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New data on four classic loess sequences in Lower Austria

Revize čtyř klasických sprašových profilů v Dolním Rakousku

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Abstract: This paper presents interim results of the investigations of the classic loess localities of Stranzendorf, Krems an der Donau Schießstätte, Furth and Paudorf bei Göttweig. Besides the palaeomalacozoology and palaeoosteology (Stranzendorf and Krems- new shooting range) the study was focused on the palaeopedological research of all the four localities. Information so far available on these loess complexes has been refined and extended. New data change considerable the stratigraphical classification of the sites at Stranzendorf and Furth.
Stranzendorf - new palaeomalacozoological and lithological data: The loess complex at this site contains assemblages of fossil molluscs and fossil soil horizons that are of Pleistocene type; the overbank loams deposited on the surface of the underlying sandy gravel always classified previously into the Neogene bear also the fossil molluscs of Pleistocene type. For this reason, the locality at Stranzendorf - like some other loess localities of the same age occurring in Europe and Asia (see fig. 6) - should be regarded as Lower Pleistocene in age, despite Rabeder's (in: Fink et al. 1974 and 1976); 1981 - small vertebrate fauna conventionally allocated to the latest Pliocene dated at 1.8 to more than 2.5 Ma.
New data were gained also from the sunken roadcut at Furth bei Göttweig - i.e. the type locality of "Göttweiger Verlehmungszone". Based on palaeopedological data, this expressive fossil soil is of interglacial type and correlates at least with the Mindelian. In all likelihood, it may be even older and may correspond to some older interglacial because it precedes stratigraphically the soil complex VII, which corresponds in Bohemian Massif to the inter-Mindelian interglacial.

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Introduction

Special studies of important localities are pursued as part of the programme of geological mapping of Lower Austria carried out by the Czech Geological Survey, Prague, in cooperation with the Geologische Bundesanstalt in Vienna. Particular attention is paid to the revision of the classical exposures, i.e. Stranzendorf, Krems a.d. Donau, Furth bei Göttweig and Pandorf. Main results are presented in this paper.

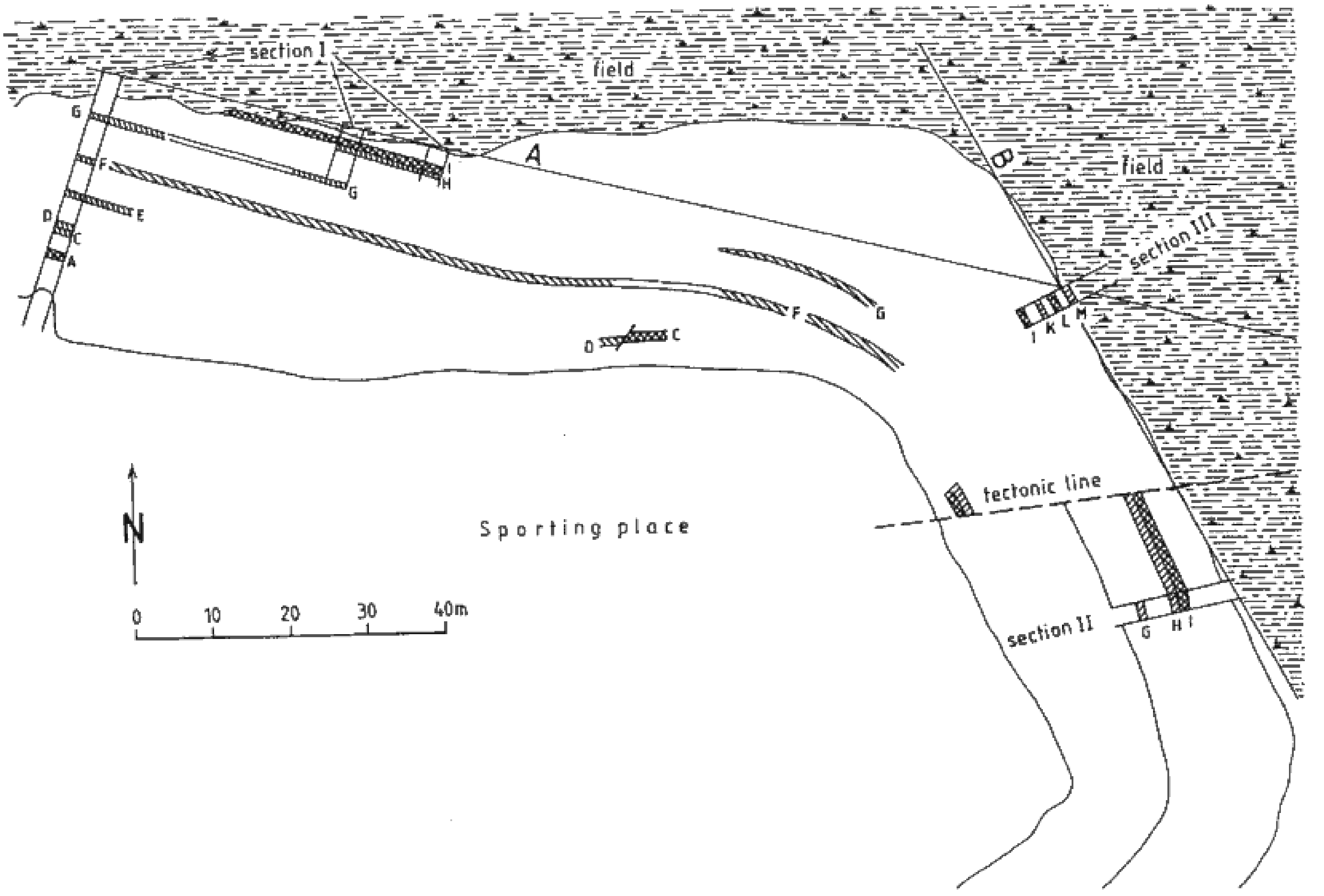
Stranzendorf (Northwest of Stockerau)

Jiří Kovanda

This locality is a now-abandoned gravel and loam pit on the south side of the Stranzendorf village. The local sequence of sediments several metres thick and more than 100 metres long was exposed in 1970. The sequence was studied in three sections (see Rabeder 1981, our figs 1, 2, 3). The oldest member of the succession consists of fluvial sand and gravel regarded as Neogene in age. It is overlain (see section I) by calcareous overbank laminites covered with colluvium and loess both containing layers of fossil soils, labeled, in ascending order, A to I. Section II shows fluvial deposits again with loess resting unconformably on them and incorporating fossil soils referred to as G, H and I.

The three sections provide evidence that a distinct fault exists between section II and III (see fig. 2) and hence the sequence in section I cannot be liked up unambiguously with that of section III. Consequently, doubts were expressed about Rabeder's (1981) original scheme showing the entire succession superimposed with fossil soils marked, from bottom upwards, with the symbols A to M (see fig. 3).

The locality has, since the beginning of studies, been regarded as late Pliocene in age. Evidence used in support of this assumption is threefold: (i) The altimetric position of the locality above the highest Quaternary terraces of the Danube; (ii) palaeontological data from small vertebrate analysis (e.g. Fink 1974, Rabeder in Fink et al. 1974,



1. Spatial distribution of fossil soil horizons (A to M) in the wall of the former pit for excavating aeolian loam, sand and gravel at Stranzendorf. After Rabeder (1981).

Rabeder 1981, Fink - Piffl 1975, Fink et al. 1976, Fejfar - Heinrich 1983, 1987, 1990, Horáček 1985, 1990, Rabeder - Verginis 1989, Verginis 1989, 1992, Horáček - Ložek 1988, Fejfar - Horáček 1990, Rabeder - Nagel 1991); (iii) position of the Gauss/Matuyama boundary (2.5 Ma) in a loess between fossil soils C and D (Kočí in: Fink et al. 1976, Fink 1979a, b, Bucha et al. 1975).

Fossil moluscs from Stranzendorf were studied by Binder (1977). Despite his statement that most of the twenty-three species found by him differ slightly from recent species and some are identical with those coming from the early Pleistocene, he places the entire locality in the late Pliocene with a question mark.

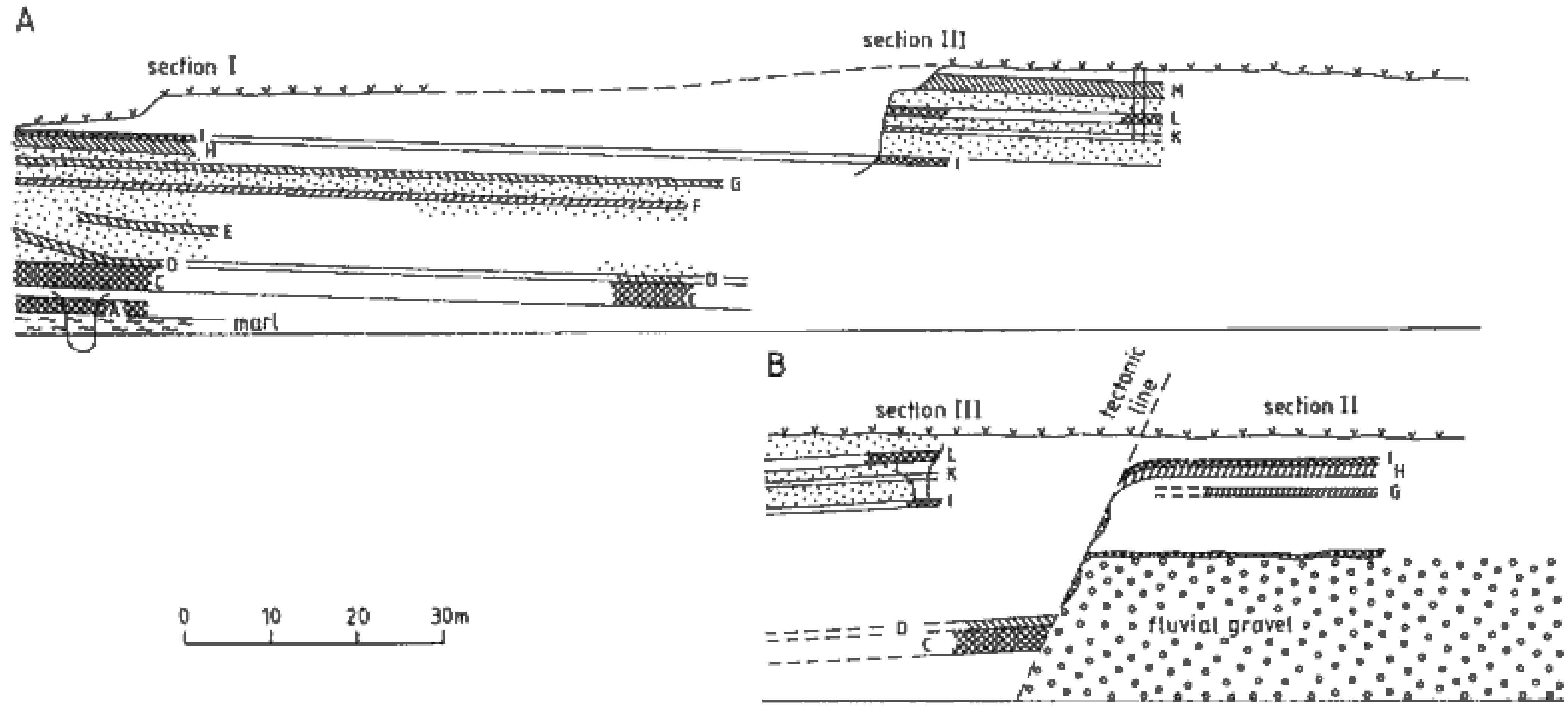
Rabeder (1981) in his monograph on the locality distinguished even four biozones of the genus *Mimomys* within the late Pliocene (lower Villányian or Beremendian), with members of upper Czarnótian age containing an unnamed zone of small vertebrates at the base of the succession, along with possible members of upper Villányian (Kislángian) age in the upper part.

Because the Gauss/Matuyama palaeomagnetic boundary can be drawn in the loess (see above) between fossil soils C and D, the loess has been claimed to be the oldest in central Europe (Rabeder - Nagel 1991), but strange enough within the Pliocene! In this case, however, the fact has been overlooked that loess deposition in Central Europe is confined with respect to the fauna to the glacial climax times, so-called pleniglacials. It is therefore necessary to resist the view that such climatic periods should be classified into the Pliocene, for glacials recognized in the Cenozoic era are restricted exclusively to the Pleistocene.

After examining Binder's (1977) list of fossil molluscs from the original sections I and II, I made three visits to Stranzendorf as follows: I. Draxler, Geologische Bundesanstalt, Wien, accompanied me in 1989; H. Kohl and R. Roetzel, Austrian colleagues, and L. Smolíková, J. Tyráček, M. Růžička, P. Havlíček, I. Horáček and E. Břízová, all from Prague, and Ĺ. Kaminská, from Košice, in 1992; and L. Smolíková, P. Havlíček and O. Holásek, all from Prague, in 1993. During the years 1989 to 1992 spot samples were taken from fossiliferous layers for palaeomalacoanalysis to extend Binder's (1977) collections. As a result, molluscs are as yet known from the twelve superimposed layers referred to as (molluscan fauna = MF) MF1 to MF12 (see fig. 3):

MF1: the oldest MF is from the alluvial (overbank) loam above fluvial sand covering fluvial sand and gravel in the SSE part of the succession (original section II), i.e. beneath the entire loess series (!) (1992)

MF2: examined by Binder (1977) immediately below "Rotlehm A"



2. Scheme showing the development of loess succession at Stranzendorf. After Rabeder (1981).

MF3, 4, 5: sampled from below immediately successive layers of colluvial loam containing rock fragments and from the Ca- horizon of "Rotlehm C1" (1989, 1992)

MF6: immediately above "Rotlehm C2" and below "Braunlehm D" (1989)

MF7: sampled directly from the "Braunlehm D" layer by Binder (1977)

MF8: from below the layer "Verbraunung E" (1992)

MF9: from the Ca-horizon of "Rotlehm L" (1989)

MF10: from the horizon with large lime nodules above "Rotlehm L" (1989, 1992)

MF11: from loess above MF10 (1989)

MF12: from the youngest loess in the east part of the exposure (Binder, 1977).

