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Relation of loess units and prehistoric find density in the Garzweiler open-cast mine, Lower Rhine

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Abstract: Based on a detailed loess stratigraphy in the loess plateau of the western Lower Rhine a statistical investigation budgets the shares of the main loess units from a wall area of 11,000 square meters. Therein the Brabant Loess (younger Late Würmian Pleniglacial, MIS 2) occupies 45%, nearly half of the preserved loess budget, the Hesbaye Loess (older Late Würmian Pleniglacial, MIS 2) about 5%. A quarter of the whole loess budget (25%) attributes to the Keldach Loess (Early Würmian Pleniglacial, MIS 4), only a small share (1,5%) to the Rheingau Loess (MIS 5). The pre-Eemian loesses take the last quarter (24%) of the whole preserved loess mass.
A statistical search for prehistoric finds recovered during prospections yielded 131 Palaeolithic bones and artefacts that could be assigned to the detailed stratigraphy. The bulk of the finds belongs to two periods, MIS 4 and MIS 2 – remarkably to two cold periods. The lack of interglacial finds such as known from the surroundings of this loess plateau are due to strong periglacial denudation processes on the loess plateau. The present finds testify local hunting activity during wet periods of MIS 4 for the first time within this area. Whether the finds from MIS 2 are autochthonous or reworked from older strata is still open.

[Beziehung zwischen Lösseinheiten und Dichte prähistorischer Funde im Tagebau Garzweiler, Niederrhein]

Kurzfassung: Auf der Basis einer detaillierten Lössstratigraphie wurden auf dem Lössplateau des westlichen Niederrheins von einer Abbauwandgesamtfläche von 11.000 qm die Anteile der wichtigsten Lösseinheiten berechnet. Darin nimmt der Brabant-Löss (spätes Jüngeres Hochwürm, MIS 2) 45% Anteil ein, also nahezu die Hälfte des vorhandenen Lösses, der Hesbaye-Löss (frühes Jüngeres Hochwürm, MIS 2) etwa 5%. Ein Viertel des Lösses (25%) geht an den Keldach-Löss (Älteres Hochwürm, MIS 4), nur wenig (1,5%) an den Rheingau-Löss (MIS 5). Dem Prä-Eem-Löss gehört das letzte Viertel (24%) des gesamten Lösses.
Eine statistische Suche nach prähistorischen Funden erbrachte 131 paläolithische Knochen und Artefakte, die stratigraphisch genau zugeordnet werden konnten. Die Hauptmasse der Funde gehört den beiden Stadien MIS 4 und MIS 2 an – bemerkenswerterweise zwei kalten Perioden. Das Fehlen interglazialer Funde – solche sind vom übrigen Lössplateau durchaus bekannt – wird der starken periglazialen Abtragung und Einebnung in Plateauposition zugeschrieben. Die vorliegenden Funde belegen erstmals lokale Jagdaktivität während feuchter Perioden im Stadium MIS 4. Ob die Funde aus dem MIS 2 autochthon sind oder aus älteren Schichten aufgearbeitet wurden, muss offen bleiben.

Keywords: *Lower Rhine, loess budget, prehistoric finds, MIS 4, MIS 2*

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1 Stratigraphic background

In the Lower Rhine area a new and detailed loess-soil stratigraphy was elaborated by Schirmer (2000a, b, 2002a, b, 2006) (Fig. 1). The essentials of this new stratigraphy are: 1) A high amount of individual lithologic and stratigraphic members. 2) Interglacials solely occur as interglacial complexes, as bundles of fossil soils. Each interglacial complex embraces more than one luvisol, and in addition interstadial soils. 3) MIS 3 is represented by a complex of at least eight interstadial calcaric cambisols. This complex is genetically interpreted as an initial, unfinished interglacial complex (Schirmer 2002c). 4) Between the interglacial complexes are thick loess units during which enormous relief transformation took place (euglacial). 5) The warm phases of an interglacial complex are separated by short glacial events (breviglacial) during which minor relief transformation took place. 6) Several distinct discordances within the loess cover vary the local preservation of the complete stratigraphy.

2 Aim, study area and methods

As the loess substratum is known for its excellent preservation of prehistoric finds the question arose, which is the statistical rate of prehistoric finds preserved by the different loess layers and fossil soils.

As the interglacial soil complexes embrace nearly the same time span as the euglacials separating them, it was expected, that the interglacial complexes would render a higher find quantity than the euglacial units – quite apart from the fact of better living conditions during warmer periods (Schirmer 2006: 84). This conception was also based on the statistical find quantity of glacial and interglacial finds known from the Rhineland up to now (cf. Bosinski 1995).

