmermann (1971). Part of the 90-160 µm fraction was heated in a furnace to 360°C for 90 minutes under air to provide thermally zeroed material for establishing a regenerated TL growth curve. Chemical preparation with 10 % HCl and the use of a defloculant in the case of the coarse grains completed the sample preparation.

TL measurements were performed in a N_2 atmosphere in a Risø DA-15 system, with a bi-alkala photomultiplier tube, with the detection restricted to the UV-blue region by a Schott BG25 and a Hoya HA-30 filter. A heating rate of 5 °C s^{-1} to 450 °C was employed with immediate background subtraction.

Samples were β-irradiated in the Risø DA-15 system with a calibrated ^{90}Sr/^{90}Y-source (about 0.109 Gy s^{-1}), while α-irradiations were done in a Littlemore 721A under vacuum with six ^{241}Am sources, calibrated to about 0.187 µm^{-2} min^{-1}. Irradiated samples were stored for 3-4 weeks at room temperature before being TL measured.

Second test for sufficiency of heating

Next the heating plateau test was repeated using material from the extracted core in order to verify that the interior of the sample had been sufficiently heated thus ensuring that the TL-signal was completely zeroed. The heating plateau is similar to the one obtained from material from the edge of the sample and indicates the sufficiency of heating of the interior of the clast. The heating plateau of this second test fell in the range 345 - 415 °C (Fig. 2-6).

Thermoluminescence methods and analysis

The potential age of the sample suggests that the NTL is well within the linear range of the additive TL growth curve. Because of low quantities of material only three additive dose points were given and a regeneration growth curve with corresponding dose points was measured. The palaeodoses were calculated from the least square linear regression results from these two dose curves (Aitken, 1985; Valladas, 1992). The alpha sensitivity (b-value) was determined on material zeroed in the laboratory at 500°C for 30 minutes (Table 2-7).

Data analysis was performed with the software Analyst. The integration range was defined as the joint temperature range of the heating (Fig. 2-7) as well as of the D_E-plateau for the additive dose curve (Fig. 2-8). The latter is the temperature region of constant results of the equivalent dose (D_E) determination. The presence of such a plateau is another indication of the sufficiency of the prehistoric heating and that the samples are well zeroed.

Results

The TL additive and regeneration glow curves are shown in Fig. 2-7 with the resulting heating plateaus determined on the material/discs eventually used for palaeodose analysis (Fig. 2-8). The two growth curves for EFD4L 332 show a similar slope which indicates little to no sensitivity change due to the heating in the laboratory (Fig. 2-9). The resulting supralinearity correction is reliable and can be used to estimate the palaeodose.

The cosmic dose rates were calculated after Barbouti & Rastin (1983) and Prescott & Stephan (1982) taking into account the elevation above sea level, longitude and latitude, as well as a sedimentary overburden of 2 m for Karabai I of 2.25 g cm-1 average density. The overburden was assumed to have been constant for the entire burial time and an error estimate of 5% is assumed for these cosmic dose rate values. The external γ-dose rate from the sediment was measured with a portable NaI-scintillator and average values for several readings are given in Table 2-8 as $\dot{D}_{\gamma-ext.}$ Gamma spectrometry laboratory measurements on the milled sediment from around the luminescence samples revealed no significant secular disequilibria for the U-decay chains. However, there could have been changes in the U-decay chain and hence alterations in the gamma dose rates which can not be detected by this method. For example disequilibrium could have occurred several times early in the history of the sediment but today the chains are back in equilibrium. In general such events can not be accounted for but in many cases γ-spectrometry provides indications of such problems, which then can be accounted for. Here it is assumed that possible disequilibria in the decay chains have a negligible effect on the dose rates, which are given in Table 2-8. However, in order to allow for any such variation or changes in the external γ-dose rate caused by changing water contents, an error estimate of 20% is used for age calculation.

The element concentration for U, Th and K were determined with INAA and ICP-MS on samples crushed to < 50 µm. While the results for U and Th were identical with the two methods, the K content varied by several orders of magnitude. ICP-MS analysis were repeated several times, but failed to provide consistent results for K, emphasising the problems for measuring this isotope with that particular method. Neither ratio of these elements measured with INAA corresponds to the average ratios observed for the composition of the earth's crust either. However, it can be

Table 2-7: Summary of TL analysis results

site name	Inv.-No.:	NTL peak (°C)	heating plateau (°C)	D_E-plateau (°C)	b-value
Karabai I	EFD4L332	365	345-435	355-380	8.0 ± 0.4

Table 2-8: Summary of dosimetric results

site name	Inv.-No.:	U (ppm)	Th (ppm)	K (ppm)	$\dot{D}_{\alpha-\text{int.}}$ (µGy a^{-1})	$\dot{D}_{\beta-\text{int.}}$ (µGy a^{-1})	$\dot{D}_{\cos m.}$ (µGy a^{-1})	$\dot{D}_{\gamma-ext.}$ (µGy a^{-1})
Karabai I	EFD4L332	0.13 ± 0.01	0.19 ± 0.12	485 ± 15	24	62	157	184

Table 2-9: Summary of results and ages for sample EVA-LUM-06/02 (EFD4L 332)

site name	EVA-LUM-	Inv.-No.:	palaeodose (Gy)	$\dot{D}_{\text{int.}}$ (µGy a^{-1})	$\dot{D}_{ext.}$ (µGy a^{-1})	age (ka)
Karabai I	06/02	EFD4L 332	61.5 ± 1.2	90	341	142 ± 23

questioned if the crust ratio is necessarily valid for flint (a quick literature survey does not suggest any correlation). We prefer to use the results obtained by INAA in this study.

