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DEUQUA EXCURSIONS

Edited by Ludwig Zöller and Andreas Peterek

From Paleozoic to Quaternary

A field trip from the Franconian Alb to Bohemia

GEOZON

Excursion B

River history of the Upper Main River area from Tertiary to Holocene

Flussgeschichte des Obermain-Gebietes vom Tertiär bis zum Holozän

Wolfgang Schirmer, with contributions of Michael Friedrich, Maria Knipping, Bernd Kromer and Uwe Abramowski

Itinerary / *Exkursionsroute*

Fig. 0.1: Location map of the excursion points. Map basis: Top 50 Bayern, Landesamt für Vermessung und Geoinformation, Version 5.

Abb. 0.1: Karte der Exkursions-Stops. Grundlage: Top 50 Bayern, Landesamt für Vermessung und Geoinformation, Version 5.

B

When was it that the River Main,
which aeons always southward ran,
followed one day a new incline
hence friendship to the Rhine began?

Wann mag das wohl geschehen sein,
dass der lyditbeladne Main,
der lange Zeit nach Süden floss,
sich plötzlich in den Rhein ergoss?

1 Introduction to the excursion area

1.1 Two great periods of river history

The Upper Main River area passed through two different great periods of river history. The first period is the drainage southward, from the Middle German Uplands – the Thüringer Wald, Frankenwald and parts of the Fichtelgebirge – to the pre-Alpine molasse basin that was drained since late Miocene by the Danube River. This southward drainage system was that of the River Moenodanuvius starting in the recent Main River area (lat. *Moenus*) and emptying in the recent Danube area (lat. *Danuvius*) (Schirmer 1984). Moenodanuvian river deposits are preserved in the foreland of the Middle German Uplands, especially in the Frankenwald foreland, moreover on top of the Northern Franconian Alb and in the Rednitz River area.

At the same time in western Franconia there existed the Primeval Main, the Ur-Main, draining to the River Rhine into the northern Upper Rhine Graben. This Ur-Main encroached step by step the eastward lying Moenodanuvian drainage system from the Spessart to the Steigerwald Mountains to the Upper Franconian highland.

The second period is that of the final diversion of the Moenodanuvian system to the Rhine system. From later Neogene into the Pleistocene this encroaching Ur-Main created the recent Main River system. The duration of the Moenodanuvian river regime lasted about from the beginning of the Cretaceous Period into the later Neogene (Fig. 0.3). After the diversion of the Moenodanuvian system in northern Franconia the Main River drained westward transverse to the Moenodanuvian north-south direction. This happens at least since later Neogene to end Neogene.

1.2 The Moenodanuvius River

In Upper Franconia gravel of the Moenodanuvius is preserved (Fig. 0.2) in the Frankenwald Foreland, on top of the Northern Franconian Alb and further south in the Rednitz valley. The gravel is mostly silica gravel with some local gravel components intermixed. The northermost preserved valley section is that of the Frankenwald Foreland Moenodanuvius. It is described in Stop 1 Espich (Figs. 0.1 and 0.2) This river might have acted – after the direction of its course and the gravel freight – as the upper course of the Kulmbach Moenodanuvius or possibly that of the Nankendorf Moenodanuvius.

In the Northern Franconian Alb up to now there a four different river branches preserved. All branches show own morphological valleys cut into the carbonate rocks of the Northern Franconian Alb.

The most western branch, the Bamberg Moenodanuvius (Schirmer 2007a), is proofed by pebble finds of quartz and few quartzites spread in relics of an incised palaeovalley on top of the plateau of the Franconian Alb close to Eschlipp (black E in Fig. 0.2). This branch might root in the Thüringer Wald (Thuringian Forest). As the valley relic lies somewhat higher than the valley of the Kulmbach Moenodanuvius this branch should be the oldest among the others.

Up to now it is the first and only river course proved to have flowed through the axis of the northward draining River Regnitz southward. There are no further findings for a river, which flowed through this valley axis southward. Black pebbles in the basal parts of the Regnitz gravel turn out to be not black radiolarite (lydite) but pebbles of silicified wood.