As proper place for such a statistical analysis the Garzweiler open-cast mine was selected with its exposed walls up to 6 km in length and a loess cover with an average height of 8.7 m (Figs. 2–4). The investigation was carried out in a joint project of the Geological Department of

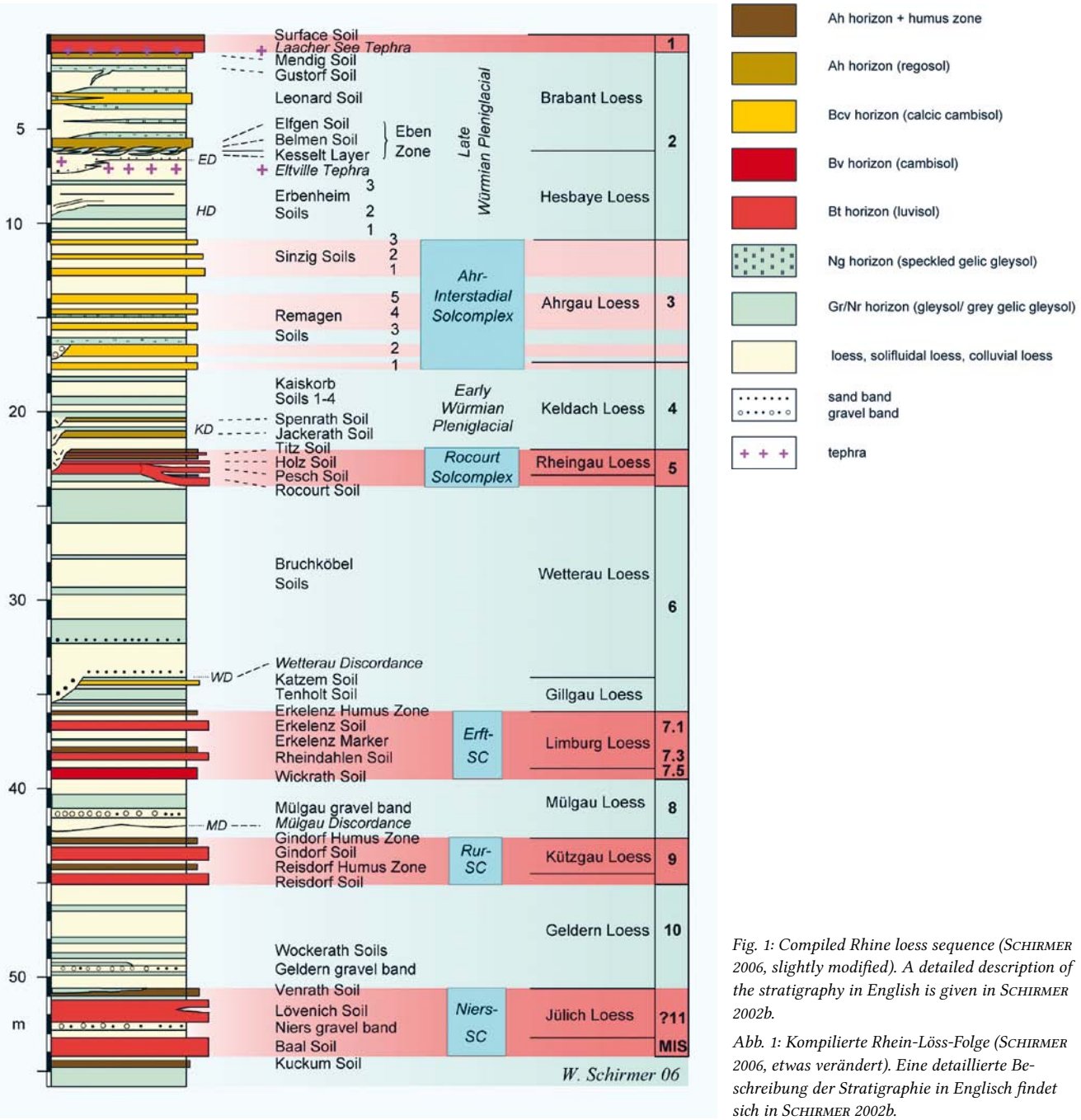

Fig. 1: Compiled Rhine loess sequence (Schirmer 2006, slightly modified). A detailed description of the stratigraphy in English is given in Schirmer 2002b.