All the twelve malacofaunas comprise more than forty species of Mollusca corresponding to all the ten ecological groups sensu Ložek (1964a) - see list of fossils (tab. 1). Molluscs living in ecologically diversified habitats, known as indifferents, closely outstrip treeless including so called "steppe" species, along with forest species s.l., in numbers and frequency. Specimens inhabiting swamp and open water are very few.

Most of the molluscan faunas from the above layers from a mixed thanatocoenoses of two horizons differing in age: an older, soil-forming parent material, the C horizon, and a younger soil substrate more properly called the Ca-horizon. The presence of "steppe" (loess) and forest species found together in the sampled material can be explained by the fact that all the preserved B soil horizons formed in the understorey of continuous mixed deciduous forests. MF12 is interpreted as a pure thanatocoenosis of loess and MF3 plus MF4 like colluvium respectively. MF11 can be regarded as a malacofauna intermediate between glacial and interglacial times.

The malacofaunas dealt with in this paper provide unequivocal evidence of the occurrence in the succession of at least seven first-order warm climatic fluctuation referred to as interglacials (MF1, 2, 5, 6-7, 8, 9, and 10-11), **and of more than six periods of loess formation** (MF6, 8, 9, 10, 11 and 12), **out of which at least four glacial climax times** were characterized by the species *Vallonia tenuilabris* (Br.) and *Columella columella* (Mart.) - MF6-7, 8, 9 and 12.

All the molluscan species found at the site occur in Quaternary type of deposits. In view of the contained specimens of *Gastrocopta serotina* Lžk. (see Ložek 1964b), *Azeca goodalli* (Fér.) and *Catinella arenaria* (Bouch.-Chant.) and with respect to *Granaria frumentum* (Drap.) continuously present throughout the whole profile it can be stated that the whole suite of sediments, with the alluvial loam as a final member of fluvial sediments on which there unconformably rests the whole loess series, should be lower Pleistocene, not upper Pliocene, in age as given in the literature (see above). After consulting V. Ložek and I. Horáček it was concluded that the faunas from Stranzendorf show close relationships to those from the site at Citiněves-Hýkovina below the Hill Říp allocated to biocoenosis MN17 (equivalent in time to Villányian).

The presence of otherwise Pliocene vertebrates at Stranzendorf (Rabeder in Fink et al. 1974, 1976 and 1981) - must therefore be explained as being relics of species persistent up to the lower Pleistocene. It should be noted that the currently used Plio/Pleistocene boundary at 1.64 Ma has not uncommonly failed to retain its validity [see, eg., Colalongo - Pasini - Sartoni (1981), Nilsson (1983), Aguirre - Pasini (1985), Cepek - Jäger (1988), Šibrava (1992, 1993), Pécsi (1993), Ložek (1994)], due either to data misinterpretation or to erroneous palaeomagnetic measurements. Evidence from an increasing variety of world sources means that the most acceptable date for the lower limit of the Pleistocene should be 2.2-2.5 Ma, what coincides with the true onset of evidently global cooling known as glacials (see fig. 6).

Table 1. Fossil molluscs from Stranzendorf

				Molluscs fauna (MF)											
				1	2	3	4	5	6	7	8	9	10	11	12
A	1	!!	*Azeca goodalli* (Fér.)					•							
		!!	cf. *Perforatella dibothrion* (Kim.)	•											
		!!	*Discus perspectivus* (Meg. v. Mühl.)								•				
		!!	*Macrogastra plicatula* (Drap.)	•											
		!	*Macrogastra* sp.									•			
		!	*Acanthinula aculeata* (Müll.)		•										
		(G)	*Discus ruderatus* (Fér.)	•				•	•		•	•	•	•	
			Vertigo pusilla Müll.		•				•	•	•	•	•		
			cf. *Vitrinobrachium* sp.		•										
	2	(+)	*Arianta arbustorum* (L.)										•		
		!	*Discus rotundatus* (Müll.)		•										
		(!)	*Bradybaena fruticum* (Müll.)									•			
			Bradybaena aut Arianta frgm.								•		•		
		(+)	*Vitrea crystallina* (Müll.)					•		•	•				
	3	(+)	*Perforatella bidentata* (Gmel.)					•			•		•		
B	4	(+)	*Granaria frumentum* (Drap.)	•	•	•	•	•	•	•	•	•	•	•	
		(+)	*Chondrula tridens* (Müll.)		•			•	•	•		•	•	•	
			Pupilla sterri (Voith)									•	•		
		(+)	*Pupilla triplicata* (Stud.)	•					•	•			•		
	5	+	*Vallonia tenuilabris* (Br.)						•	•		•			•
		+	*Columella columella* (Mart.)								•				•
		+	*Pupilla muscorum* (L.)						•	•		•	•	•	
		(+)	*Vallonia costata* (Müll.)							•	•	•	•	•	•
		(+)	*Catinella arenaria* (Bouch.-Chant.)						•	•					
			Vallonia sp. frgm.	•				•			•				
			Pupilla sp. juv. et frgm.								•				
		(!)	*Truncatellina cylindrica* (Fér.)		•				•				•		
		G	*Vallonia pulchella* (Müll.)		•			•	•	•			•		
C	6	(!)	*Euomphalia strigella* (Drap.)				•		•		•				
	7	(+)	*Cochlicopa lubrica* (Müll.)	•	•				•	•	•	•	•	•	
		(+)	*Euconulus fulvus* (Müll.)						•	•					
		(+)	*Nesovitrea hammonis* (Ström)								•				
		(+)	*Punctum pygmaeum* (Drap.)		•					•	•				
		+	*Trichia* cf. *hispida* (L.)												•
			Gastrocopta serotina Ložk.						•	•					
			Trichia sp. frgm.	•					•						
			Limacidae	•							•				
		(+)	Clausilia dubia *Drap.*	•	•		•	•		•	•	•			•
		(+)	*Clausilia parvula* Fér.												•
		!	*Helicigona lapicida* (L.)					•							
			Vertigo aff. *alpestria* Alder	•							•	•			
	8	!	*Carychium tridentatum* (Risso)								•	•		•	
		+	*Succinea oblonga* Drap.						•						•
D	9	(G)	*Vertigo angustior* Jeffr.					•							
		(G)	*Vertigo antivertigo* (Drap.)					•							
		G	*Carychium minimum* Müll.								•				
	10	(+)	*Lymnaea truncatula* (Müll.)											•	
?			*Helicidae* frgm.	•			•	•				•		•	
			Zonitidae frgm.	•		•	•								
			Clausiliidae frgm.			•		•	•						
			cf. *Oxychilus* sp. frgm.								•				
			Vertigo angustior or *pusilla* juv.	•											

Stranzendorf provides therefore an additional evidence for the proposed lowering of the Plio/Pleistocene boundary.

Fossil soil micromorphology

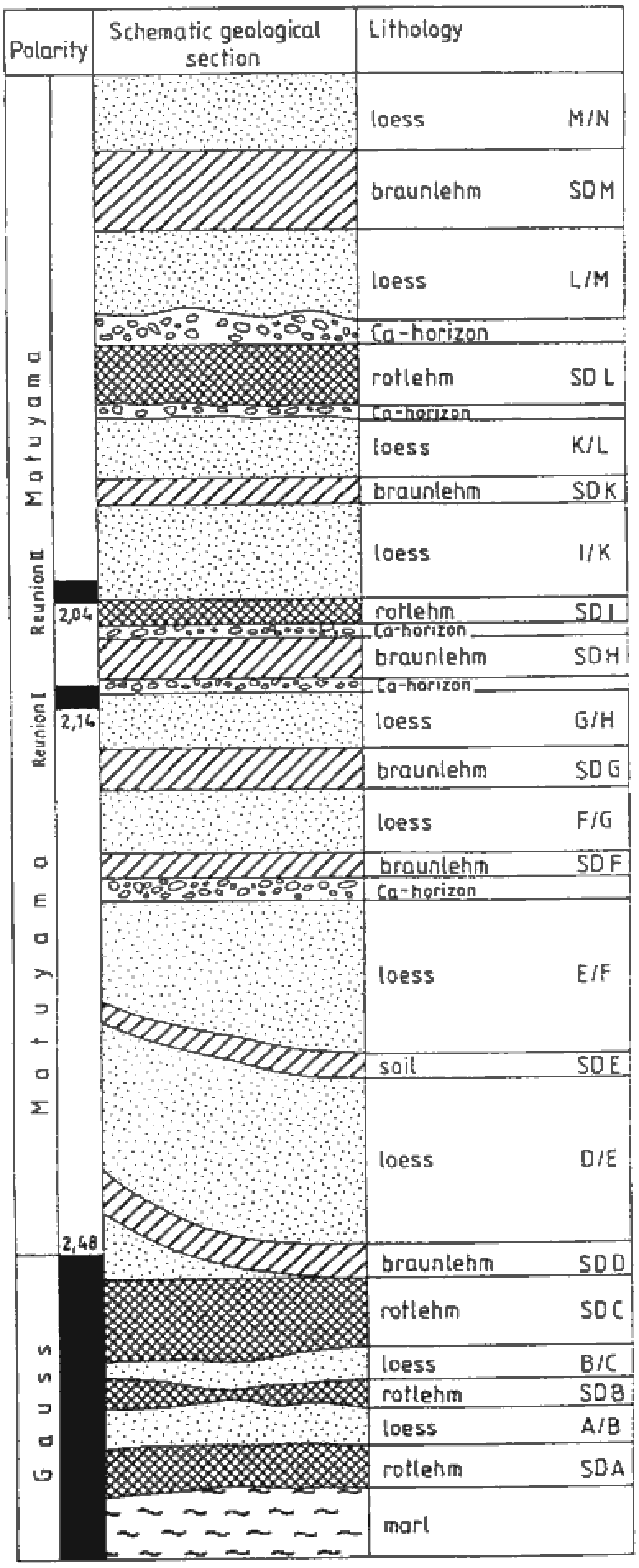
Libuše Smolíková

Preliminary samples were taken from hitherto well accessible and identifiable soils horizons (see Rabeder's figures, 1981. our figs. 1, 2) at Stranzendorf in 1992. The horizons were sampled for palaeopedological purposes and were coded with Rabeder's symbols A, C_1, C_2, D, F and L. The presence of rotlehm and braunlehm was confirmed in the C, D and F horizons, whereas the soil labeled A and L were identified as rubified braunlehm, not rotlehm as described previously. The detailed description of individual soils is always supplemented in following text by an account of pedogenetic processes known to have been operating subsequently in each of the horizons under consideration (see Smolíková 1994).

Sample 1 = B horizon of soil A (5YR 5/6 - examined dry):
Matrix, dark-ochreous-yellow; contains braulehm fabric plasma; segregated; voids represented by acutely bent, irregularly reticulate joints and fractures but cut secondarily by parallel fractures; segregated parts contain few microvoids. - Primary components dominated by quartz grains and fragments or pebbles of quarzite having joints filled with dark red plasma; orthoclase, muscovite, biotite, augite, amphibole, and plagioclase sparse. Secondary components are beside the plasma described above, braunlehm nodules circular or oval in outline and having smooth faces. Matrix contains a mixture of carbonate (loess) particles, both rounded and angular. - Channelway walls covered by heavy amorphous calcium carbonate accumulation.