The next eastern branch is the Kulmbach Moenodanuvius locally with two terraces, the Blütental (B) and Nebelberg Terraces (N). Its main gravel components are quartz, radiolarite and quartzite (Schirmer 1985). Its valley is well traceable by form and gravel finds from the Kainach brook in the north downriver to Streitberg in the south.

The easternmost branch is the Nankendorf Moenodanuvius (formerly called Bayreuth Moenodanuvius, Schirmer 2007a). Up to now there was no gravel found farther north or northeast than marked in Fig. 2. To keep the afflux from north or northeast open I took a local name. Its main components are quartz and radiolarite.

All branches merge to one river course that south of Streitberg should have flowed towards the Regnitz-Rednitz axis. The Moenodanuvius River in the Rednitz axis was recently described by Berger (2010, 2011). Berger (2011) records of Moenodanuvian gravel of Cenomanian age in the Southern Franconian Alb. On the other hand, he stresses (Berger 2010: 165) that the Moenodanuvian gravel along the Rednitz valley is of Tertiary prae-Riesian age, and there would be no indication for a southward drainage after the Ries impact, that happened at 14.6 Ma (Buchner et al. 2010). This well confirms the estimated old age for the Moenodanuvius in the Northern Franconian Alb (Schirmer 2007a: 172). But it puts question marks to the end of the Moenodanuvian existence (see also Hofbauer 2011).

The big question is the time and way of the diversion of the Moenodanuvius to the Urmain River. Uplift of the southern Franconian Alb starting during late Miocene (Peterek & Schröder, 2010: 333) was the initiation of the reversal of the flow direction within the Rednitz-Regnitz axis. Probably the uplift and modelling of the northeasternmost escarpment of the Northern Franconian Alb between Hollfeld and Kulmbach caused the end of the southern discharge of the Moenodanuvius and initiated its diversion to the Urmain, thereby forming the River Main. This could happen from late Miocene through Pliocene. Consequently the arrival of the Upper Franconian Main River on the Rhine could have taken place earlier than so far has been assumed. (Schirmer, 2007b: 104, assumed and discussed still an early Lower Pleistocene age). This needs search for pre-Quaternary Main deposits in the Lower Main area. All in all, the present knowledge concerning the Moenodanuvius-Main transition shows a gap from late Miocene to end of Pliocene.