Abb. 1: Kompilierte Rhein-Löss-Folge (Schirmer 2006, etwas verändert). Eine detaillierte Beschreibung der Stratigraphie in Englisch findet sich in Schirmer 2002b.

the Heinrich Heine University of Düsseldorf (W. Schirmer and H. Kels) and the Institute of Prehistoric Archaeology of the University of Cologne (J. Richter, T. Uthmeier, U. Böhner) supported by the APA project ("Archäologische Prospektion der Abbaukanten", archaeological prospection of the mining walls) of the "Stiftung Archäologie im Rheinischen Braunkohlenrevier".

The geological part was to recognize and subdivide the different loess units and their stratigraphic attribution by drawings of long wall sections with a total length of 1,6 km (Schirmer 1999, Schirmer & Kels 2002, Schirmer & Kels 2006, Kels 2007). The archaeological part was to investigate these walls in vertical 1 m wide strips in distances of about 10 meters looking there for prehistoric finds (Böhner & Uthmeier 2000, Uthmeier 2006: 280).

Within the years 1998–2001 a variety of geological documentations was made in the loess cover beds of this mine. Through three years T. Uthmeier, U. Böhner and H. Kels yielded numerous finds of Palaeolithical artefacts and bones from the Garzweiler loess wall. 131 of them could be assigned to the local loess stratigraphy by W. Schirmer and H. Kels. An example of a loess wall section is shown in Figs. 3 and 4.

3 Shares of loess units and prehistoric finds

3.1 Shares of loess units composing the western Lower Rhine plateau

Within the open-cast mine Garzweiler several loess walls were drawn and stratigraphically analysed. Tab. 1 presents a statistical budgeting of wall areas with a total of over

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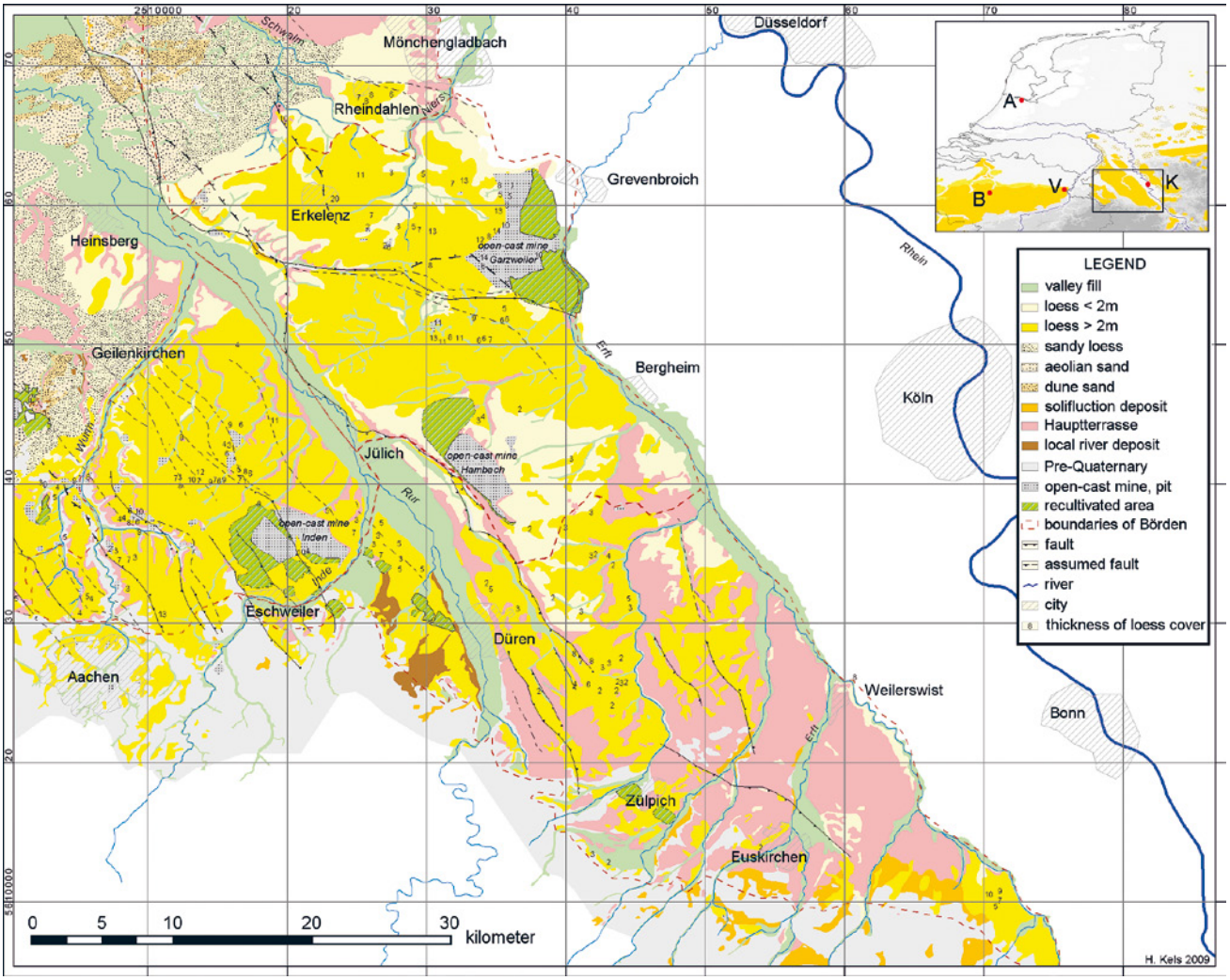