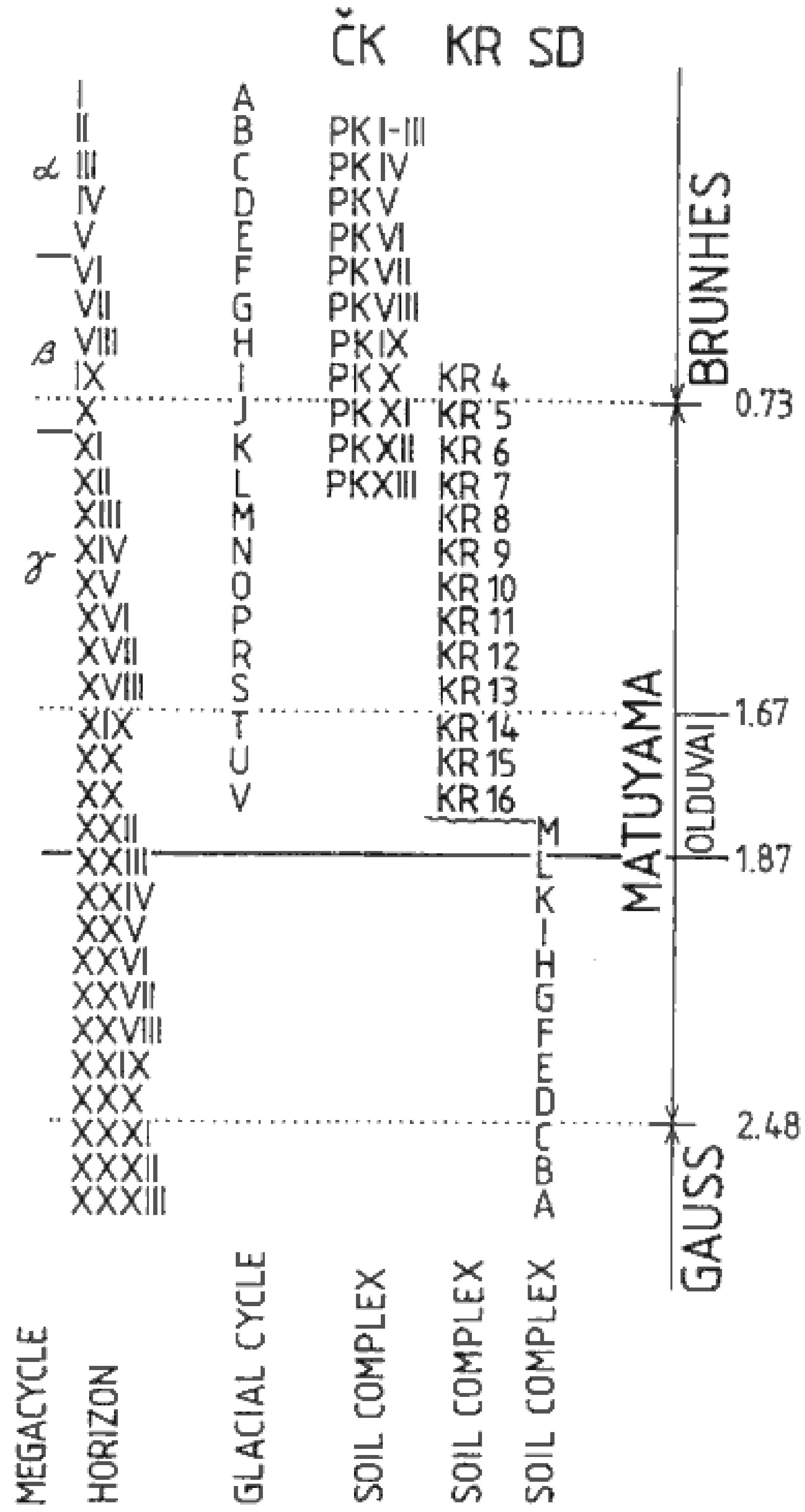
Sample 2 = Ca horizon of soil A (5YR 6/6):
Matrix, light-ochreous; contains predominantly amorphous calcium carbonate, with dark-yellow, optically highly active peptized plasma cutting it at places only. Primary components are the same as those recognized in sample 1 but differ only in containing a little higher proportion of muscovite. Secondary components include braunlehm nodules in addition to sparse streaks of "manganolimonite" stairs irregularly lobate in app- earance. Matrix is cut by parallel joints and fractures, as in sample 1.

Explanations (symbols by Ložek in this volume - paper on Skalka travertine mound at Hôrka-Ondrej): A - woodland; B - open country; C - woodland/open country; D - marshlands, waters; 1 - closed woodland; 2 - predominantly woodland (mesic or dry habitats); 3 - damp woodland, riverine forest; 4 - stepes; 5 - open habitats in generel; 6 - predominantly dry; 7 - mesic or indifferent; 8 - predominantly moist; 9 - moist terrestrial habitats (swamps, moorlands); 10 - aquatic habitats.
! - species characteristic of warm phases; !! - interglacial index species; (!) - tolerant species of warm phases; + - loess species; ++ - index species of loess; (+) - local or occasional loess species; G - species surviving the glacials out of the loess zone; (G) - ditto as relicts



3. Reconstruction of the stratigraphical scheme showing the development of loess succession at Stranzendorf. After Rabeder (1981).

Genetic assessment: A redeposited soil of braunlehm - type having two horizons, B and Ca. The soil sediment (horizon B) contains dark-red material derived from older (sub) tropical weathered rocks. Its redeposition was operative concurrently with discontinuous sedimentation allow-



4. Comparison of the 33 pedogenetic cycles of aeolian deposits during the last 2.5 million years: ČK = Brno-Červený kopec Hill; KR = Krems a.d. Donau - shooting range; SD = Stranzendorf. The scheme shows the site at Stranzendorf to be chronologically older than that at Krems a.d. Donau - shooting range. Compiled from the following papers: Ložek (1973), Kukla (1975), Fink - Kukla (1977), Fink (1979a, b) and Rabeder (1981).

ing the strongly weathered soil to incorporate unweathered allochthonous component, e.g. plagioclase. The soil was intensively re-calcified before becoming mantled by other deposits.

Sample 3 = B horizon of soil C_1 (5YR 5/6):

Dark-brownish-yellow, locally reddish matrix contains braunlehm fabric plasma; found as crumbs and well preserved excretions of fossil earthworms (*Lumbricidae*). Voids filled with acutely bent joints and fissures typical of segregate structure; earthened parts (pseudo) aggregate structure characterized by a low proportion of voids within coprogenic edaphic elements and by a higher amount of voids between aggregates; both fabric forms are cut by joints and fractures running parallel to soil surface. Primary components dominated by quartz grains; orthoclase and muscovite present; and biotite, augite and amphibole found in lesser amounts; dark red plasma fills fractures of quartzite. - Secondary components include rare braunlehm nodules and black, irregularly radial manganese coatings locally rimming fractures expert those running parallel one to another.

Sample 4 = B horizon of soil C_2 (5YR 5/4):

Matrix, deep-orange-red, braunlehm plasma. Processes leading to earthening more prominent here than in the horizon below (sample 3). Voids and fabric also identical with those observed in the preceding sample but differ only in having more aggregates and wider fractures produced by frost effects. - Primary components well sorted in grain; predominantly silt; mineralogically invariable; quartz grains dominant, some orthoclase and muscovite, pebbles of quartzite rare. Secondary components are braunlehm nodules and manganese coatings often seen on aggregates and covered by amorphous calcium carbonate mostly filling matrix voids.

Genetic assessment: Both B horizons (lower soil C_1, sample 3; upper soil C_2, sample 4) indicate rotlehm - type soils subject to a stronger and a weaker earthening respectively. There main polygenetic processes operated subsequently in both soils. The first process was pseudogleying during a period of higher humidity (and colder climate); the second the cryogenic disturbation; and third a final recalcification suggesting glacial climate in the upper soil; there is no evidence of recalcification of the lower soil for, once slightly pseudogleyed, it was covered by a thin, but well sorted loess from which the upper soil of the same type developed.

Sample 5 = B horizon of soil F (7.5YR 7/6):

Matrix, deep-ochreous-yellow, peptized, cut by a network of acutely bent joints and fractures as the only voids observed; forms mainly segregated polyhedrons. Mineralogical composition of soil microskeleton perfectly sorted in grain is invariable throughout; quartz grains and little muscovite only. Matrix contains numerous braunlehm nodules of prominent concentric texture, sparsely scattered manganese oxide coatings irregularly lobate in appearance, and parts subject to uneven and slight earthening; pelitomorphic recalcification in some channelways.

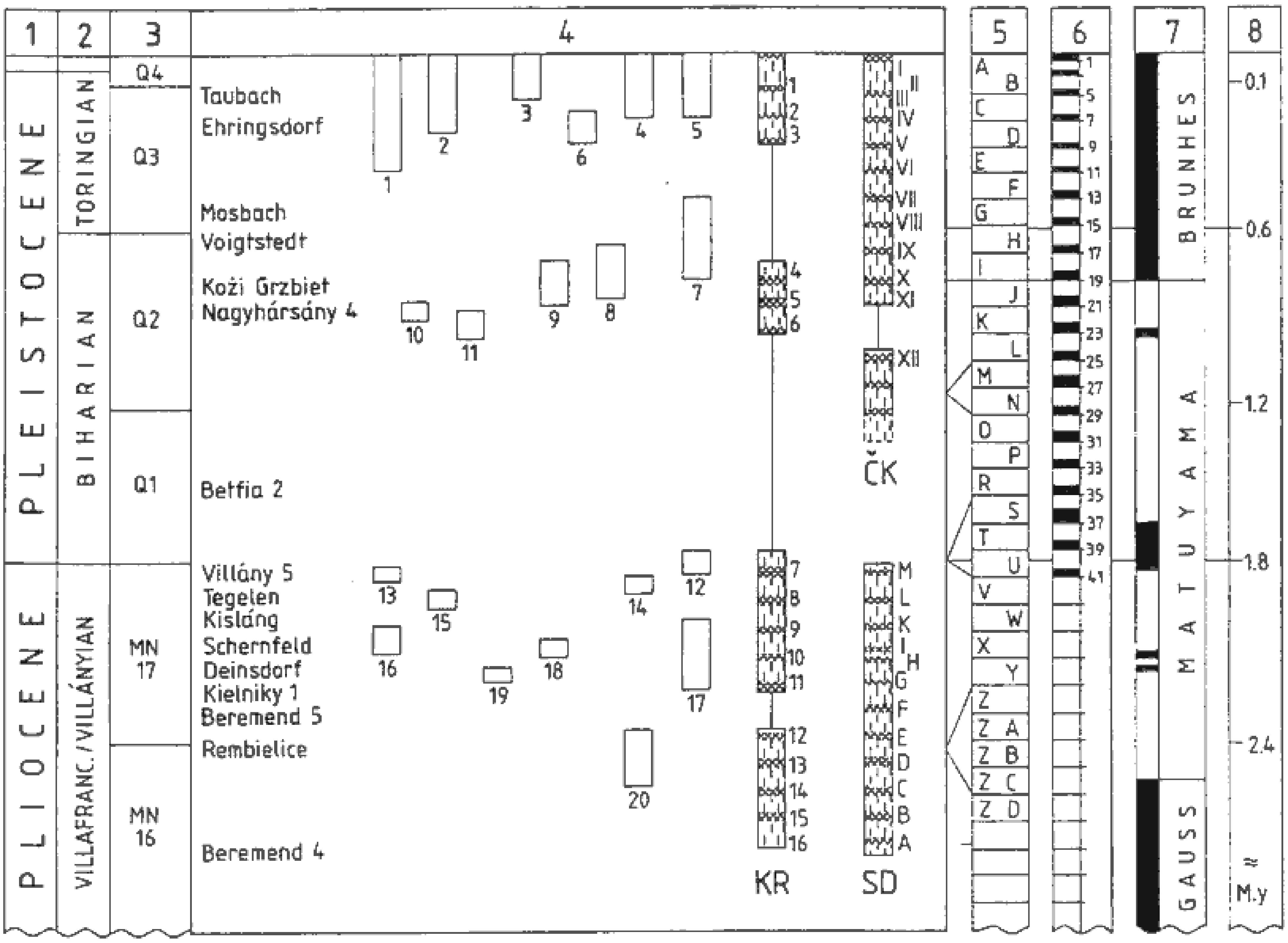
Sample 6 = Ca horizon of soil F (10YR 8/2):

Matrix, whitish-gray; calcium-carbonate cemented primary components dominated by quartz, orthoclase, and muscovite; amphibole, augite, baueritized biotite; plagioclase, etc. rare. Signs of weak pseudogleying extend into this horizon.

Genetic assessment. After reaching its climax time, the well-developed soil of braunlehm type was weakly earthened, slightly pseudogleyed and recalcified.

Sample 7 = B horizon of soil L (7.5YR 5/8):

Matrix consists of two different fabric elements: one predominates as a deep-ochreous-yellow braunlehm plasma and the other



5. Comparison of the hitherto conventionally adopted Upper Pliocene and Lower Pleistocene localities yielding fossil mammalian assemblages.
1- standard subdivision; 2 - stages of the biostratigraphic system (see Fejfar - Heinrich 1983); 3 - the Quaternary and the Late Pliocene biozones; 4 - assumed position of several Middle European and Czechoslovak sites (1 - Dolní Kounice; 2 - Předmostí; 3 - Kobyla-Chlupáčova sluj; 4 - Podbaba; 5 - Letky; 6 - Turold u Mikulova; 7 - Chlum u Srbska; 8 - Únětice; 9 - Brno-Stránská skála; 10 - Brno-Lažánky 2; 11 - Gombasek 1, 2; 12 - Včeláre 3; 13 - Koliňany 3; 14 - Včeláre 5; 15 - Včeláre 7; 16 - Koliňany 1, 2; 17 - Ctiněves-Hýkovina; 18 - Plešivec-Csepkö; 19 - Včeláre 6; 20 - Javoříčko 1-11; KR = Krems a.d. Donau - shooting range; SD = Stranzendorf; ČK = Brno-Červený kopec Hill). The sites at Krems a.d. Donau - shooting range containing fossil soils KR 16 through KR 7 and at Stranzendorf are considered to have originated during the same period of time, i.e. biozones MN 16 and MN 17. 5 - sequence of glacial cycles (sensu Kukla, 1978); 6 - sequence of ^{18}O stages; 7 - sequence of magnetostratigraphic stages; 8 - chronology. Compiled from Horáček - Ložek (1988) and Horáček (1990).

is red in colour and flocculated. In the former case voids are represented by a network of acutely bent joints and fractures; whereas in the latter case they lie between and within aggregates where coprogenic elements of fossil earthworms have been found preserved. Braunlehm nodules within the peptized matrix are rusty-black when seen in the incident light but red when flocculated. Primary components are dominated by quartz grains and minute, strongly weathered fragments and pebbles of quartzite. The matrix is cut sparsely by a black powder of manganese oxide locally forming thin coatings on channelways left by rootlets or worms; manganese oxide is coated by amorphous calcium carbonate.