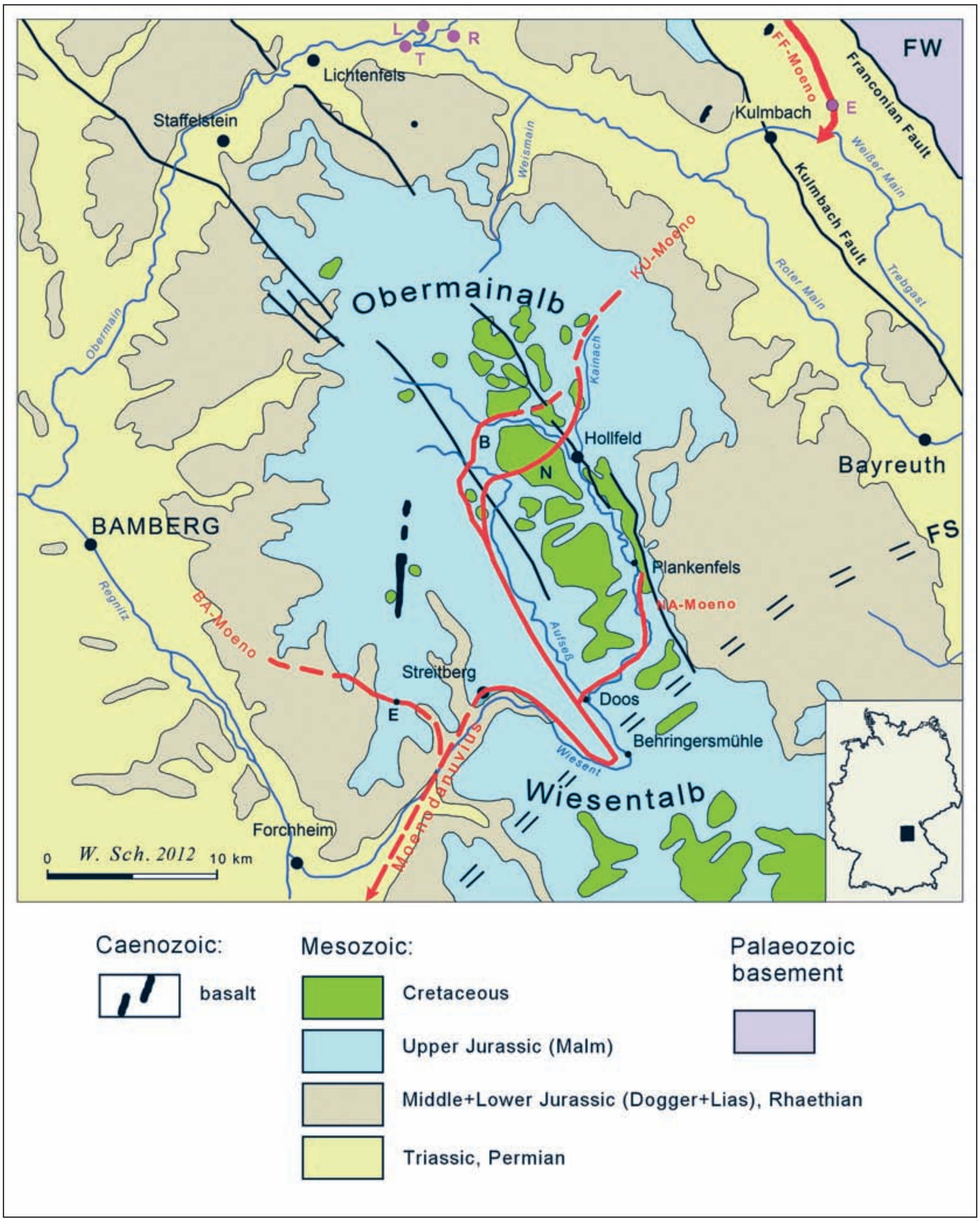

Fig. 0.2: Moenodanuvius River system in the Frankenwald foreland and the Northern Franconian Alb (Obermainalb and Wiesentalb). B = Blütental Terrace, BA-Moeno = Bamberg Moenodanuvius, E (violet) = Espich Site, E (black) = Eschlipp, FF-Moeno = Frankenwald Foreland Moenodanuvius, FS = Fichtelgebirge Swell, FW = Frankenwald (part of the Bohemian basement), KU-Moeno = Kulmbach Moenodanuvius, L = Lettenreuth Site, N = Nebelberg Terrace, NA-Moeno = Nankendorf-Moenodanuvius, R = Redwitz Site, T = Trieb Site.

Abb. 0.2: Flusssystem des Moenodanuvius im Frankenwaldvorland und der Nördlichen Frankenalb. B = Blütental-Terrasse, BA-Moeno = Bamberger Moenodanuvius, E (violett) = Espich, E (schwarz) = Eschlipp, FF-Moeno = Frankenwald Vorland-Moenodanuvius, FS = Fichtelgebirgsschwelle, FW = Frankenwald, KU-Moeno = Kulmbacher Moenodanuvius, L = Grube Lettenreuth, N = Nebelberg-Terrasse, NA-Moeno = Nankendorfer Moenodanuvius, R = Grube Redwitz, T = Grube Trieb.

1. 3 Short outline of the history of the River Main

A discharge to the Rhine from the Spessart exists since the subsidence of the Upper Rhine Graben in Eocene. This is the Primeval Main, the Urmain (Fig. 0.3). With ongoing subsidence of the Upper Rhine Graben this Urmain encroached backward eroding step by step the Moenodanuvian realm in the Spessart, Lower Franconia Gäu Plain and the Steigerwald-Hassberge cuesta. By conquering the source area of the Moenodanuvius system in the Upper Franconian basement the Urmain became the River Main.