Fig. 2: Map of the loess plateau of the western Lower Rhine Basin (Kels 2007: Fig. 35; slightly modified). The inset map uses the European loess map (Haase et al. 2007). A = Amsterdam, B = Brüssel, K = Köln, V = Veldwezelt.

Abb. 2: Karte des Lössplateaus des westlichen Niederrheins (Kels 2007: Abb. 35; leicht verändert). Die eingefügte Übersichtskarte wurde der Europäischen Lösskarte entnommen (Haase et al. 2007). A = Amsterdam, B = Brüssel, K = Köln, V = Veldwezelt.

0.1 square kilometers. Therein the pre-Eemian loess covers a quarter (24%) of the whole wall area. The bulk of it belongs to the Wetterau Loess (Schirmer 2002a: 16) that represents the penultimate glaciation (MIS 6). 1.5% of the wall area takes the Rheingau-Loess (MIS 5). This thin loess unit is often eroded by the Keldach Discordance or younger discordances. The following Keldach Loess (corresponding to Early Würmian (Weichselian) Pleniglacial, MIS 4) takes 25% of the wall area. It exhibits two humic regosols, the Jackerath and Spenrath Soil, and four grey gelic gleysols, the Kaiskorb Soils 1–4. The two regosols proof that this first peak of the last glaciation was less cold than presumed before (Schirmer 2000b: 45). A following unconformity veiling the Ahr Interstadial Solcomplex (corresponding to MIS 3) and the main part of the Hesbaye Loess (corresponding to early MIS 2) was caused by the Eben Discordance (Schirmer 2003b). Thus, for the Ahr Interstadial Solcomplex only 0.01% of the wall area remain. A reworking product of the Eben Discordance is the Kesselt Layer, the uppermost part of the Hesbaye Loess (older Late Würmian Pleniglacial, MIS 2) that takes 5% of the wall area. It is followed by the Brabant Loess representing the younger Late Würmian Pleniglacial, MIS 2 – the youngest loess with a wall area of 45%.

3.2 Shares of prehistoric finds within the different loess units

The stratigraphical distribution of the prehistoric finds in the Garzweiler open-cast mine was extremely surprising. Judging from the finds prior to our study made in the Lower Rhine loess plateau a prevalence of finds from the fossil soil clusters (Fig. 1) within the loess pile was expected. However, our statistical approach (Tab. 1) showed quite different results (Kels & Schirmer 2006a, b) (Tab. 2):

- Only a few finds are from the Pre-Eemian loess which covers a quarter of the complete loess mass. Likewise the Rocourt Solcomplex = MIS 5 was free of prehistoric finds.
- The first cold maximum of the Last Glacial (MIS 4) is represented by the Keldach Loess. Surprisingly half of all finds was yielded here (Fig. 5). Therein the finds are common in all horizons with a distinct concentration to its deeper part.
- The Ahrgau Loess (MIS 3) only sparsely preserved was free of finds.

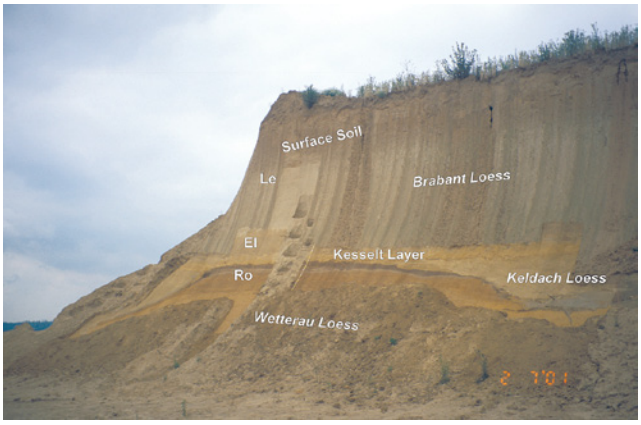

Fig. 3: Garzweiler open-cast mine. Loess wall section with the Rocourt solcomplex (Ro, red and dark brown), there incised colluvial Keldach Loess (light grey), and the small Kesselt Layer (Ke, yellow brown) (Hesbaye Loess) unconformably covering both older units, covered by Brabant Loess up to the top. At its base the brown Elfgen Soil (El), below the dark brown surface soil the slight brown fossil Leonard Soil (Le). Meter stick is 2 m long (Kels 2007: 140). Compare the associated drawing in Fig. 4.