The alpha sensitivity of the sample is extremely low, which leads to a very small internal dose rate. The age is thus heavily dependant on the estimation of the external gamma and cosmic dose rates. While for the latter an error of 5 % is assumed, the associated error for the external gamma dose was set to 20% in order to include the effects of possible variations due to changes in water content or in the geometries used. The result (Table 2-9) is a value of 142 ± 23 ka for sample EVA-LUM-06/01 (EFD4L 332).

DISCUSSION

The OSL and post IR OSL measurements on coarse material have produced apparent ages in the range 30-60 ka. However, since the OSL and post IR OSL quartz signal appear to be saturating, these are likely to be underestimating the true age. The IRSL and post IR&OSL TL from the polymineral coarse fraction indicate ages in the range 60-115 ka for the sampled profile. The thermoluminescence determination is older, 142 ± 23 ka. Thus one set of date measurements suggests that the site is MIS 4-5 whereas the other is indicating an age within MIS 6.

It is important to qualify these outcomes. There may be uncertainty on whether the heated flint was fully zeroed. In terms of the OSL large uncertainties relating to Uranium series dosimetry were observed in the present study, not to mention indications of calcareous precipitation in the sediments. These would need to be further investigated if a more detailed investigation was undertaken. Relevant factors include (i) Pre Rn and 210Pb are often higher than 214Pb and 214Bi, indicating Rn escape in the lab and not in the field, however (ii) field gamma agrees with a complete radon escape scenario in the field, despite the sediments being damp at the time of sampling (this would limit potential migration).

If radon were emanating and ultimately escaping from the dry sample in the lab and in situ following excavation of the section and partial drying, but it had been largely kept in place prior to excavation by water in the sediment, then the Full Series sealed HRGS result would be the most reliable. Uncertainties and potential variability in the radon condition of the samples mean that the uncertainty on this value should be based on dose rates resulting from the conditions of no radon escape and complete radon escape (Table 2-5). In this study we have used the average deviation of the dose rates from the extreme scenarios.

Such indications of radon escape from the lab samples were not observed elsewhere in the EFCHED study, but are consistently present at Karabai. The luminescence results from Kabazi V (Housley et al. 2007) are perhaps the closest in terms of poor behaviour, for these yielded high Pre-Rn values for the upper samples but 210Pb values were as low as or lower than 214Pb and 214Bi. The Karabai lab gamma samples were re-measured and are presented here – relative to the initial measurements the re-measured values are more consistent between samples and within the series (wildly outlying low 210Pb values were not reproduced), but variability in the Pre and Post Rn results is still high, more or less consistent with the large estimated uncertainties.

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Abstract

К.И. БАРБИДЖ, Д. РИХТЕР,
Д.К.В. САНДЕРСОН, Р.А. ХЁСЛИ

КАРАБАЙ I: ЛЮМИНЕСЦЕНТНЫЙ (ОСЛ И ТЛ) АНАЛИЗ

В данной главе представлены предварительные результаты люминесцентного анализа образцов из раскопок 2004 года стоянки Карабай I. Анализ проведен двумя лабораториями: Центром Шотландского университета по исследованию окружающей среды (Scottish Universities Environmental Research Centre – SUERC); Институтом эволюционной антропологии Макса Планка в Лейпциге (Max-Planck-Institute for Evolutionary Anthropology). В первой лаборатории исследовались оптически стимулированные люминесцентные свойства седиментов методом люминесцентного профилирования (Burbidge et al. 2007). В Институте эволюционной антропологии были проведены термолюминесцентные исследования небольшой коллекции обожженных кремней.

Люминесцентное профилирование является методом быстрого определения пригодности седиментов для полного люминесцентного датирования. Данный метод основан на обнаружении определенных минералов, установления степени их зернистости и выявлении люминесцентных сигналов. В Карабае I люминесцентным профилированием обнаружено значительное количество факторов, которые усложняют проведение полного исследования. Изученные седименты представлены полиминеральной грубой фракцией. Используя «IRSL» и «post IR & OSL TL» сигналы, в предварительном плане установлен возраст в пределах 60-115 тыс. лет назад. Сигналы выявлены в люминесцентно перенасыщенных частицах кварца, что, в свою очередь, приводит к определению минимального возраста.

В археологическом слое 2, квадрат 4H был обнаружен достаточно хорошо обожженный для успешного ТЛ датирования артефакт. Полученный ТЛ возраст, 142±23 тыс. лет (EVA-LUM-06/01) соответствует времени MIS 6, что противоречит результатам люминесцентного профилирования, согласно которых Карабай I, культурный слой 2 аккумулировался в рамках MIS 4-5. Результаты датирования методами ТЛ и люминесцентного профилирования носят предварительный характер.