A simplified scheme of the River Main deposits is shown in Fig. 0.4. The texture of this river deposits is a result of interlinking of tectonic uplift and subsidence on the one hand, accumulation and erosion under the periglacial climate on the other hand. The following elements are visible in the Main River area:

Plateau terraces: River deposits mainly of late Cretaceous to Tertiary age, not bound to valley forms, or the valley forms are not visible any longer. They include some deposits of the Urmain and the Moenodanuvius, for example at Stop 1 Espich.

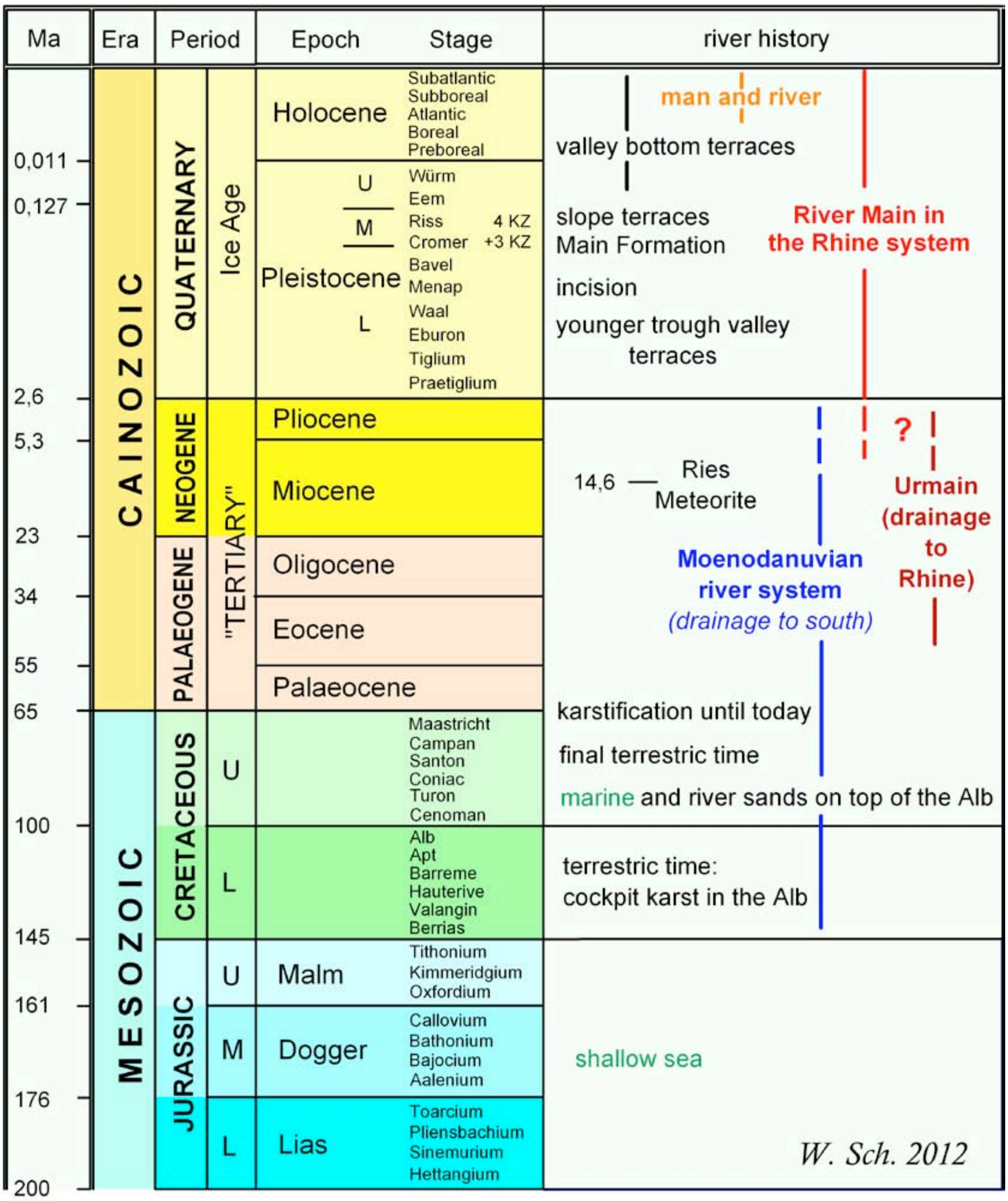

Fig. 0.3: Stratigraphic table for the Moenodanuvius and Main River (Schirmer 2010, modified).