Abb. 3: Tagebau Garzweiler. Abschnitt der Lösswand mit dem Rocourt Solkomplex (Ro, rot und dunkelbraun), darin eingeschnitten der verspülte Keldach Loess (hellgrau), and die geringmächtige Kesselt Lage (gelbbraun, Hesbaye-Löss), welche beide älteren Einheiten diskordant schneidet und bis zur Geländeoberkante durch den Brabant-Löss abgedeckt wird. An dessen Basis befindet sich der braune Elfgen-Boden (El), unterhalb des dunkelbraunen Oberflächenbodens der hellbraune Leonard-Boden (Le). Länge des Maßstabs: 2 m (Kels 2007: 140). Vergleiche hierzu auch die zugehörigen Zeichnung Abb. 4.

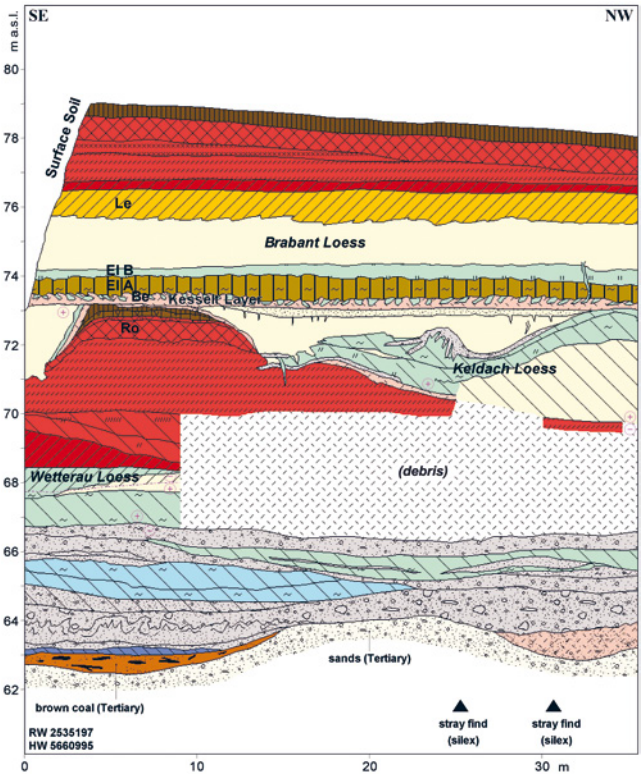

Fig. 4: Garzweiler open-cast mine. Loess section (Kels 2007: 200, meter 0–35, slightly modified). Le = Leonard Soil, El = Elfgen Soil (A/B), Be = Belmen Soil, Ke = Kesselt Layer, Ro = Rocourt Soil.

Abb. 4: Tagebau Garzweiler. Abschnitt der Lösswand (Kels 2007: 200, Meter 0–35, leicht verändert). Le = Leonard-Boden, El = Elfgen-Boden (A/B), Be = Belmen-Boden, Ro = Rocourt-Boden.