чем в микокских поселениях Карабая I. Для указанных слоев Пролома характерно несколько более высокое содержание «конвергентных», несколько более низкое содержание «двусторонних» (Табл. 9-3) орудий и гораздо меньшие метрические параметры всего орудийного набора. С другой стороны, микокские комплексы Пролома II и Карабая I демонстрируют практически одинаковые показатели плотности находок на 1 м^3 культурного слоя (Табл. 9-5). Следовательно не исключено, что определенная часть орудийного набора была редуцирована до того как она попала на поселения II и III культурных слоев в гроте Пролом II. Различия в степени редуцированности орудийных наборов нашли отражение в фациальной принадлежности комплексов Пролома II и Карабая I. Комплексы Пролом II, культурные слои II и III относятся к старосельской фации. По крайней мере, пачка горизонтов 4 в Карабае I определена как аккайская фация крымского микока.

Таким образом, при практически полном сходстве моделей эксплуатации кремневого сырья в гроте Пролом II, II, III и на стоянке под открытым небом Карабай I, 3, 4, 5 основные отличия состоят в расстояниях, на которые транспортировались готовые двусторонние орудия и интенсивности использования кремневого сырья.

ЗАКЛЮЧЕНИЕ

Исходя из того, что топография балки Карабай Куба не претерпела значительных изменений со времени позднего плейстоцена, и, учитывая наличие в балке мощных плейстоценовых отложений, содержащих верхнепалеолитические и среднепалеолитические материалы, необходимость будущих исследований на этой территории представляется одной из приоритетных задач в изучении палеолита Крыма. Начавшиеся раскопки стоянки Карабай II в непосредственной близости от Карабай I открывают новые перспективы исследований в балке Карабай Куба (Евтушенко, 2009). Карабай II является лессово-почвенным разрезом с отличной сохранностью фаунистического и кремневого материала. Наличие микокской индустрии в отложениях Карабая II не вызывает сомнений. Дальнейшие полевые исследования позволят уточнить и дополнить литологическую и археологическую стратиграфию Карабая II. Не менее перспективным выглядит открытие новых палеолитических стоянок в балке Карабай Куба, изучение которых позволит во многом по новому интерпретировать различные стороны жизнедеятельности палеолитических коллективов на границе степи и предгорий Крыма.

Abstract

ALEXANDER YEVTUSHENKO
VICTOR CHABAI

KARABAI I: RESULTS AND TRENDS FOR FUTURE INVESTIGATIONS

The unique character of Karabai I is defined by its topographical setting and stratigraphical sequence. Karabai is the only Crimean Palaeolithic open-air site, which is situated so close to a water source and presents a loess-soil sequence (Chapter 1, by Yevtushenko and Chabai). The majority of the Crimean Middle and Upper Palaeolithic sites were found in either buried or still open rock-shelters. Late Upper Palaeolithic open air sites as Vishennoe 1 and 2, Skalistoe, Bodrak, and Mushash are located on the 1st or 2nd river terraces. The Middle Palaeolithic open air sites Krasnaya Balka, Sary Kaya, Kabazi II are situated on the cuesta slopes. In the case of Krasnaya Balka and Kabazi II, it has been assumed that they correlate with the deposits of the 3rd terraces of Bijuk Karasu and Alma rivers, respectively. Also, Krasnaya Balka and Sary Kaya are situated on the bank of a gorge, which cuts the cliffs and slopes of cuesta. Thus, the topographical position of Krasnaya Balka and Sary Kaya is very similar to Karabai I. But few differences exist: there is no connection between Karabai I and the river terrace, as in the case of Krasnaya Balka; Karabai I is closer to the bottom of the gorge and to the water source than both, Krasnaya Balka and Sary Kaya. Thus, the topographical situation of Karabai Kuba gorge has not been changed so dramatically since Upper Pleistocene times, as it is the case for the other well known Crimean Middle Palaeolithic sites.

The cultural layer 0 contains redeposited Swiderian artefacts (Chapter 3, by Yevtushenko and Nuzhnyi). These might have originated from the pit-cash of pre-cores, which was destroyed by slope erosion. The artefacts of the cultural layers 1A and 1, which accumulated in silty sediments of the lithological layers 10a and 10b, were found in a secondary context. The depositional process of cultural layer 2A material (lithological layer 10b, lower) is very problematic to evaluate, because of a small amount of artefacts. Also, the small number of artefacts makes it difficult to classify the industry of the cultural layer 2A. The *in situ* artefact assemblage from cultural layer 2 shows clear attributes of a Levallois-Mousterian techno-complex. The artefacts of cultural layer 2 compose a thin, carpet-like surface of finds – a “living floor” in silty loess deposits of lithological layer 13 (Chapter 3, by Yevtushenko and Ignatenko). Also, the artefacts of Units 3, 4 and cultural layer 5 still exist in their primary context, in silty loess sediments of lithological layers 15a and 15b. The flint assemblages from Unit 3, 4 and cultural layer 5 belong to the Micoquian techno-

complex (Chapters 5, 6 and 7, by Yevtushenko and Chabai). A mixture of Micoquian and components of an yet unknown industry was identified in Unit 6 assemblage, which accumulated in soil sediments of lithological layer 16a. The Unit 6 assemblage was found in a secondary context (Chapter 8, by Yevtushenko and Chabai). Unit 7 yielded only a small amount of artefacts, which, along with a small excavated area of lithological layer 16b, does not allow for an interpretation.