Sample 8 = Ca horizon of soil L (10YR 8/2):

Micromorphological features are the same as those observed in thin section 6 showing the carbonate horizon of soil F.

Genetic assessment: The soil corresponds to braunlehm subsequently rubified (red earthened), slightly pseudogleyed, and finally recalcified.

Sample 9 = B horizon of soil D (10YR 6/6):

Matrix, yellowishochreous, of braunlehm plasma; contains minute braunlehm nodules circular or elliptical in outline and having smooth faces; contains also a substantially lower amount of flocculated material with interstices booth between and in voids within aggregates. Primary components are especially guartz grains followed by abundant biotite, muscovite, and orthoclase; augite, amphibole and plagioclase are few; largely silt; coarse sand also present. Matrix contains fairly abundant manganese oxide black in colour and irregularly radial in outline; wide fractures running parallel to soil surface; and calcium-rich accumulation ditions different from those existing at the site of Krems-shooting range.

Krems a.d. Donau - Schießstätte (= shooting range)

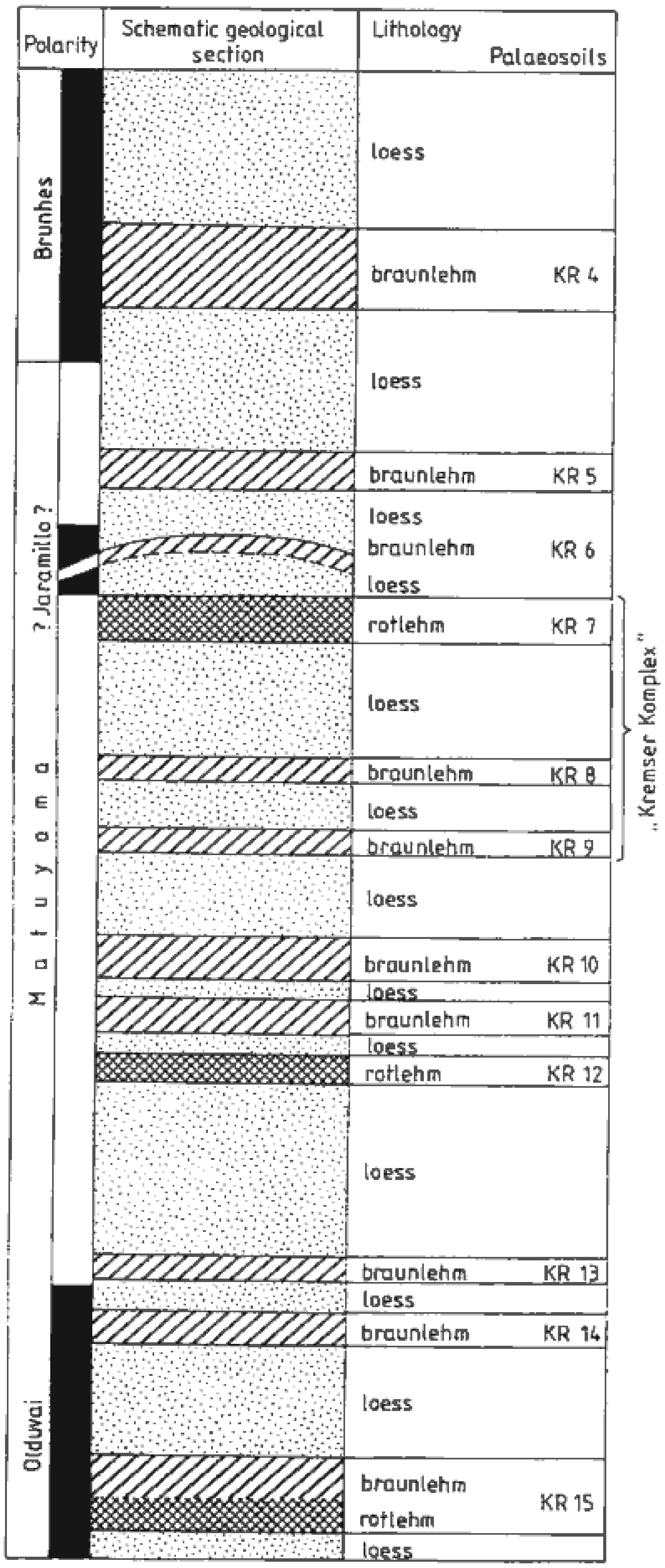
Jiří Kovanda

A sequence of loess and fossil soils nearly 35 meters thick contains 15 (to 16?) fossil soils hitherto described from this locality. It has been known since the beginning of this century. As early as 1903, the locality was visited by the participants of the IX. International Geological Congress under the guidance of A. Penk. As the local brickyard was then abandoned, the sequence has remained virtually intact over ninety years - a rather unique situation encountered in unconsolidated Quaternary deposits.

The locality was reported on for the first time by Hoernes, also in 1903 - see also Bayer (1909). It was not until 1935 and 1936 that studies of the sequence by Götzinger resulted in a description of the group of horizons (now marked with the symbols KR 7 to KR 9) called "Kremser Verlehmungszone" or "Kremser Komplex" synchronous, in his view, with the occurence of the Mindel/Riss "great interglacial". The name "Göttweiger Verlehmungszone" was used by him to analogue the fossil soils exposed in the roadcuts west of Furth bei Göttweig and north neighbour roadcut Aigen. The fossil soil lying still higher (and hence younger in age) at the nearby Paudorf locality was called by him "Paudorfer Verlehmungszone" or "P. Boden" (Fink et al. 1976).

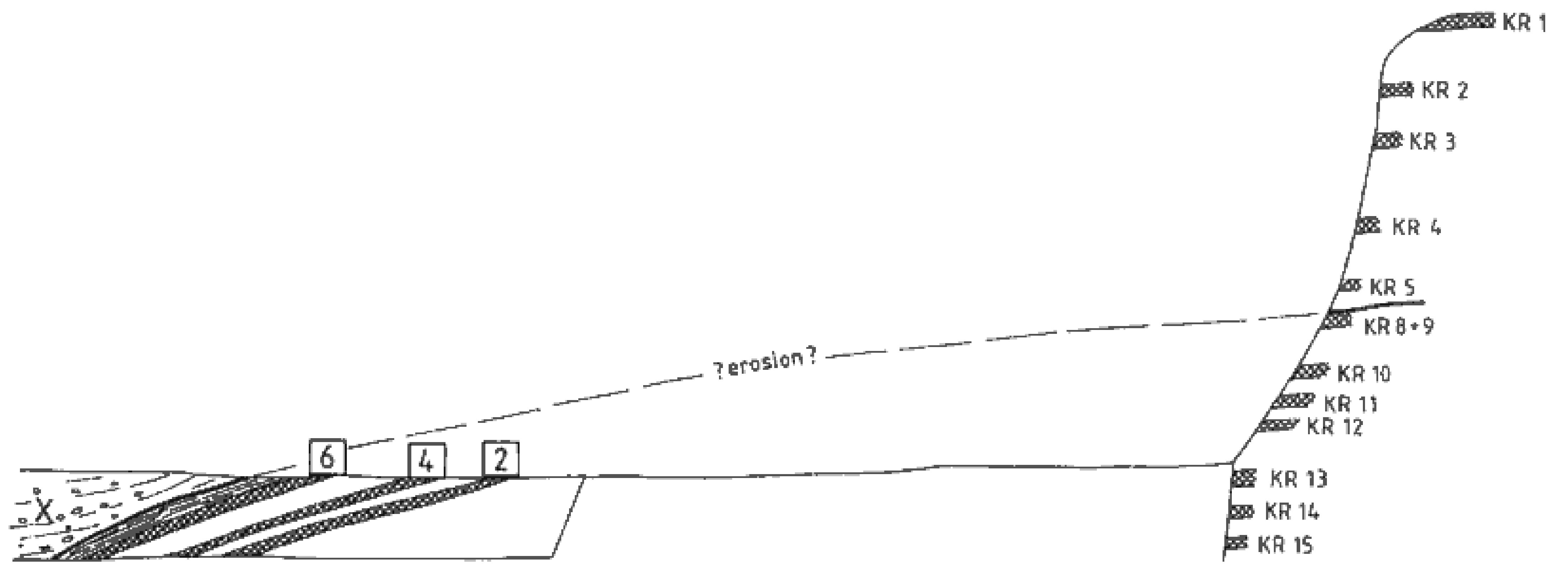
After revising the horizons described above, Fink produced (1954-1969) a new stratigraphical scheme of Lower Austrian loess complexes linked with the Danube terrace system. However, the validity of his system was gueried by J. Kovanda during a joint Czech-Austrian field trip made in 1967. In support of his critical view he pointed to the presence of peak interglacial molluscan faunas in the "Paudorfer Boden" (Šibrava 1986) which J. Fink thought were referable to the Würm Interstadial. Further, J. Kovanda put forward arguments for a considerably higher age of the "Göttweiger Verlehmungzone" than previously reported as a soil equivalent to the interstadial W I/II or the last interglacial. Conclusive evidence needed to establish the validity of the view held by this author soon became available (e.g. Freising 1951, 1956, Lais 1951, Brandtner 1956, Wiedenbach 1956, Gross 1957, Woldtstedt 1958a, Fink 1969a, b, c, 1973a, b, Demek - Kukla et al. 1969, Šibrava 1972, Bronger 1976, Nilsson 1983, etc.).

During the sixties the importance of loess sequences in Lower Austria led to the renewed special studies of the above mentioned localities using palaeomagnetic, palynological a palaeoosteological methods supplemented, from 1968 onwards, by palaeomalacozoological examination. The results of these studies were submitted to the INQUA Loess Commission in 1970. They appeared also in the excursion guide for those visiting the Alpine foreland



8. Reconstruction of the stratigraphical scheme showing the development of loess succession at Krems a.d. Donau - shooting range. After Rabeder (1981).

between Krems a.d. Donau and the Vienna Gate in Austria (Fink et al. 1974, 1976), and in other numerous publications, e.g. by Ložek (1964c), Fink (1974, 1979a, b), Kočí (1974), Fink - Piffl (1975), Fink - Kukla (1977), Ložek - Frenzel in: Fink et al. (1978), Rabeder (1981), Horáček (1981, 1985,



9. Scheme showing the roadcut in the new section drawn across the abandoned brickyard base at Krems a.d. Donau - shooting range. Numbers 2 through 6 in quadrangles indicate recently exposed fossil soil horizons yielding (below) ample mollusc and vertebrate fauna of Lower Pleistocene age (orig. J. Kovanda 1993).

1990), Fejfar - Heinrich (1983, 1990), Kohl (1986), Horáček - Ložek (1988), Rabeder - Verginis (1989, 1992), Kovanda (1987, 1993).

The previous publications on Krems can be summarized as follows:

1. The loess soil complex exposed at the locality attains an unusually great thickness and overlies amphibolite at altitudes between 255 and 290 metres above sea level.

2. Evidence exists indicating the presence of 15 to 16 (?) fossil soil or soil complex marked, in descending order, with the symbols KR 1 to KR 15 (KR 16?) - see, e.g., Kukla (1975), Fink et al. (1976), Fink - Kukla (1977), Ložek in: Fink et al. (1978), and Rabeder (1981) - see fig. 7.

3. From KR 4 (inclusive) downwards, fossil soils are represented by braunlehms or rotlehms - see, e.g. Rabeder (1981).

4. Since the beds immediately overlying KR 7 reportedly suffered extensive erosion, it is to be expected that a break in deposition of unknown duration intervenes between KR 6 and KR 7 (Kukla 1975, Fink - Kukla 1977, etc.).

5. The Brunhes/Matuyama reversal dated by palaeomagnetic investigations at 0.788 Ma lies in loess between KR 4 and KR 5 (Kočí 1974), whereas the normal Jaramillo polarity (0.89 to 0.95 Ma) lies (i) between KR 5 and KR 6 (Fink 1974) or (ii) within KR 6 and the loess below (Bucha et al. 1975, Kočí - Kukla in: Fink et al. 1976, Rabeder 1981) or (iii) within and immediately above KR 7 (Fink - Kukla 1977). The palaeomagnetic reversal equated with the Olduvai Event (1.67 Ma) within the Matuyama Epoch, is assigned between KR 11 and KR 12 (Buchta et al. 1975) or between KR 13 and KR 14 (Kočí - Kukla in: Fink et al. 1976, Fink - Kukla 1977, Fink 1979a, b and Rabeder 1981).

6. Borehole No. 2 situated on the floor of the former brick-yard, has yielded impoverished assemblages of pollen of the steppe and steppe-forest vegetation suggesting KR 13 to KR 15 (? KR 16) - cf. Frenzel in Fink et al. (1978).

7. Horizons KR 7, 8, 9, 10 and 12 contain rare bones and teeth. This interval was assigned stratigraphically by Rabeder (1981) to the Lower Pleistocene, particularly the Kislángian, i.e. the upper Villányian producing faunas known as V3 and V5 from the localities Včeláre 3B3, Kisláng, Osztramos 3, Kadzielnia, Tegelen or Koliňany.