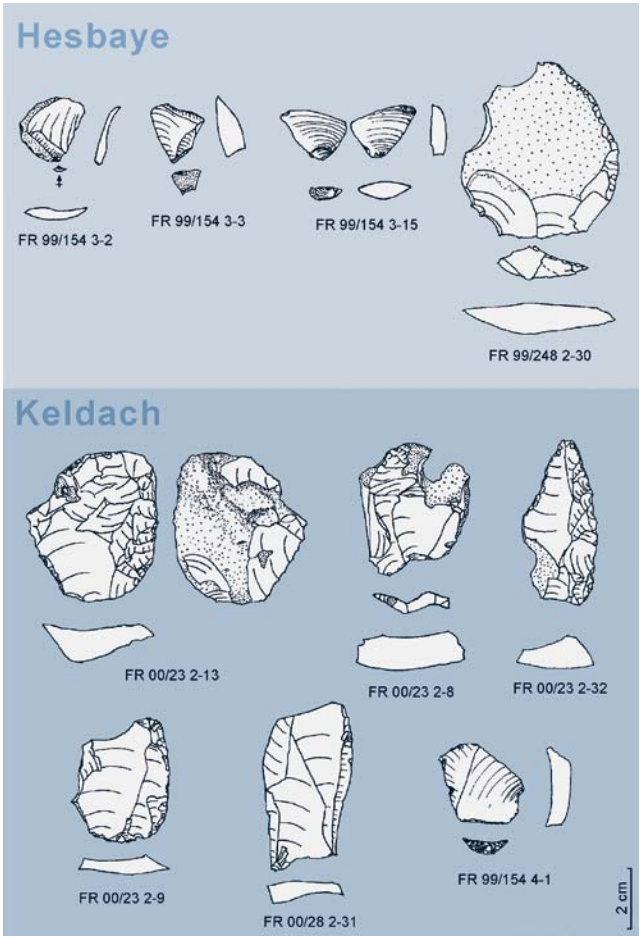

Fig. 5: Variety of Paleolithic stone tools from Keldach Loess (MIS 4) and Hesbaye Loess (MIS 2) excavated during the APA project from the Garzweiler open-cast mine (stone tool drawings from Böhner 2000).

Abb. 5: Bandbreite paläolithischer Steingeräte aus dem Keldach-Loess (MIS 4) und Hesbaye Loess (MIS 2), geborgen während des APA-Projekts im Tagebau Garzweiler (Zeichnungen der Steingeräte aus Böhner 2000).

• On the other hand, the very thin preserved uppermost Hesbaye Loess (lower MIS 2) representing the mature stage of the second cold maximum of the Last Glaciation yielded the other half of all finds in Garzweiler (Fig. 5).

• Unlike this, the Brabant Loess (upper MIS 2) deposited since the maximum of the Last Glacial did not deliver one single find, although this unit is widely preserved in its full thickness and comprises nearly the half of the whole loess cover of the examined walls.

4 Discussion

We interprete the find distribution as follows:

• The lack of Pre-Eemian finds may be due to the lack of the Erft Solcomplex along this wall. In Rheindahlen, this soil complex yielded a lot of finds (Schirmer 2002b, find compilation in Ikinger 2002). The Rocourt Solcomplex (MIS 5) was exposed over longer distances, but delivered no prehistoric finds. This may be due to local conditions. Other localities as Veldwezelt on the Maas river show rich find assemblages therein (Gullentops & Meijs 2002).

• The Keldach Loess – representing the Early Würmian maximum period – was exposed in a quantity as much as the whole pre-Eemian loess. Its find assemblage is unique for

Tab.1: Shares of the different loess units in the Garzweiler open-cast mine taken from 12 wall drawings (improved calculations compared to Kels 2007: Tab. 7).

Tab.1: Anteile verschiedener Lösseinheiten des Tagebaus Garzweiler, aus 12 Wandzeichnungen entnommen.