Two interpretations about the chrono-stratigraphical sequence of Karabai I are possible, and three interpretations about its absolute chronology. The preliminary variant of N. Gerasimenko's point of view on the chrono-stratigraphy of Karabai I is discussed in Chapter 1, this volume. According to Gerasimenko, the Pleistocene stratigraphical sequence of Karabai I, lithological layers 16b until 3, cover the time span from MIS 5 to MIS 2, inclusively (Table 9-1). According to Yevtushenko, lithological layers 15b to 10a accumulated during the Early and Middle Pleniglacial (Table 9-1). The first version of the OSL chronology (Chapter 2, Burbidge et al.) supports Yevtushenko's assumption, while the second version of the OSL chronology supports the preliminary observations by Gerasimenko (Table 9-1). The TL date 142±23 ka BP made on burnt flint from cultural layer 2 (lithological layer 13) is beyond the temporal frames of discussion. Two possible consequences arise from these chrono-stratigraphical interpretations. First, following the second version of OSL chronology and Gerasimenko's point of view on Karabai I chrono-stratigraphy, it will be necessary to accept an MIS 5a age for the Levallois-Mousterian assemblage of cultural layer 2. In that case, it would be the earliest manifestation of Levallois-Mousterian techno-complex in Crimea (Table 9-2). Second, following the first version of OSL chronology and Yevtushenko's point of view on Karabai I chrono-stratigraphy, it would be necessary to conclude that Karabai I, 2 is more or less contemporaneous with such Crimean Levallois-Mousterian assemblages as Kabazi V, IV and Kabazi II, IIA/2, which accumulated at the very beginning of the Middle Pleniglacial (Table 9-2). Neither Gerasimenko's interpretation / the second OSL version, nor Yevtushenko's interpretations and the first OSL version, affect the known chronological frames of the Crimean Micoquian (Table 9-2).

Within the frames of typological variability of the Crimean Micoquian, the assemblage from Unit 4 belongs to the Ak Kaya facies (Chapter 6, by Yevtushenko and Chabai), because of the minimal reduction of artefacts, which is reflected in specific compositions of «simple», «convergent» and «bifacial» tools (Table 9-3). Also, the Ak Kaya facies assemblages are typical ephemeral / short-term occupations. The statistical incompleteness of Unit 3 and the tool kit of cultural layer 5 assemblage do not allow for a definition of their respective facies variability.

The facies variability of Crimean Levallois-Mousterian is not defined yet. On the other hand, an assumption about the place of Karabai I, 2 in the Crimean Levallois-Mousterian settlement system is possible: In spite of the absence of cores, a high number of attributes of on-site core reduction and tool production could be identified (Chapter 3, by Yevtushenko and Ignatenko). The raw material exploitation of Karabai I, 2 anticipates an ephemeral workshop site, or station, of type A, according to the Crimean Middle Palaeolithic studies terminology (Table 9-4). The model of raw material exploitation, executed by the carriers of the Karabai I Micoquian, consist of an off-site bifacial tool production along with further bifacial tool import on site area, and an on-site core and unifacial tool production. This model of raw material exploitation was studied in Prolom II, layers II, III, which are defined as camps of type C (Table 9-5).

The investigations in Karabai Kuba gorge are far from complete. Karabai II – the new Middle Palaeolithic location with loess-soil sequence and excellent fauna preservation was discovered in 2005. There is still an existing possibility that Upper Palaeolithic sites are to be found in this area. At least, the late MIS 3 and MIS 2 sediments are well preserved on the slopes of Karabai Kuba gorge. Hopefully, the ongoing field investigations help to answer the numerous questions, presented in this volume.

LIST OF CONTRIBUTORS
СВЕДЕНИЯ ОБ АВТОРАХ

ALEXANDER YEVTUSHENKO	Crimean branch of Archaeology Institute, National Academy of Sciences of Ukraine
CHRIS I. BURBIDGE	Grupo Património Cultural e Ciências, Instituto Tecnológico e Nuclear, SACAVÉM, Portugal
DANIEL RICHTER	Department of Human Evolution, Max-Planck-Institute for Evolutionary Anthropology, Leipzig, Germany
DAVID C. W. SANDERSON	Scottish Universities Environmental Research Centre, East Kilbride, Glasgow, UK
DMYTRO NUZHNYI	Institute of Archaeology, National Academy of Sciences of Ukraine
OLGA IGNATENKO	Crimean branch of Archaeology Institute, National Academy of Sciences of Ukraine
RUPERT A. HOUSLEY	Department of Geography, Royal Holloway College, University of London, UK
VALÉRY SITLIVY	Institut für Ur- und Frühgeschichte der Universität Köln, Germany
VICTOR CHABAI	Crimean branch of Archaeology Institute, National Academy of Sciences of Ukraine

BIBLIOGRAPHY
СПИСОК ЛИТЕРАТУРЫ

Борисковский П. И., 1953. Палеолит Украины // Материалы и исследования по археологи СССР. – № 40. – Москва – Ленинград: Издательство Академии наук СССР. – 463 с.