8. Utilizing Rabeder's analysis, other authors (Fejfar - Heinrich 1983, Horáček - Ložek 1988, Horáček 1990) also allocated the larger part of the sequence to the Kislángian, particularly the Villányian 3, i.e. the stage *Lagurodon*-Villányian equivalent to the Tegelenian or lower Steinheimian in which other localities such as Citiněves-Hýskovina and Stranzendorf are also placed. Both are dated to more than 2 million years. The prevailing part of the sequence exposed at Krems-shooting range thus falls within the range of mammal fauna referred to as biozone MN 16 and, in particular, MN 17. This is clearly in conflict with those (e.g. Rabeder 1981, Kovanda 1987) who favour Stranzendorf as an older locality assigned to the so-called Beremendian (lower Villányian, that is, older than the entire succession at the site of Krems-shooting range.

9. Ložek (1964a, b) was the first to record the occurrence of fossil molluscs at the locality. Specimens of the rare extinct species *Gastrocopta serotina* Lžk. were collected already from the site by A. Edlauer. In 1969 Ložek took three spot samples from (i) beneath KR 8 (I), (ii) above KR 7 (II) and (iii) beneath KR 4 (III) (Ložek in: Fink et al. 1976). He obtained 43 molluscs species together with seeds of *Celtis* sp. The oldest faunal fragments (I) including species known from the interglacial climatic optimum namely *Aegopis klemmi* Sch. a Lžk. *Helicigona čapeki* (Pbk.) and especially *Gastrocopta serotina* Lžk. are classified to the upper Villafrankian; then he compared the malacofauna (II) from the middle horizon above the "**Kremser Komplex**", again which contains interglacial species inclusive of *Helicigona čapeki* (Pbk.) and *Celtis* sp., with that found at the Chlum IV locality in the Bohemian Karst. The age given for this locality is pre-Biharian to which he assigned the young-

Table 2. Fossil molluscs from Krems a.d. Donau new shooting range (for explanation see Table 1)

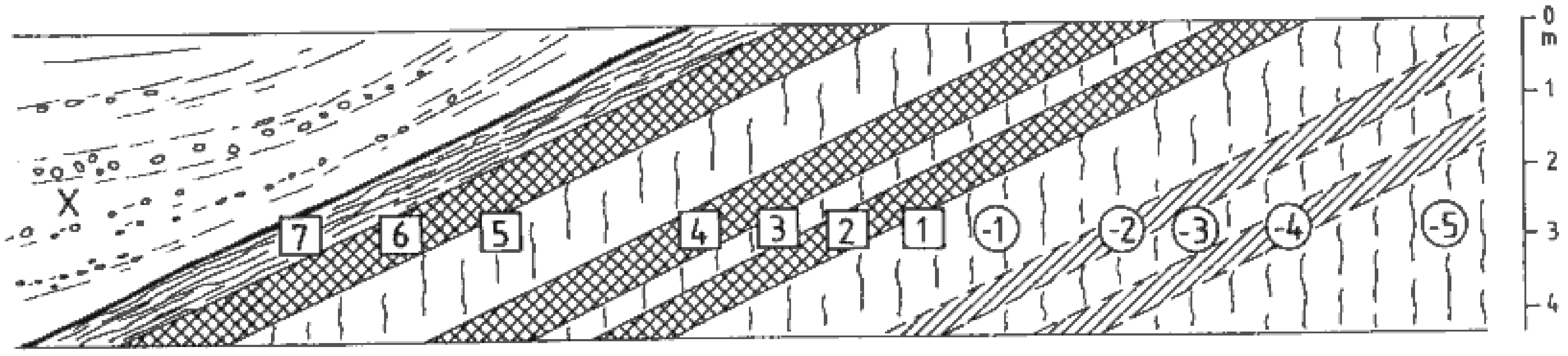
				Layer No.				
				-1	-2	-3	-4	-5
A	1	!!	*Discus perspectivus* (Meg. v. Mühl.)				/	
		!!	*Macrogastra densestriata* (Rossm.)		/			/
		!	*Macrogastra* sp. (small form)	/	/			/
		!	*Macrogastra* sp.	/	/	/	/	/
		!	*Acanthinula aculeata* (Müll.)					/
		(G)	*Discus ruderatus* (Fér.)		/	/	/	/
			Vertigo pusilla Müll.	/	/	/	/	/
			Clausilia cf. *cruciata* Stud.	/	/	/	(/)	/
	2	(+)	*Bradybaena aut Arianta* frgm.	/	/	/	/	/
	3	(G)	*Clausilia pumila* PF.	/	/	/	/	/
		(+)	*Perforatella bidentata* (Gmel.)	/	/			
B	4	(+)	*Granaria frumentum* (Drap.)	/	/	/	/	/
		(+)	*Pupilla triplicata* (Stud.)	/		/	/	/
		+	*Pupilla sterri* (Voith)	/	/	/		
		+	*Helicopsis striata* (Müll.)	/	/	/	/	/
		(+)	*Chondrula tridens* (Müll.)	/	/	/		/
		!!	*Truncatellina callicratis* (Scacchi)	/		/	/	/
	5	(!)	*Truncatellina cylindrica* (Fér.)		/		/	
		(+)	*Vallonia costata* (Müll.)	/	/	/	/	/
		+	*Vallonia tenuilabris* (Br.)		/	/		/
		(+)	*Catinella arenaria* (Bouch.-Chant.)	/	/	/		/
		+	*Pupilla muscorum* (L.)	/	/	/	/	/
C	7	(+)	*Cochlicopa lubrica* (Müll.)	/	/	/	/	/
		(+)	*Clausilia dubia* (Drap.)	(/)	/	/	/	/
		(+)	*Nesovitrea hammonis* (Ström)			/		
			cf. *Neostyriaca* sp.	/	/	(/)		(/)
			Gastrocopta serotina Lžk.		/	/	/	
			Vertigo aff. *alpestris* Alder	/		/		
			Limacidae sp. div.		/	/	/	/
			Trichia sp. frgm.					/
	8	+	*Succinea oblonga* Drap.	/			/	/
D	9	(G)	*Vertigo angustior* Jeffr.			/	/	/
	?	!!	*Vertigo* new sp. ("*dextropusilla*" Lžk.)			/		/
			Vertigo sp. (toothless)		/		/	
			Helicidae sp. juv.	/				
			Zonitidae sp. frgm.		/			

est assemblage (III) coming from KR 4 and characterized by being richest in species of recurring *Helicigona čapeki* (Pbk.) accompanied by *Acicula diluviana* (Hocker), *Aegopis verticillus* (Lam.), *Aegopinella ressmanni* (West.), *Pagodulina pagodula* (Desm.), etc. Finally, Ložek (in: Fink et al. 1976) correlated this malacofauna with the interglacial assemblage from the colluvial-fan deposits on the Stránská skála Hill near Brno (cf. Kovanda, in print a, b).

Another paper (Ložek in: Fink et al. 1978) contains a list of the main representatives of malacofauna revealed in 51 samples taken mostly by J. Kukla from the entire sequence including soils beneath KR 15. Examination of these samples resulted in the discovery of as many as eleven (!) superimposed interglacial malacofaunas - see also Kukla (1975) and Fink - Kukla (1977). These are described in the following text.

(1) KR 4: The youngest interglacial recognized at the locality characterized by the index species Helicodonta obvoluta (Müll.), Macrogastra densestriata (Rossm.), Zonitoides sepultus Lžk. and others (see above). These, along with *Celtic* sp., provide evidence of Biharian age within the Cromerian. *Catinella arenaria* (Bouch.-Chant.) disappears and does not continue into KR 4.

(2) From KR 5 downwards, especially between KR 7 and KR 12, the deposits contain some exotic elements, such as *Serrulina* cf. *serrulata* (L. Pf.), *Neostyriaca* cf. *australoloessica* Klemm and, in particular, the species *Gastrocopta serotina* Lžk. noted earlier. Of the significant interglacial



10. New section drawn through the excavation in the abandoned brickyard base at Krems a.d. Donau - shooting range. Numbers 1 through 7 in quadrangles indicate palaeopedological sampling sites; numbers -1 through -5 in circles, palaeomalacozoological and palaeoosteological sampling sites (orig. J. Kovanda 1993).

species of Mollusca found KR 5 to KR 12, the main representatives, are: *Helicigona banatica* (Rossm.), *H. čapeki* (Pbk.), *Cepaea nemoralis* (L.), *Discus ruderatus* (Fér.), *Macrogastra densestriata* (Rossm.) and *Macrogastra* sp. (small from).

(3) The soil underlying KR 12 contains impoverished, thermally less demanding types of Mollusca, but with a representative of the genus *Helicodiscus* in KR 15.

Gastrocopta serotina Lžk., which typically occurs in the oldest Pleistocene fauna, has been found to persist from KR 7 to KR 11, but still higher up, in the time span covering KR 5 and KR 6, it is believed by Ložek (in: Fink et al. 1978) to occur as individuals suggesting allochthonous deposition. Likewise important is the persistent, small-sized, conspicuously ribbed species *Granaria frumentum* (Drap.) evidencing together with *Catinella arenaris* (Bouch.-Chant.), an earliest Pleistocene age. In addition to the molluscs, seeds of *Celtic* sp. were obtained by Ložek from KR 4 to KR 5. Therefore, on the basis of the fossil molluscs evaluated by Ložek, the whole succession underlying KR 4 can be regarded as older than Biharian but still Lower Pleistocene in age.

New shooting range

In the autumn of 1992 a new visit to the site was arranged jointly with Prof. H. Kohl (Linz). Its objective was (i) to collect samples of most fossil soils for micromorphological examination (L. Smolíková) and (ii) to study provisionally the succession in the cut beneath the brickyard floor (a new shooting range - figs 9, 10). This succession with three fossil soils was also sampled for palaeopedological (L. Smolíková), palaeosteological (I. Horáček) - see next chapters - and palaeomalacozoological (J. Kovanda) studies. These interim results are believed to supplement data hitherto available on the locality.

The highly developed molluscan assemblage, if considered from palaeomalacological point on view, comes from five loess-like horizons beneath a fossil soil. The layers are indexed in circles -1 to -5, out of which those designated -2 to -4 indicate indistinct initial soils horizons so far not determined in greater detail.

The 33 species of Mollusca yielded by all the five horizons are mixtures of all ecologic groups (sensu Ložek 1964a) except water species. There are no substantial differences in the fossil assemblages. They represent a mixture of the forest (interglacial) and steppe (loess-like glacial) species supplemented by what was in Ložek's (1964a) concept so-called "**intermediate faunas**" designed to illustrate the period recognized between the occurrence of typical glacials and interglacials. This is a phenomenon commonly observed in loess soil deposits, for forest species may not have been generally preserved directly in the B horizons of fossil soils, but if found they always form an admixture to the soils of the subjacent Ca- or C-horizons.

The finds of greatest importance include *Macrogastra densestriata* (Rossm.) and two hitherto more closely indeterminable species of the same generic status, accompanied by *Clausilia* cf. *cruciata* Stud., cf. *Neostyriaca* sp., *Discus perspectivus* (Meg. v. Mühlf.), *Discus ruderatus* (Fér.), *Acanthinula aculeata* (Müll.), and *Truncatellina callicratis* (Scacchi). This assemblage also comprises *Gastrocopta serotina* Lžk. and the *Vertigo* generic representatives referred to tentatively by V. Ložek as "*V. dextropusilla*" occurring, among others, in Lower Pleistocene beds at the Kurovice locality (Kovanda - Smolíková - Fejfar 1982).

Loess species typically occurring at the locality are *Vallonia tenuilabris* (Br.), *Helicopsis striata* (Müll.), *Pupilla triplicata* (Stud.), *P. sterri* (Voith) and *Catinella arenaria* (Bouch-Chant.) in particular. By no means less important are the species *Vertigo pusilla* Müll., *Perforatella bidentata* (Gmell.), and the small-sized, conspicuously ribbed *Granaria frumentum* (Drap.).

Obviously the interglacial documented by the fossil molluscs recovered from the lower soil horizon belongs to one of Lower Pleistocene interglacial periods, the full stratigraphical clasification of which is as yet unknown. Because the fossil soils now exposed at the locality trend obliquely upwards to the brickyard face, they can undoubtedly be regarded as a continuation of some of the soils studied previously. Moreover, with regard to Ložek's (in: Fink et al. 1978) list of only the index species dominating the assemblages found in the individual fossil soils, it is not possible for our malacofauna to be compared directly with some assemblages yielded by soil horizons occurring in the brickyard wall, simply because any horizon starting with KR 7 to KR 12 may be theoretically involved. Further, the dip angle of the fossil soils as seen in the new cut is likely to suggest the original "**Kremser Komplex**" including soils KR 7 to KR 9 rather than KR 10 to KR 12. The malacofaunas available also appear to be in agreement with this pattern. Overall, the mollusc fauna as described above provides additional information on the abundance and diversification of Lower Pleistocene interglacial assemblages of the Mollusca as a whole.

Fossil soil micromorphology from the Krems- shooting range

Libuše Smolíková

Left side of abandoned brickyard (see fig. 7)

Thin section 36 = Ca horizon of soil KR 12 (10YR 8/4):
Matrix, light-ochreous, much carbonate; contains numerous fragments of molluscs shells, minute braunlehm and pseudogley nodules. Soil microskeleton well sorted, silt: predominantly quartz grains, muscovite, augite, amphibole; small fragments of calcareous rocks.