wall drawing no.	Holocene [m²]	average thickness [m]	Brabant Loess (MIS 2) [m²]	average thickness [m]	Hesbaye Loess (MIS 2) [m²]	average thickness [m]	Ahrgau Loess (MIS 3) [m²]	average thickness [m]	Keldach Loess (MIS 4) [m²]	average thickness [m]	Rheingau Loess (MIS 5) [m²]	average thickness [m]	Pre-Eemian [m²]	average thickness [m]	total [m²]	minimum loess thickness [m]	maximum loess thickness [m]	average total thickness [m]	wall length [m]
Wz 1-1 (FR 99/14-1)	–	–	371,88	4,36	40,62	0,53	–	–	59,96	1,54	3,04	0,16	301,48	3,97	776,98	9,66	10,56	10,22	76
Wz 1-2 (FR 99/14-2)	–	–	463,02	5,70	30,10	0,40	–	–	102,30	2,04	27,60	0,60		2,91	623,02	10,57	11,22	8,20	76
Wz 2-1 (FR 99/154-1)	–	–	128,22	2,47	29,24	0,73	–	–	182,52	4,56	–	–	–	–	339,98	8,17	8,52	8,50	40
Wz 2-2 (FR 99/154-2)	7,70	0,53	268,07	2,91	46,95	0,62	–	–	290,32	3,82	–	–	–	–	613,04	7,71	8,51	8,07	76
Wz 3-1 (FR 99/173-1) *	175,38	2,31	152,32	1,61	30,00	0,39	–	–	16,52	1,31	–	–	69,98	0,92	444,20	4,76	6,36	5,84	76
Wz 3-2 (FR 99/173-2)	6,94	0,45	203,04	2,90	26,34	0,43	–	–	61,96	1,63	8,93	0,22	104,54	1,71	411,75	6,37	6,92	6,75	61
Wz 4-1 (FR 99/248-1)	–	–	372,76	4,06	64,26	0,85	–	–	51,66	0,76	19,52	0,31	94,28	1,24	602,48	6,17	9,22	7,93	76
Wz 5-1 (FR 00/23-1-1)	–	–	240,74	2,85	24,14	0,32	–	–	376,56	4,95	–	–	178,22	2,35	819,66	10,21	10,91	10,79	76
Wz 5-2 (FR 00/23-1-2)	–	–	165,04	2,60	22,04	0,40	–	–	301,64	5,48	–	–	103,42	1,88	592,14	10,40	10,90	10,77	55
Wz 6 (FR 00/23-2)	–	–	287,48	3,60	13,82	0,18	–	–	125,88	2,03	32,06	0,51	239,58	3,15	698,82	8,80	9,25	9,20	76
Wz 7-1 (FR 00/28-1)	–	–	150,88	1,85	10,40	0,14	–	–	129,27	3,40	51,04	1,34	134,70	3,54	476,29	12,43	12,88	12,53	38
Wz 7-2 (FR 00/28-2)	–	–	156,59	1,75	23,28	0,31	–	–	167,81	4,67	10,99	0,84	101,09	2,66	459,76	11,82	12,62	12,10	38
Wz 7-3 (FR 00/28-3)	–	–	157,51	1,93	10,99	0,14	1,21	0,20	229,72	6,05	–	–	56,38	1,48	455,81	11,87	12,17	12,00	38
Wz 8-1 (FR 00/34-6-1)	30,52	1,60	39,15	1,81	4,74	0,28	–	–	13,97	0,74	–	–	–	–	88,38	4,80	4,50	4,65	19
Wz 8-2 (FR 00/34-6-2)	12,18	1,11	28,64	2,06	5,96	0,54	–	–	7,08	0,64	–	–	–	–	53,86	4,74	4,99	4,90	11
Wz 9-1 (FR 00/34-9-1)	–	–	432,44	5,27	31,84	0,42	–	–	177,10	2,33	–	–	302,94	3,99	944,32	11,71	13,06	12,43	76
Wz 9-2 (FR 00/34-9-2)	–	–	472,74	5,84	28,78	0,38	–	–	347,70	4,58	–	–	330,08	4,34	1179,30	13,70	16,25	15,52	76
Wz 10-1 (FR 01/1-1) *	127,58	1,70	253,50	2,77	42,64	0,57	35,18	0,92	88,99	1,21	–	–	11,04	0,43	558,93	4,11	10,61	7,35	76
Wz 10-2 (FR 01/1-2) *	–	–	463,66	5,61	37,08	0,49	8,54	0,56	138,82	2,26	–	–	10,92	0,51	659,02	6,25	10,40	8,67	76
Wz 10-3 (FR 01/1-3)	–	–	422,58	5,26	22,88	0,30	–	–	20,70	0,83	4,48	0,43	256,10	3,37	726,74	6,03	14,38	9,56	76
Wz 11-1 (FR 01/2-1) *	32,56	1,09	329,14	3,92	31,20	0,41	–	–	173,46	2,32	3,20	0,32	384,82	5,06	954,38	10,73	14,48	12,56	76
Wz 11-2 (FR 01/2-2) *	295,96	3,89	270,96	3,20	27,58	0,36	–	–	119,04	1,57	–	–	11,58	0,49	725,12	8,80	10,80	9,54	76
Wz 11-3 (FR 01/2-3) *	6,00	0,54	307,76	3,85	15,24	0,20	–	–	67,56	1,99	2,49	0,17	–	–	399,05	3,89	9,09	5,25	76
Wz 12-1 (FR 01/3-1)	54,94	0.75	63,00	0,68	21,84	0,33	–	–	53,98	0,87	–	–	5,96	0,16	199,72	0,67	4,92	2,63	76
Wz 12-2 (FR 01/3-2)	–	–	277,82	3,49	12,90	0,17	–	–	25,48	0,34	–	–	216,30	2,85	532,50	4,28	8,93	7,01	76
Wz 12-3 (FR 01/3-3)	–	–	152,08	4,24	7,82	0,23	–	–	30,70	0,90	–	–	127,46	3,75	318,06	8,93	9,63	9,35	34
total	112,28		4853,68		478,94		1,21		2756,31		157,66		2552,53		10912,61				1626
percental	1,03%		44,48%		4,39%		0,01%		25,26%		1,44%		23,39%		100,00%				
% without Holocene	0,00%		44,94%		4,44%		0,01%		25,52%		1,46%		23,63%		100,00%				

Note: italics = presumably; min. & max. loess thickness rounded to 5 cm; marked by*: wall drawings not usable for total balance

Tab. 2: Shares of both the loess units in the Garzweiler open-cast mine (from Tab. 1) and of Palaeolithic finds. (The small differences of the values given in Tab. 1 to that in Kels & Schirmer, 2006b are due to an improved planimetry.)