Гиря Е. Ю., 1997. Технологический анализ каменных индустрий. – Спб. – 198 с.

Гладилин В. Н., 1976. Проблемы раннего палеолита Восточной Европы. – Киев: Наукова Думка. – 228 с.

Горелик О. Ф., 2003. Дежнеківський “скарб” неолітичних тесел (Південно-Східна Україна) // Археологический альманах. – № 13. – Донецк. – С. 272-280.

Губонина З. П. 1985. Условия обитания палеолитического человека в предгорьях Крыма // Палинология четвертичного периода. – М.: Наука. – С. 95-103.

Гурина Н. Н., 1976. Древние кремнедобывающие шахты на территории СРСР. – Ленинград: Наука. – 177 с.

Демиденко Ю.Э., 2003. Кииккобинский тип микокских индустрий среднего палеолита Крыма: дискретная культура «шарантоидного парамикока» или индустриальное проявление крайней степени кремнеобработки крымской микокской традиции? // Варіабельність середнього палеоліту України. – Редактор Л.В. Кулаковська. – Київ: Шлях, 2003. – С. 140-171.

Демиденко Ю. Э., 2004. Буран-Кая-III, слой В – технико-типологическая характеристика и анализ артефактов, модели общей кремнеобработки и редукции орудий // Буран-Кая-III, слой В – эталонный памятник кииккобинского типа индустрии крымской микокской традиции. Комплексный анализ кремневых артефактов. – Редактор Ю.Э. Демиденко. – Киев-Симферополь: Шлях. – С. 30-88.

Евтушенко А. И., 2009. Палеолитические стоянки Карабай I и Карабай II: предварительные результаты исследований // Актуальные проблемы первобытной археологии Восточной Европы. – Ответственный редактор В.П. Чабай. – Археологический альманах. – № 20 – Донецк: Донбасс. – С. 77-88.

Евтушенко А. И., Чабай В. П., Весельский А. П., 2006. Отчет о полевых исследованиях восточного отряда Международной Крымской палеолитической экспедиции в 2005 году. – Архив Крымского филиала Института археологии НАН Украины, Симферополь.

Колосов Ю. Г., 1978. Специфические типы орудий аккайской мустьерской культуры в Крыму // Орудия каменного века. – Киев: Наукова думка. – С. 6-19.

Колосов Ю. Г., 1983. Мустьерские стоянки района Белогорска. – Киев: Наукова думка. – 206 с.

Колосов Ю. Г., 1986. Аккайская мустьерская культура. – Киев: Наукова думка. – 223 с.

Колосов Ю. Г., Степанчук В. Н., Чабай В. П., 1990а. Палеолит Крыма. Поздний палеолит Крыма. – Вып. 1. – Киев. – 40 с.

Колосов Ю. Г., Степанчук В. Н., Чабай В. П., 1990б. Палеолит Крыма. Поздний палеолит Крыма. – Выпуск 2. – Киев. – 48 с.

Колосов Ю. Г., Степанчук В. Н., Чабай В. П., 1993. Ранний палеолит Крыма. – Киев: Наукова Думка. – 221 с.

Лев С. Ю., 2009. Каменный инвентарь Зарайской стоянки // Исследования палеолита в Зарайске. – Редактор Х. А. Амирханов. – Москва: Палеограф. – С. 37-185.

Нехорошев П. Е., 1999. Технологический метод изучения первичного расщепления камня среднего палеолита. – СПб.: Европейский Дом. – 171 с.

Підоплічко І. Г., 1947. Дослідження палеоліту в УРСР// Палеоліт і неоліт України. – Київ: Видавництво Академії наук України. – С.7-39.

Семенов С. А., 1957. Первобытная техника // Материалы и исследования по археологи СССР. – №54. – Москва – Ленинград: Издательство Академии наук СССР. – 240 с.

Ситник О., 2000. Середній палеоліт Поділля. – Львів. – 368 с.

Степанчук В. М., Ковалюх М. М., Пліхт Й. Ван дер., 2004. Радіовуглецевий вік пізньоплейстоценових палеолітичних стоянок Криму // Кам’яна доба України. – Київ: Шлях. – Випуск 5.– С. 34-61.

Чабай В. П., 2000. Особенности перехода от среднего палеолита к позднему палеолиту в Крыму // Время последних неандертальцев. – Stratum plus. – №1. – СПб.-Кишинев-Одесса-Бухарест. – С. 54-83.

Чабай В.П., 2002. Моделі використання крем'яної сировини та фауни в другому культурному шарі середньопалеолітичної стоянки Пролом II (Крим) // Записки наукового товариства імені Шевченка. Праці Археологічної комісії. – Львів: НТШ. – Том CCXLIV. – С. 355-379.

Чабай В. П., 2004. Средний палеолит Крыма. – Симферополь: Шлях. – 323 с.