Thin section 35 = B horizon of soil KR 12 (7.5YR 6/6):
Matrix, unevenly dark-reddish-brown, locally slightly humic, mostly flocculated, with locally preserved relics of only braunlehm plasma. Accordingly, interstices are largely those between aggregates, few voids within aggregates and acutely bent joints; soil matrix is also cut by fractures running parallel to soil surface. Most aggregates are excrements of fossil earthworms (*Lumbricidae*) and *Enchytraeidae*; contain more humus than surrounding matrix unaffected biogenically. - As compared with thin section 36, primary components are rather coarser in grain (supply of allochthonous material) and also contain, for example, unweathered plagioclase. - Matrix contain sparsely scattered minute braunlehm and pseudogley nodules together with disintegrated fragments of coalified wood. Channelway walls having tubes left by roots and earthworms and cut by fractures are covered with heavy amorphous calcium carbonate accumulation.

Genetic assessment: Rubified braunlehm subsequently exposed to slight pseudogleying and frost activity, enriched in unweathered allochthonous component and ultimately recalcified.

Thin section 34 = Ca horizon of soil KR 11 (10YR 8/3):
Matrix, light-ochreous, with much carbonate; contains well-sorted microskeleton, minute braunlehm nodules, manganese oxide accumulation, and earthworm excrements from overlying horizon; cut by parallel fractures.

Thin section 33 = B horizon of soil KR 11 (10YR 6/6):
Matrix yellow, peptized, segregate, numerous joints and fractures between polyhedrons and with a small amount of inner (micro) voids; coprogenic earthworm elements locally clustered as aggregates; contains braunlehm and rare pseudogley nodules. Primary components coarser-grained than thin section 34; quartz, orthoclase, muscovite, baueritized biotite, augite, amphibole, plagioclase, and small fragments of quartzite. - Recalcification prominent as heavy calcium carbonate amorphous accumulation and calcite needles on channelway walls. - Matrix shows signs of frost deflocculation.

Genetic assessment: Braunlehm subsequently subject to slight brown earthening, weak pseudogleying and strong periglacial activity, then enriched in a somewhat coarser allochthonous component and ultimately strongly calcified.

Thin section 32 = Ca horizon of soil KR 10 (10YR 8/2):
Matrix, light-grayish-ochreous, much carbonate; contains perfectly sorted primary components dominated by quartz grains, muscovite and weathered biotite; conspicuously concentric braunlehm nodules, clusters of black manganese oxide in matrix and on some manganese-coated channelway walls, and wide fractures parallelling soil surface.

Thin section 31 = B horizon of soil KR 10 (10YR 6/6):
Matrix, dark-yellow, peptized, concentrated in polyhedrons, locally in fossil earthworm excrements. Accordingly, it largely forms segregates and the remainder consists of aggregates, with a network of acutely bent joints and fractures present in the former case, and interstices between aggregates in the latter; soil cut by parallel fractures throughout, as in thin section 32. - As compared with thin section 32, soil (micro) skeleton is coarser and more varied in mineralogical composition; augite, amphibolite and especially plagioclase all suggest supply of the material as soon as the soil-formation was terminated. Matrix contains sparsely scattered braunlehm and pseudogley nodules, as well as opal phytoliths; calcium carbonate amorphous accumulation on channelway walls.

Genetic assessment: Braunlehm. The succession of polygenetic processes operating after the soil reached its climax development stage is as follows: very weak brown earthening, pseudogleying, cryogenic disturbances contemporaneous with the supply of an unweathered allochthonous component, and ultimate recalcification.

Thin section 30 = Ca horizon of soil KR 9 (10YR 8/2):
Matrix, grayish-ochreous, with much carbonate. Primary components represented, besides quartz grains, by fairly common baueritized biotite, plagioclase and fragments of quarzite; secondary elements are minute braunlehm and pseudogley nodules. Traces of brown earthening seen as earthworm excrements; some thinly manganese-coated. Channelway walls locally coated by minute calcite needles. - Matrix cut by parallel joints and fractures.

Check sample 26 (10YR 7/3) was taken additionally from the same soil carbonate horizon exposed on the right side of the loess brickyard. For micromorphological features, see thin section 30.

Thin section 29 = B horizon of soil KR 9 (10YR 5/6):
Matrix, dark-ochreous-yellow, braunlehm plasma; cut by a network of acutely bent joints and fractures; locally concentrated in secondary aggregates formed chiefly of earthworm excrements

and less common *enchytraeids*, abundant interstices, especially between aggregates. Primary components sorted to a various degree silt; quartz grains dominant; muscovite, orthoclase, augite, and amphibole common; plagioclase sparse. Matrix contains numerous large braunlehm nodules, manganese coatings, rare opal plytoliths. Channelway walls, especially those consisting of tubes left by roots and earthworms, covered by amorphous calcium carbonate accumulation.

Genetic assessment: Braunlehm subject to weak brown earthening after reaching its climax development stage. Then a weak pseudogleying followed replaced by periglacial processes, and ultimately by recalcification.

Thin section 28 = Ca horizon of soil KR 8 (10YR 8/2):

For micromorphological features, see the underlying carbonate horizons. In addition, large-sized augite, amphibole and glauconite are present alongside small braunlehm nodules and thin black manganese coatings on channelway walls.

Thin section 27 = B horizon of soil KR 8 (10 YR 5/8):

Matrix, dark-yellow, peptized, concentrated in both original polyhedrons and in secondary aggregates. In the former case interstices are represented only by fractures between segregates and joints within polyhedrons; in the latter case wide voids occur between aggregates and few microvoids lie within aggregates. Aggregates consist of coprogenic earthworm elements and less common *Enchytraeidae*. Primary components well sorted, silt; quartz grains, orthoclase, muscovite, biotite, augite, amphibole, and minute fragments of quartzite and shale. - Matrix contains small braunlehm nodules and irregular radial manganese oxide coatings on some channelway walls, with amorphous calcium carbonate accumulation above. - Some channelway are covered by stringers of partial, dark-orange braunlehm plasma still showing optical activity and having both original growth zones and flow fractures.

Note: No signs of illimerization were observed in check sample 25 (7.5YR 5/8) taken form the same-soil B horizon exposed in the right side of the same-soil B horizon exposed in the right side of the loess succession. Contrary to thin section 27, plagioclase was found but other features are identical.

Genetic assessment: Braunlehm subsequently subject to slight earthening and pseudogleying. As compared with the subjacent soils, its polygenetic development was rather complicated by the fact that the unweathered allochthonous component deposited after a wet period was illimerized during a younger and relatively short-lived phase of warmer and wetter climatic conditions accompanied by afforestation. Once illimerized, the soil was affected periglacially and calcified.

Right side of abandoned brickyard (see fig. 7)

Thin section 24 = Ca horizon of soil KR 7 (7.5YR 8/2):

Micromorphological features same as those described in preceding carbonate horizons. Matrix stratified owing to strong periglacial effects; contains abundant manganese oxide coatings on channelway walls; fossil edaphic coprogenic elements present.

Thin section 23 = B horizon of soil KR 7 (7.5YR 5/6):

Matrix, brownish-red, flocculated; forms aggregates of mainly earthworm and *Enchytraeidae*; locally relict braunlehm plasma cut by sharply bent joints providing evidence that soil was not rubified throughout. - Primary components are dominated by quartz; muskovite, baueritized biotite, orthoclase, augite, amphibole, pebbles of shale and quartzite present; secondary plagioclase admixed. - Braunlehm nodules red in incident light less common; manganese oxide coatings numerous on some larger mineral grains and channelways, with amorphous calcium carbonate accumulation above. - Matrix laminated, bedded owing to frost deflocculation.

Genetic assessment: Rubified braunlehm subsequently subject to slight pseudogleying, affected periglacially, enriched in an allochthonous component, and recalcified.

Thin section 22 = Ca horizon of soil KR 4 (10YR 6/4):

It differs from the other Ca horizons of underlying soils only in having more braunlehm plasma.

Thin section 22 = Ca horizon of soil KR 4 (10YR 5/6):

Matrix mosaic in colour, brownish-yellow and ochreous-yellow, contains both braunlehm and brownerde plasma resulting from deep brown earthening; in the former case it forms (sub) polyhedrons, in the latter, aggregates; accordingly, interstices (voids) differ in nature - primary or secondary. - Matrix contains abundant braunlehm nodules, coarse fragments of rocks, and numerous fragments of coalified wood showing well preserved cellular structure; wide channelways coated by or filled with calcite rhombohedrons.

Thin section 20 = A horizon of soil KR 4 (10YR 5/4):

Humic soil, brown; mull, flocculated, mainly aggregates. *Lumbricidae* excrements abundant; *Enchytraeidae* less common. Small relict of original braunlehm have been found preserved as dark-yellow braunlehm plasma. - As compared with thin section 21, primary components are coarser-grained and dominated by quartz grains; fragments of especially quartzite and shale are filled with and covered by conspicuous granules on plasmatic parts; minute dark-reddish grains of iron (Fe^{3+}) hydroxides formed by flocculation from original peptized plasmatic form. - Thinly laminated matrix contains black manganese oxide covered by thin coatings black manganese oxide covered by thin coatings of amorphous calcium carbonate; channelway walls with predominant tubes left by rootlets and eartworms covered by manganese oxide and overlying amorphous calcium carbonate as well.

Genetic assessment: After reaching its climax development stage, braunlehm was exposed first to granulation and then to strong brown earthening resulting in the formation of secondary humic A horizon. Like all the older soils having no humic horizons, it was subject subsequently to slight pseudogleying and frost deflocculation; the following process was accumulation of a coarser-grained allochthonous component and ultimate recalcification.

Krems - a new shooting range (see figs. 9, 10)

Sample 1. Thin section 13 = Ca horizon of lower soil (10YR 8/4):

Matrix, light-ochreous-gray; contains amorphous calcium carbonate; only channelway walls coated by calcite needles. Matrix contains minute braunlehm and pseudogley nodules.

Sample 2. Thin section 14 = B horizon of the same soil (7.5YR 5/6):

Matrix, dark-reddish-yellow, peptized; concentrated in original (sub)polyhedrons containing few inner voids and in secondary aggregates containing sparsely preserved coprogenic fossil earthworm elements but a substantially higher proportion of inner voids. - Primary components found as well sorted silt; quartz grains dominant, some orthoclase, muscovite, augite, and amphibole; plagioclase subordinate. Matrix contains small braunlehm nodules, numerous clusters of "manganolimonite", decomposed fragments of coalified wood, and opal phytoliths. Black manganese oxide coats some mineral grains. Matrix slightly recalcified.

Genetic assessment: Slightly rubified braunlehm subsequently exposed to hydromorphic effects, e.g. weak pseudogleying; enriched in an unweathered allochthonous component e.g. plagioclase; and slightly recalcified.

Sample 3. Thin section 15 = C horizon of middle soil (10YR 6/4):

Matrix, light-ochreous-brown, flocculated; contains well sorted microskeleton and rare fragments of quartzite coarse sand in size; commented by politomorphic calcite; braunlehm nodules few; irregular radial manganese oxide coatings, signs of deep brown earthening; some channelway covered by calcite needles.

Sample 4. Thin section 16 = B horizon of the same soil (10YR 5/8):

Matrix, dark-ochreous-yellow, peptized; concentrated in primary (sub)polyhedrons and in brown and containing excrements of especially fossil earthworms. Interstices represented by (i) original, acutely bent fractures and joints, (ii) subsequent voids between and within aggregates and, ultimately, (iii) a system of fractures parallel to soil surface. - As compared with its substratum (sample 3), primary components are coarser in grains (owing to the strong supply of allochthonous material after the soil ceased to develop) and - Matrix contains numerous braunlehm nodules, manganese oxide coatings and rare opal phytoliths. - Amorphous calcium carbonate accumulation in both the matrix and channelways suggests strong recalcification.

Genetic assessment: Brown earthened braunlehm underlain by loess slightly slope wash in nature with much carbonate. The sequence of polygenetic processes in the same as that described for the subjacent soil.

Sample 5. Thin section 17 = Ca horizon of upper soil (10YR 8/3):

Matrix, light-ochreous-gray; amorphous calcium carbonate; numerous fragments of carbonaceous rocks; abundant manganese oxide coatings on some large grains of plagioclase.

Sample 6. Thin section 18 = B horizon of upper soil (7.5YR 5/8):

Matrix, dark-reddish-yellow, peptized; has two structures: one is segregate with numerous, acutely bent fractures and joints; the other is aggregate with excrements of fossil earthworms and an increased amount of inner and outer voids. - Primary components well sorted; only less numerous fragments of quartzite and shale of coarse sand size; mineralogical composition same as thin section 14 and 16; plagioclase supplied during a post-pedogenetic phase also present. - Matrix contains braunlehm nodules sometimes red in incident light; manganese oxide coating and fragmentary mollusc shells present as well. amorphous calcium carbonate coats channelway walls.

Sample 7. Thin section 19 = layer above B horizon of upper soil (10YR 5/6):

Uneven colouring of matrix derived from a mixture of yellow substance seen as braunlehm plasma with light-brownish-ochreous flocculated soil. In both cases slightly rounded clods were re-deposited. This mixed matrix contains braunlehm and pseudogley nodules alongside parallel fractures and joints.