Tab. 2: Anteile der Lösseinheiten des Tagebaus Garzweiler (aus Tab. 1) und der zugeordneten paläolithischen Funde (geringe Abweichungen der Werte aus Tab. 1 zu denjenigen in Kels & Schirmer 2006b resultieren aus einer verbesserten Flächenberechnung).

Stratigraphy	MIS	Loess unit	Quota of wall area %	Number of finds	Quota of finds %
Late Würmian maximum 2	MIS 2	Brabant	45	0	0
Late Würmian maximum 1 Middle Würmian	MIS 2 MIS 3	Hesbaye Ahrgau	4 0,01	64 0	49 0
Early Würmian maximum	MIS 4	Keldach	25,5	66	50
Rhein Interglacial Complex	MIS 5	Rheingau	1,5	0	0
Pre-Eemian	MIS 6 to ?11	Pre-Eemian loess	24	?1	1
Total	-	-	100	131	100

this area. The Keldach Loess is very rich in solifluidal loess at its base. This is a widespread situation in central Europe. Semmel (1968: 30) named this solifluidal layer "Niedereschbacher Zone". Schirmer (2003a: 49) stated that this solifluidal layer according to local morphology may represent only a thin time slice at the base of the Keldach Loess as well as a rather long period comprising the whole Keldach and parts of the overlying Ahrgau Loess. There is no need to consider redeposition of finds into the Keldach loess because from the underlying Rocourt Solcomplex no finds are registered along the walls investigated, although this Solcomplex was exposed over very long distances. In most cases, the artefacts were accompanied by mammal bones, in some cases even artifical, which supports the glacial origin of the material. The finds of the Keldach complex are situated in close connection to small stream positions. Thus, these more moisture positions of the surface environment might have attracted both animals and hunters (Schirmer 2005: 32).

• The Ahrgau Loess was exposed only with its basal part in one small place (see Tab. 1). Thus, there was a limited possibility for preservation of possible relics.

• It is the uppermost Hesbaye Loess represented by the Kesselt Layer that yielded 50% of all finds despite of its share of only 5% of the whole wall area. The Kesselt Layer with an age around the Late Würmian maximum (Schirmer 2000b: 324, 2003b: 406) is a reworked deposit following the Eben Discordance, the most striking unconformity within the Last Glacial loess of the Lower Rhine-Maas area. Both find complexes, the Keldach and the Hesbaye complex, show low distance to episodic water run off and possible concentration of finds by soil wash and soil creep (Schirmer 2005: 32). Thus, the finds or some of them may result from reworking of older strata. Since the material is mostly still sharp-edged and likewise bone finds do not show rounding effects only little transportation over meters or decametres is estimated. Nevertheless, the question whether the finds of the Keldach Layer are autochthonous or reworked from nearby older strata remains open.

5 Conclusion

When starting statistical search for prehistoric finds within the loess plateau of the western Lower Rhine area it was expected that usually the interglacial complexes would yield the bulk of finds. The 6 km long Garzweiler exposure is assessed to exhibit a rather common situation for the loess plateau. Moreover, there occur small loess localities in the Lower Rhine area within tectonical subsidence position that exhibit quite different stratigraphical sections from that exposed in the Garzweiler exposure. These localities are, for example, the brickyards of Erkelenz (Schirmer 2002a) and Rheindahlen (Schirmer 2002b). Rheindahlen gave a large find inventory the bulk of which is of MIS 7 age. Those rarely exposed strata normally are cut by the great discordances along the long Garzweiler walls.

Surprisingly, the Garzweiler wall exhibited mostly finds from euglacial layers (Keldach Loess and Hesbaye Loess) (Tab. 2). This demonstrates that during wet euglacial periods hunters were active in the loess environment. It shows on the other hand that main interglacial find complexes are normally eroded on the extended western Lower Rhine loess plateau.

Nevertheless, the Garzweiler open-cast mine gave the opportunity to present two euglacial loess units of tundra environment (MIS 4 and MIS 2) with a human inventory of hunters in the tundra, which is unique up to now for the Rhineland.

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