Чабай В. П., 2009. Роль крымского микока в поисках генетической подосновы костенковско-стрелецкой культуры // Актуальные проблемы первобытной археологии Восточной Европы. – Ответственный редактор В.П. Чабай. – Археологический альманах. – № 20 – Донецк: Донбасс. – С. 129-148.

Чабай В. П., Маркс Э. Э., Отт М., 1998. Вариабельность среднего и ранней поры позднего палеолита Крыма (предварительные итоги международного археологического проекта) // Археологія. – №4. – Київ. — С. 19-47.

Черниш О. П., 1961. Палеолітична стоянка Молодове V. – Київ: Видавництво Академії наук України. – 172 с.

Черныш А. П., 1987. Эталонная многослойная стоянка Молодова V. Археология // Многослойная палеолитическая стоянка Молодова V. Люди и окружающая среда. – Редактор И. К. Иванова, С. М. Цейтлин. – Москва: Наука. – С. 7-93.

Яневич А. А., 1992. Новая финальнопалеолитическая стоянка Вишенное II в Крыму // Пізньопалеолітичні пам'ятки центру Північного Причорномор'я (препринт). – Херсон. – С. 20-31.

Aitken, M. J., 1983. Radioactivity data using S.I. Units // PACT. – 9 (1). – Pp. 69-71.

Aitken, M. J., 1985. Thermoluminescence Dating. – London: Academic Press

Barbouti, A. I., and Rastin, B. C., 1983. A study of the absolute intensity of muons at sea level and under various thickness absorber // Journal of Physics G: Nuclear Physics. – 9. – Pp. 1577-1595.

Burbidge, C. I., Allsworth-Jones, P., Housley, R. A., Sanderson, D. C. W., Pyle, D. M., Bazely, O., McCave, N., and van Andel, T. H., 2005. Middle Palaeolithic sites in Russia and Ukraine: site summaries and fieldwork 2004. – Glasgow: Scottish Universities Environmental Research Centre and Glasgow University. – 470 p.

Burbidge, C. I., Sanderson, D. C. W., Housley, R. A., and Allsworth-Jones, P., 2007. Survey of Palaeolithic sites by luminescence profiling, a case study from Eastern Europe. – Quaternary Geochronology. – #2. – Pp. 296-302.

Chabai, V. P., 1998a. Kabazi-II: The Western Crimean Mousterian Assemblages of Unit II, Levels II/7-II/8C // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol.1. – Edited by: A. Marks and V. Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – 1998. – No 84. – Pp. 201-252.

Chabai, V. P., 1998b. Kabazi-II, Units IIA-III: Artifacts // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol.1. – Edited by: A. Marks and V. Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – 1998. – No 84. – Pp. 253-272.

Chabai, V .P., 2004a. Chokurcha I, Unit IV: Artifacts // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A. Marks. – Études et Recherches Archéologiques de L'Université de Liège. – 2004. – No 104. – Pp. 377-416.

Chabai, V. P., 2004b. Chokurcha I: Introduction // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A. Marks. – Études et Recherches Archéologiques de L'Université de Liège. – 2004. – No 104. – Pp. 343-354.

Chabai, V. P., 2005a. Kabazi II, Units V and VI: artefacts // Kabazi II: Last Interglacial Occupation, Environment & Subsistence.The Palaeolithic Sites of Crimea, vol. 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne, 2005. – Pp. 99-132.

Chabai, V. P., 2005b. Kabazi II: stratigraphy and archaeological sequence // Kabazi II: Last Interglacial Occupation, Environment & Subsistence. The Palaeolithic Sites of Crimea, vol. 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne, 2005. – Pp. 1-24.

Chabai, V. P., 2006. The Western Crimean Mousterian and Micoquian at Kabazi II, Units A, II, IIA, and III // Kabazi II: the 70000 years since the Last Interglacial. The Palaeolithic Sites of Crimea, vol. 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. –Simferopol-Cologne: Shlyakh. – Pp. 1-36.

Chabai, V. P., 2007. Kabazi V: The Lithological and Archaeological Sequences // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. The Palaeolithic Sites of Crimea, volume 3, part 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 1-26.

Chabai, V. P., 2008a. Kabazi V, Unit IV: Western Crimean Mousterian // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. Palaeolithic sites of Crimea, volume 3, part 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. –Simferopol-Cologne: Shlyakh. – Pp. 395-426.

Chabai V. P. 2008b. Kabazi V, Sub-Unit III/2: The Ak-Kaya Facie of the Crimean Micoquian // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. – Palaeolithic sites of Crimea, volume 3, part 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. –Simferopol-Cologne: Shlyakh. – Pp. 181-210.

Chabai, V. P., and Yu. E. Demidenko, 1998. The classification of flint artifacts // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol.1. – Edited by: A.Marks and V.Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – 1998. – No 84. – Pp. 31-51.

Chabai, V. P., Th. Uthmeier, 2006. Settlement Systems in the Crimean Middle Palaeolithic // Kabazi II: the 70000 years since the Last Interglacial. Palaeolithic sites of Crimea, Vol. 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 297-359.

Chabai, V. P. and M. Patou-Mathis, 2009. Kabazi V, Late Middle Palaeolithic camps: raw material and fauna exploitation // The top issues of the Eastern European prehistoric archaeology. – Edited by V. P. Chabai. – Archaeological Almanac. – № 20. – Donetsk: Donbass. – Pp. 59-76.