Genetic assessment: Slightly rubified braunlehm subsequently exposed to hydromorphic effects and frost deflocculation, enriched in an unweathered allochthonous component, recalcified, and ultimately mantled by a re-deposited soil material (i.e. soil sediment) previously mixed with loess.

Palaeogeological conclusions

Seven fossil soils sampled from **the section in the abandoned (old) brickyard at Krems a.d. Donau** have been studied. Of these, soils KR 12 to KR 8 were taken from the left side and soils KR 7 to KR 4 are from the right side of the exposure.

From the palaeopedological point of view it is interesting to note that:

1. the soils do not group to from soil complexes but occur separately

2. the soils, as far as the typology is concerned, show an extremely invariable development, thereby all correspond to braunlehm-type soils. It is worth mentioning that soils KR 12 and KR 7 were later rubified, whereas the other were exposed to brown earthening of varying degree, with soil KR 4 exhibiting signs of previous granulation.

All the fossil soils are highly polygenetic. After reaching their climax, i.e. the braunlehm stage, they were subject, as noted earlier, either to red (KR 12, KR 7) or largely slight brown earthening, followed by weak pseudogleying, contemporaneous with the supply of an unweathered allochthonous component, and ultimate recalcification indicating the onset of a new loess deposition. In addition, the unweathered allochthonous component of soil KR 8 was strongly illimerized in response to period of mild warming and wetness accompanied by forest growth. In should be mentioned that illimerization has not been recognized in any of the other soils under study.

Micromorphological studies have confirmed the original typological assignment of soils KR 4, 8, 9, 10 and 11 (see, e.g. Rabeder, 1981) **to braunlehm; soils KR 7 and KR 12 regarded as rothlehm are in fact rubified braunlehm.**

New shooting range

Three fossil soils are exposed in the new section (new shooting range) of this locality. Of these, the lower and upper samples 2 and 6 respectively correspond to slightly rubified braunlehm; the middle sample 4 indicated braunlehm earthening (fig. 10). The micromorphology of the lower soil (sample 2) resembles the soil KR 7 exposed in the wall of the abandoned brickyard. However, because the soil has an extremely similar developmental history, the possibility cannot be ruled out that the soils can be equated with soil KR 12. If so, soil KR 7 offers a clear parallelism with the upper soil (sample 6) taken from this new section. Another possibility exists that both rubified braunlehms are soils not present in the abandoned brickyard. This being the case, the lower soil (sample 2) from the new section at Krems a.d. Donau-shooting range is the upper member of the basal soil complex and the upper soil complex consists of a basal brown earthened (sample 4) and upper rubified braunlehm (sample 6).

Translated by V. Marek

Fossil vertebrates from the Krems a.d. Donau new shooting range

Ivan Horáček

The samples taken from layers -2 and -4 (see fig. 10) at the recently investigated site yielded a few but well-preserved bone remains belonging to the following taxa (numbers in brackets indicate minimum number of individuals):

Layer -2:	*Pisces, Cypriniformes* indet.	(1)
	Aves, Passeriformes indet.	(1)
	Talpidae g. sp.	(1)
	Soriculus sp.	(1)
	Beremendia fissidens	(1)
	Clethrionomys kretzoi	(1)
	Borsodia newtoni (=hungarica)	(1)
	Lagurodon arankae	(1)
	Mimomys cf. *coelodus*	(1)
	Microtus (*Allophaiomys*) *pliocaenicus*	(4)
	Lemmus kowalskii	(1)
Layer -4:	*Aves, Passeriformes* indet.	(1)
	Glis cf. *Seckdillingensis*	(1)
	Mimomys sp.	(1)
	Microtus (Allophaiomys) pliocaenicus	(1)
	Ochotona sp.	(1)

This record is of primordial importance for two principal reasons: one is the local stratigraphy of the site and the other is the chronostratigraphical correlation of Mid-European biozones.

Only a few teeth so far available from the exposure at Krems do not permit precise identification to be made at species level, notably from layers KR 7, 8, and 9 - cf. Rabeder (in Fink et al. 1976), Rabeder (1981). Rabeder's identification suggested an age of the upper Villányian sensu Fejfar - Heinrich (1983), i.e. the uppermost stage of the MN17 biozone for the "**Krems soil complex**". This view was also followed in our previous discussions about the stratigraphy of the Krems loess series (Horáček 1981, 1985, Horáček - Ložek 1988), in contrast to the view held by Fink - Kukla (1977), Kukla (1975, 1978).

The recent record available makes us take a different altitude towards the solution of the problem. The most pertinent point made here is the appearance of *Microtus pliocaenicus* indicating that the assemblage listed above comes from the beginning of the Q1 biozone, i.e. from the earlier part of the *Betfia* phase of the Biharian.

Four M/1 found in our sample exhibit a fairly advanced *pliocaenicus* pattern without showing enamel arrangement reminiscent of the *Mimomys* pattern as seen in *Microtus* (*Allophaiomys*) *deucalion*.

Nevertheless, the other forms obtained from our samples can be regarded as highly characteristic elements of upper MN17 communities. Particularly noteworthy among them is the lemming M2/ corresponding to *Lemus kowalskii* Carls - Rabeder (1988). All these forms commonly occur also in the communities known from the earliest stage of Q1 (Mokrá 1, Včeláre 3, 5 and 10, Osztramos 8, etc.). All the communities of this type are considered to be roughly the same age, just around the MN 17/Q1 boundary, thereby supposedly corresponding to 18O zones 36-40.

Anyway, from a rather general point of view, the chief value of this record is as follows:

- it points to incorrect stratigraphical interpretations made previously of the soil complex at Krems (provided there is a direct relationship between layers -2, -4 and KR 7, 8 as suggested by Kovanda and Smolíková in this paper)
- it makes us change the opinion regarding the chronostratigraphy of the MN 17/Q1 boundary. Thus, if the palaeomagnetic record of the site is correct, then the first appearance datum of *Microtus* - one of the major and best traceable faunal events during the Eurasian Plio-Pleistocene history if applied as a range zone criterion for the MN 17/Q1 boundary - must be referred to the Matuyama Epoch and may not have been correlated with the Olduvai Event and hence with the conventional currently used Plio-Pleistocene boundary (e.g. Horáček 1981, 1985).

On the whole, these possibilities call for a highly careful assessment of our record and re-examination of both the sites and contextual framework of the topics in great detail.

Translated by the author

The roadcut west of Furth bei Göttweig

Jiří Kovanda

The distinct horizont of fossil soil, called "**Göttweiger Verlehmungszone**", can be traced at the type locality continuously for a distance of 300 m. It was initially classified stratigraphically into the last interglacial or the interstadial Würm I/II (for more detail, see e.g. Bayer 1909-1927, Menzel 1914, Zapletal 1929, Kölbl 1931, Wieseneder 1933, Götzinger 1935, 1936, Freising 1951, 1956, Lais 1951, Zotz 1951, Wiedenbach 1952, Brandtner 1956, Gross 1956-1960, Woldtstedt 1956, 1958a, b, De Vries 1958, Brunnacker 1959, Felgenhauer et al. 1959, Ložek - Kukla 1959, Ložek 1960, 1964a, c, 1973, Ložek - Kukla - Šibrava 1961, Klíma - Kukla 1961, Kukla - Ložek 1961, Fink et al. 1974, 1976, Bronger 1976, Binder 1977, Nilsson 1983 etc.). However, at the time of our visit to the locality (together with J. Fink) in 1967, this strongly weathered soil with top interglacial molluscs seemed to have been formed during a period much older than Riss/Würm (Fink 1969a, b, c, Demek - Kukla 1969, Binder 1977). On the basis of the following analysis of mollusc fauna, Ložek in Fink et al. (1974, 1976) suggested that this interglacial should be allocated provisionally to the Mindel/Riss (Holsteinian), i.e. to the period corresponding to the soil complex V.

Micromorphology of the "Göttweiger Verlehmungszone" from the roadcut of Furth

Libuše Smolíková

Thin section 41 = B horizon (7.5YR 5/8):

Matrix, dark-ochreous-yellow, contains braunlehm plasma; cut by a network of acutely bent joints and fractures and contains abundant large braunlehm nodules circular or smoothly elliptical in outline; similar nodules of only manganese oxide present, fairly abundantly scattered in matrix or form irregular radial clusters. Primary components dominated by quartz grains; orthoclase, augite, amphibole, muscovite, plagioclase, and glauconite subordinate; mostly correspond to silt varying in grain size. - Original segregate (polyhedral) structure turned to aggregates (except relict material) by subsequent earthening and hence matrix is largely concentrated in coprogenic elements of fossil earthworms (*Lumbricidae*) and interstices, especially between aggregates, are more numerous. - Local recalcification forming thin coatings of amorphous calcium carbonate on channelway walls.

Thin section 42 = Ca horizon (10YR 8/4):

Matrix, light-ochreous; contains amorphous calcium carbonate; parts corresponding to thin section 41 including braunlehm and pseudogley nodules and signs of strong brown earthening. Genetic assessment: Earthened braunlehm subsequently slightly pseudogleyed and recalcified.

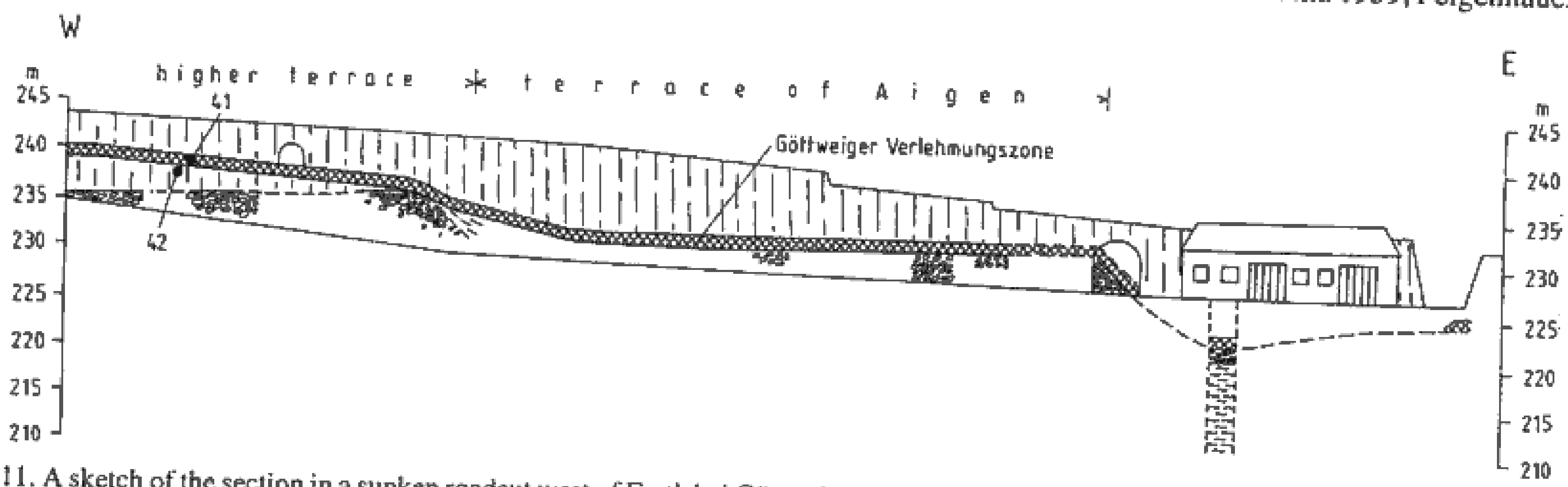
Genetic assessment: Earthened braunlehm subsequently slightly pseudogleyed and recalcified.

This soil is undoubtedly stratigraphically older than the soil complex V or VI (Mindel/Riss, Holsteininan) in its development stage and hence suggests some of the warm periods (starting with the youngest warming) within the Mindelian, i.e. preceding stratigraphically the soil complex VII.

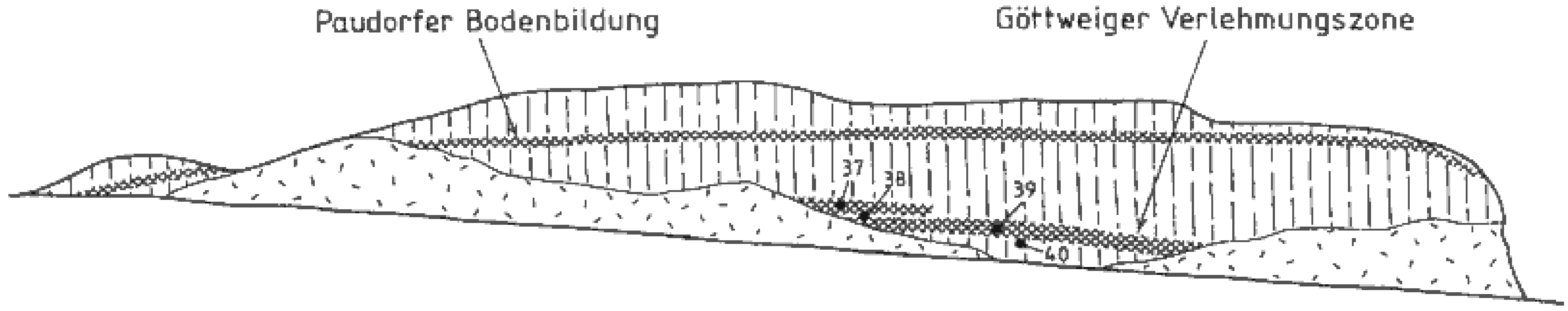
Paudorf (near Göttweig monastery)

Jiří Kovanda

The upper fossil soil horizon, called "**Paudorfer Verlehmungszone**", at its type locality has not yet been studied on palaeopedological grounds. It was supposed e.g. by Götzinger (1936) to be a result of a pedogenetic process from the interstadial W 1/2. Later Fink (see references) reevaluated its stratigraphical position and dated it to the "Stillfried B" - interstadial W 2/3 (see e.g. Brandtner 1950, 1954, 1956, Lais 1951, Gross 1957, 1958, Woldtstedt 1958a, Brunnacker 1959, Ložek - Kukla 1959, Felgenhauer



11. A sketch of the section in a sunken roadcut west of Furth bei Göttweig (after Fink et al. 1976). Numbers 41 and 42 mark the locations of palaeopedology sample takings.