Demidenko, Yu. E., 2004. Buran-Kaya III Layer B: The Lithic Assemblage // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol.3. – Edited by: V. Chabai, K. Monigal, and A. Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 113-149.

Demidenko, Yu. E., 2008. Kabazi V, Sub-Unit III/3: Western Crimean Mousterian Assemblages // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. Palaeolithic sites of Crimea, volume 3, part 2. – Simferopol-Cologne: Shlyakh. – Pp. 211-274.

Ferring, C. R., 1998. Contribution to V.P. Chabai: Kabazi-II: Introduction // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol.1. – Edited by: A.Marks and V.Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – No 84. – Pp. 167-200.

Fiedorczuk, J., 1992. Poznopaleolityczne zespoly krzemienne ze stanowiska Rydno IV 57 w swietle metodu skladanek // Przeglad Archeologiczny. – Vol. 39. – S. 13-65.

Gerasimenko, N., 1999. Late Pleistocene vegetational history of Kabazi II // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol.2. – Edited by: V.Chabai and K.Monigal. – Études et Recherches Archéologiques de L'Université de Liège.– No 87. – Pp. 115-141.

Gerasimenko, N., 2004. Vegetational History of Buran-Kaya III // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 19-34.

Gerasimenko, N., 2005. Vegetation evolution of the Kabazi II site // Kabazi II: Last Interglacial Occupation, Environment & Subsistence. The Palaeolithic Sites of Crimea, vol. 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 25-49.

Gerasimenko, N., 2007. Pollen study of Kabazi V // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. Palaeolithic sites of Crimea, volume 3, part 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 89-95.

Ginter, B., 1974. Wydobuwanie, przetworstwo i dystrybucja surowcow i wyrobow krzemiennych w schylkowym paleolicie polnocnej chesci Europy Srodkowej // Przeglad Archeologiczny. – Vol. 22. – S. 5-122.

Ginter, B., 1984. The Swiderian flint workshops in the Upper Warta region // Jungpaleolithishe siedluungstrukturen in Europa, eds. H. Berke, J. Hahn, C-J. Kind. – Reisenburg/Gumzburg: Verlag archaeological ventoria Institute fur Urgeschichte der Universitat Tubingen. – S. 221-223.

Hedges, R. E. M., Housley, R. A., Pettitt, P. B., Bronk Ramsey, C. and Van Klinken, G. J., 1996. Radioñarbon dates from Oxford AMS system: Archaeometry datelist 21 // Archaeometry. – Vol. 38 (1). – Pp. 181-207.

Housley, R. A., D. C. W. Sanderson, C. I. Burbidge, D. Richter & T. F. G. Higham., 2007. Luminescence analyses (OSL and TL) and AMS radiocarbon determinations from Kabazi V // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. Palaeolithic sites of Crimea, volume 3, part 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 51-67.

Housley, R. A., van Andel, T. H. and Sanderson, D. C. W., 2006. A new research project to investigate the chronology connected with Neanderthal climate preferences and tolerances in the North-East Black Sea region // The Early Upper Palaeolithic of Eurasia: General Trends, Local Developments. – Edited by: M. V. Anikovich and N. I. Platonova. – St. Petersburg: Nestor-History. – Pp. 26-38.

Janevich, A. A., 1998. Buran- Kaya 3 – Neue ausgraben zur kulturgliederrung des jungpalaolithicums der Krim // Prehistoire Europeenne. – Vol. 13. – S. 133 – 148.

Markova, A., 1999. Small mammal fauna from Kabazi II, Kabazi V, and Starosele: paleoenvironments and evolution // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol. 2. – Edited by: V.Chabai and K.Monigal. – Études et Recherches Archéologiques de L'Université de Liège. – No 87. – Pp. 75-95.

Markova, A., 2004a. Small Mammal fauna from Buran-Kaya III // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 35-48.

Markova, A., 2004b. Rodent (Rodentia) fauna from Chokurcha I Unit IV // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 371-376.

Markova, A., 2005. Small mammals from the Palaeolithic site Kabazi II, Western Crimea // Kabazi II: Last Interglacial Occupation, Environment & Subsistence. The Palaeolithic Sites of Crimea, vol. 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne, – Pp. 51-65.

Markova, A., 2007. Small mammal fauna from the Middle Palaeolithic site Kabazi V. Palaeoenvironmental reconstruction // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. The Palaeolithic Sites of Crimea, volume 3, part 1.– Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Palaeolithic sites of Crimea. – Simferopol-Cologne: Shlyakh. – Pp. 69-87.

Marks A. E., Demidenko Yu. E., Monigal K., and V. Usik., 1998. Starosele: The 1993-95 excavations // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol. 1. – Edited by: A.Marks and V.Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – No 84. – Pp. 67-99.

Marks A. E. and K. Monigal., 1998. Starosele: The Lithic Artifacts // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol. 1. – Edited by: A.Marks and V.Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – No 84. – Pp. 117-165.

Melcher, C. L., and D. W. Zimmerman., 1977. Thermoluminescent determination of prehistoric heat treatment of chert artefacts. – Science. – 197. – Pp. 1359-1362.