12. A sketch of the section in loess near Paudorf (after Fink et al. 1976). Numbers 37-40 mark the locations of palaeopedology sample takings.

et al. 1959, Ložek 1960, 1964a, c, 1973, Ložek - Kukla - Šibrava 1961, Kukla - Ložek 1961, Klíma - Kukla 1961, Bronger 1976, etc.). During the excursion with J. Fink in 1967 (attended by V. Šibrava, J. Macoun and A. Zeman) I picked up from the Ca-horizon of this upper fossil soil several shells of typical interglacial gastropods (Šibrava 1986). Giving the samples together with their determination and interpretation to J. Fink I wanted to enable him to correct his stratigraphical classification (Fink 1969a, b, c, 1973b). The palaeomalacozoology of the locality was evaluated later by Ložek (in Demek - Kukla 1969 and Fink et al. 1976).

The two underlying soils forming a soil complex were regarded by Götzinger (1936) as another locality of the "**Göttweiger Verlehmungszone**" and ranged to the last, Riss/Würm, interglacial (see Felgenhauer et al. 1959). Ložek (in Fink et al. 1976) did not make an explicit statement on the age of this lower soil complex, but since he allocated the overlying "**Paudorfer Boden**" to the last (or even older) interglacial it seems logical to assume that the lower soil complex is at least one interglacial older. Four samples were taken from the lower soil complex only.

Micromorphology of lower soil complex (incorrectly also as "Göttweiger Verlehmungszone") from Paudorf

Libuše Smolíková

Thin section 37 = B horizon of upper soil (10YR 6/6):

Matrix, light-ochreous-brown, flocculated, slightly and unevenly humic; humus represented by mull; concentrated in original (primary) non-humic subpolyhedrons and in secondary, slightly humic aggregates; traces left by fossil edaphic activity are specially excrements of *Lumbricidae* and *Enchytraeidae*. - Primary silt, variously sorted in grain; quartz grains dominant; orthoclase, plagioclase, augite, amphibole, and mica; garnet and glaukonite also present; opal phytoliths scarce. - Matrix contains small braunlehm nodules; channelway walls thinly coated by manganese oxide and amorphous calcium carbonate; calcite needles also present. - Matrix cut by parallel fractures and joints having no coatings and by passing coprogenic elements.

Thin section 38 = Ca horizon of upper soil (10YR 7/3):

It differs from thin section 37 in the lighter colour of the matrix derived from a high amount of carbonate, a somewhat coarser (micro) skeleton also containing small fragments of shale and quartzite and especially in having some channelway walls thinly coated by partial braunlehm plasma optically inactive and brownish instead of dark-orange in colour. Sings of brown earthening traceable as far as this horizon.

Thin section 39 = B horizon of lower soil (10YR 5/6):

Main micromorphological features same as thin section 37. It differs in containing relics of brownish and optically inactive braunlehm plasma still having flow structure; in coarser (micro) skeleton with fragments of shale and quartzite filled with dark-red plasmatic stringers and rimmed by black manganese oxide coatings and in the absence of sings of recalcification. - Fossil edaphic excrements are clearly more humic than biogenically unaffected material; coprogenic *ascarid* elements in matrix loose or embedded in earthworm excrements.

Thin section 40 = Ca horizon of lower soil (10YR 8/6):

Matrix, light-grayish-ochreous, flocculated; contains amorphous calcium carbonate. Some channelways thinly coated by partial braunlehm plasma brownish in colour but having growth zones and locally showing weak birefringence; higher up, thin coatings of black manganese oxide also rim some minute braunlehm nodules and are scattered as irregular radial pseudogley nodules in the matrix. - Small opal phytoliths scarce.

Genetic assessment: Both soils are considered to be slightly developed illimerized soils, the lower one showing a somewhat more advanced development stage. After reaching their climax development stage, both were subject to strong brown earthening (leading up to humification of the upper soil) resulting from dryness and replacement of forest vegetation by steppe one. In accordance with the Quaternary climatic-sedimentary and soil-forming cyclical process, in both soils a weak pseudogleying and ultimate calcification followed, with additional mechanical disturbance of the upper soil by frost deflocculation.

By analogy, **it can be assumed that the two soils correspond to the soil complex (PK) IV suggesting a warm period within the Riss glacial**. A similar situation is known from the localities at Sedlec-Prague, Letky n. Vlt., Červený kopec Hill in Brno, etc. A common feature of this soil complex is the absolutely same development and lower degree of illimerization of both soils as compared, e.g., with the basal soil of **Stillfried A** (i.e. the R/W soil complex III), as well as with the basal soils ranged to the soil complexes V or VI, apart from other features. The lower soil complex (PK IV) from Paudorf is not therefore equivalent to the original one "Göttweiger Verlehmungszone" from its locus typicus from roadcut west of Furth.

Translated by V. Marek

K tisku doporučil P. Havlíček

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Revize čtyř klasických sprašových profilů v Dolním Rakousku

(Résumé anglického textu)

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V práci jsou podány nové výsledky orientačně provedených výzkumů na klasických dolnorakouských lokalitách Stranzendorf, Krems a.d. Donau-střelnice, Furth a Paudorf (bei Göttweig). Vedle paleomalakozoologie (Stranzendorf a Krems-nová střelnice) a paleoosteologie (Krems-nová střelnice) jsme se soustředili zejména na paleopedologii, a to na všech čtyřech uvedených lokalitách. Kromě upřesnění a doplnění dosavadních znalostí o vývoji těchto sprašových sérií jsme získali také nové poznatky, na jejichž základě je třeba změnit dosud předpokládané stratigrafické zařazení lokalit Stranzendorf a Furth bei Göttweig.

Na lokalitě Stranzendorf jsme zjistili (na základě paleomalakozoologických a litologických poznatků), že celé sprašové souvrství chová společenstva fosilních měkkýšů a horizonty fosilních půd, vyskytující se pouze v pleistocénu. Podle fosilních měkkýšů jsou bezpochyby pleistocenního stáří i ulehlé nivní hlíny na povrchu souvrství písčitých štěrků v podloží spraší, které jsou v literatuře řazeny do neogénu. Proto je třeba považovat Stranzendorf (podobně jako některé další obdobně staré lokality ve sprašových sériích v Evropě a v Asii - viz obr. 6) za spodnopleistocenní, a to i přes bohatou faunu drobných obratlovců, vyhodnocenou Rabederem (1981) a odpovídající konvenčně nejmladšímu pliocénu s udávaným stářím od 1,8 do více než 2,5 mil. let. Rovněž v úvozu u Furth bei Göttweig je třeba chápat (na základě paleopedologického výzkumu) průběžně sledovatelnou fosilní půdu (locus typicus tzv. „Göttweiger Verlehmungszone") jako produkt interglaciálního období minimálně uvnitř mindelu, ale spíše ještě starší meziledové doby, tedy od půdního komplexu (PK) VII stratigraficky níže.

Texty k obrázkům

1. Prostorové rozložení fosilních půd horizontů (A - M) ve stěně bývalé těžebny hlín a písčitých štěrků ve Stranzendorfu (podle Rabedera 1981).
2. Schéma vývoje sprašového souvrství v průběhu defilé ve Stranzendorfu (podle Rabedera 1981).
3. Konstrukce stratigrafického schématu vývoje sprašového souvrství ve Stranzendorfu (podle Rabedera 1981).
4. Srovnávací schéma 33 pedogenetických cyklů z eolických sedimentů za posledních 2,5 mil. let: ČK = Brno-Červený kopec; KR = Krems a.d. Donau-střelnice; SD = Stranzendorf. Chronologiky je zde Stranzendorf řazen jako starší, tj. pod profil Krems a.d. Donau-střelnice. Sestaveno podle prací Ložka (1973), Kukly (1975), Finka - Kukly (1977), Finka (1979a, b) a Rabedera (1981).
5. Srovnávací tabulka svrchnopliocenních a spodnopleistocenních lokalit fosilních savčích společenstev.
1 - standardní dělení; 2 - stupně biostratigrafického schématu (podle Fejfara - Heinricha 1983); 3 - kvartérní a svrchnopliocenní biozóny; 4 - stratigrafická pozice některých středoevropských, českých a slovenských lokalit ve srovnání s lokalitami Krems a.d. Donau-střelnice (KR), Stranzendorf (SD) a Brno-Červený Kopec (ČK): 1 - Dolní Kounice; 2 - Předmostí; 3 - Kobyla-Chlupáčova sluj; 4 - Podbaba; 5 - Letky; 6 - Turold u Mikulova; 7 - Chlum u Srbska; 8 - Únětice; 9 - Brno-Stránská skála 1; 10 - Brno-Lažánky 2; 11 - Gombasek 1, 2; 12 - Včeláre 3; 13 - Koliňany 3; 14 - Včeláre 5; 15 - Včeláre 7; 16 - Koliňany 1, 2; 17 - Ctiněves-Hýkovina; 18 - Plešivec-Csepkö; 19 - Včeláre 2; 20 - Javoříčko 1-11. 5 - sled glaciálních cyklů (podle Kukly, 1978); 6 - sled $\delta^{18}O$ stadií; 7 - sled magnetostratigrafických epoch; 8 - časová škála. Sestaveno podle prací Horáčka - Ložka (1988) a Horáčka (1990). Lokality Krems a.d. Donau-střelnice (s fosilními půdami KR 16 až KR 7) a Stranzendorf jsou zde chronologicky řazeny do stejného období, tj. do biozón MN 16 a MN 17.
6. Srovnávací tabulka několika spodnopleistocenních profilů sprašových sérií. Počátek sprašových (tedy glaciálních!) akumulací spadá u všech profilů hluboko pod konvenčně vedenou hranici pliocén-pleistocén z roku 1948, tj. 1,87 mil. let (podle Pécsiho 1993).
7. Schéma stěny staré cihelny v Krems a.d. Donau-střelnice s vyznačením jednotlivých půdních horizontů KR 1 - KR 15 (podle Rabedera 1981).
8. Konstrukce stratigrafického schématu vývoje sprašového souvrství na lokalitě Krems a.d. Donau-střelnice (podle Rabedera 1981).
9. Schéma zářezu nové střelnice na dně staré cihelny na lokalitě Krems a.d. Donau-střelnice. Čísla 2-6 ve čtverečcích označují nově odkryté fosilní půdní horizonty, pod nimiž byla nalezena bohatá měkkýší a obratlovčí fauna spodního pleistocénu (orig. J. Kovanda).
10. Profil stěnou výkopu nové střelnice na dně staré cihelny - lokalita Krems a.d. Donau-střelnice. Čísla 1-7 ve čtverečcích udávají místa odběrů vzorků pro paleopedologii, čísla -1 až -5 v kroužcích vyznačují místa odběrů vzorků pro paleomalakozoologii a paleoosteologii (orig. J. Kovanda).
11. Schéma profilu v úvozu z. od Furth bei Göttweig (podle Finka et al. 1976). Čísla 41-42 označují místa odběrů vzorků pro paleopedologii.
12. Schéma sprašového profilu u Paudorfu (podle Finka et al. 1976). Čísla 37-40 označují místa odběrů pro paleopedologii.

Texty pod tabulky v textu

1. Symboly - vlevo od seznamu druhů - jsou podle Ložka (práce v tomto svazku „Výzkum travertinové kupy Skalka v Hôrce-Ondreji"): A - lesy; B - otevřené plochy; C - lesy i otevřené plochy; D - bažiny, vody. 1 - uzavřené (souvislé lesy); 2 - lesostepi a světlé háje; 3 - lužní (vlhké) lesy; 4 - stepi; 5 - otevřené (zatravněné) plochy; 6 - suchá stanoviště; 7 - mesické či indiferentní stanoviště; 8 - vlhké plochy; 9 - bažiny, břehy vod; 10 - vodní stanoviště.
! - druhy teplých období; !! - druhy typicky interglaciální; (!) - tolerantní druhy teplých období; + - druhy stepní; ++ - druhy chladných fází sprašových; (+) - druhy přítomné místy ve spraších; G - druhy přežívající z glaciálů mimo sprašovou zónu; (G) - dtto jako relikty.
2. Vysvětlivky viz tab. 1.

Text k barevné příloze

Sprašový profil s fosilní půdou "Göttweiger Leimen (Verlehmung) zone" v úvozu u obce Furth nedaleko zámku Göttweig. Reprodukce akvarelu L.H. Fischera z knihy J. Bayera z r. 1927 "Der Mensch im Eiszeitalter".