Mikhailesku, K., 1999. Malacology and paleoenvironments of Western Crimea // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol. 2. – Edited by: V.Chabai and K.Monigal. – Études et Recherches Archéologiques de L'Université de Liège. – No 87. – Pp. 99-113.

Mikhailesku, K., 2004. Snails from Karabi Tamchin, Buran-Kaya III and Chokurcha I // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – Vol. 104. – Pp. 299-305.

Mikhailesku, K., 2005. Snail fauna from Kabazi II // Kabazi II: Last Interglacial Occupation, Environment & Subsistence. The Palaeolithic Sites of Crimea, vol. 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 67-76.

Monigal, K., 2004a. The Lithic assemblage from Buran-Kaya III Level C // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 57-78.

Monigal, K., 2004b. Introduction to the site of Buran-Kaya III // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 3-18.

Patou-Mathis, M., 2005. Analyses Archéozoologiques des Unités V et VI de Kabazi II // Kabazi II: Last Interglacial Occupation, Environment & Subsistence. The Palaeolithic Sites of Crimea, vol. 1. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne. – Pp. 77-98.

Patou-Mathis, M., 2006a. Analyse Archéozoologique de l'Unite III // Kabazi II: the 70000 years since the Last Interglacial. Palaeolithic sites of Crimea, volume 2. – Edited by V. Chabai, J. Richter & Th. Uthmeier. – Simferopol – Cologne: Shlyakh. – Pp. 209-240.

Patou-Mathis, M., 2006b. Analyse Archéozoologique de l'Unite II, Niveaux II/7AB à IIA/4B // Kabazi II: the 70000 years since the Last Interglacial. The Palaeolithic Sites of Crimea, volume 2. – Edited by V. Chabai, J. Richter & Th. Uthmeier. – Simferopol – Cologne: Shlyakh. – Pp. 37-62.

Pettitt, P. B., 1998. Middle Palaeolithic and Early Upper Palaeolithic: the radiocarbon chronology // Prehistoire de d'Anatolie. Genese de deux mondes. Vol. 1. – Edited by: M.Otte. – ÉRAUL. – No 85. – Pp. 329-338.

Prescott, J. R. and L. G. Stephan., 1982. The contribution of cosmic radiation to the experimental dose for thermoluminescent dating: latitude, altitude and depth dependencies // PACT/ -- 6. – Pp. 17-28.

Rink, W. J., Hee-Kwon Lee, J. Rees-Jones and K. A. Goodger., 1998. Electron Spin Resonance (ESR) and Mass Spectrometric U-series (MSUS) Dating of Teeth in Crimean Paleolithic Sites: Starosele, Kabazi-II and Kabazi-V // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol. 1. – Edited by: A. Marks and V. Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – No 84. – Pp. 323-340.

Rink, W. J., Ferring C. R. and V.P. Chabai, in press. Coupled ESR/Mass Spectrometric U-Series Dating of the Middle Palaeolithic Site of Kabazi II, Southwestern Crimea, Ukraine // Journal of Field Archaeology.

Uthmeier, Th., V. Chabai, 2010. Neanderthal subsistence tactics in the Crimean Micoquian // Settlement Dynamics of the Middle Paleolithic and Middle Stone Age, volume III – Edited by N. Connard. – Tübingen: Kerns Verlag. – Pp. 195-234.

Valladas, H., 1992. Thermoluminescence dating of flint // Quaternary Science Reviews. – 11. – Pp. 1-5.

Veselsky, A. P., 2008a. Kabazi V, Sub-Unit III/1: The Starosele Facie of Micoquian // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. Palaeolithic sites of Crimea, volume 3, part 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 129-179.

Veselsky, A. P., 2008b. Kabazi V: production and rejuvenation of bifacial tools // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. Palaeolithic sites of Crimea, volume 3, part 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. – Simferopol-Cologne: Shlyakh. – Pp. 455-479.

Yevtushenko, A. I., 1998. Kabazi V: Assemblages from selected levels // The Paleolithic of Crimea. The Middle Paleolithic of Western Crimea, vol. 1. – Edited by: A.Marks and V.Chabai. – Études et Recherches Archéologiques de L'Université de Liège. – No 84. – Pp. 287-322.

Yevtushenko, A. I., 2004. Karabi Tamchin: Assemblages from Selected Levels // The Paleolithic of Crimea. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea, vol. 3. – Edited by: V. Chabai, K. Monigal, and A.Marks. – Études et Recherches Archéologiques de L'Université de Liège. – No 104. – Pp. 307-340.

Yevtushenko, A. I., 2008. Kabazi V, Sub-Unit III/5: The Staroselian Industry // Kabazi V: Interstratification of Micoquian & Levallois-Mousterian Camp Sites. Palaeolithic sites of Crimea, volume 3, part 2. – Edited by: V. Chabai, J. Richter, Th. Uthmeier. — Simferopol-Cologne: Shlyakh. – Pp. 311-359

Zimmerman, D. W., 1971. Thermoluminescence dating using fine grains from pottery // Archaeometry. – 13. – Pp. 29-52.