Abb. 0.3: Stratigraphische Tabelle für den Moenodanuvius und Main (Schirmer 2010, geändert).

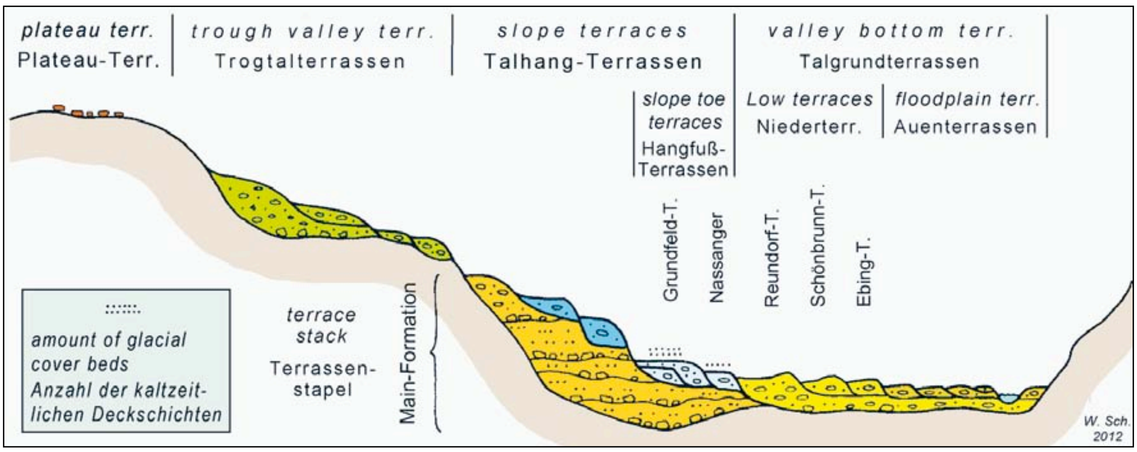

Fig. 0.4: Scheme of terrace flight of the Main River and other tributaries of the Upper Rhine (from Schirmer 2010, slightly modified).

Abb. 0.4: Schema der Terrassentreppe des Mains und anderer Oberrheinzuflüsse (aus Schirmer 2010, leicht verändert).

Trough valley terraces: From late Cretaceous to Tertiary age strong valley incision took already place. It resulted in a trough valley form incised in the plateau surface, generally wider than the Pleistocene valleys are. Along the Main river the early Pleistocene terraces lie in this trough valley, too. Within these wide trough valley the river could form wide free meanders.

During the Lower Pleistocene land uplift and subsidence of the Upper Rhine Graben caused a very deep incision of the rivers that accessed down to the level of the recent valley sole. Thereby, the free meanders became bound meanders.

Main Formation: The deadlock of the vertical movements, perhaps 1 Ma–800 ka ago, should have caused the fill-up of a thick fluvial stack of some decameters in thickness, the so-called Main Formation (Schirmer 2007c) (Stop 2 Lettenreuth). The filling up ended perhaps around 550 or 400 ka BP. It coincides with the increasing cold periods between MIS 22–12 with its change from frost to thawing activity that provided a lot of solifluction material especially in the sandy–clayey Upper Triassic (Keuper) and Lower Triassic (Buntsandstein) landscapes (Schirmer 2007c: 313–317). The principal part of the fill falls in the Cromerian Period. The longest possible time interval for the Main Formation stretches from Jaramillo event until MIS 11. In the minimum it lasted 200–250 thousand years (Schirmer 2007a: 315).

Slope terraces: New land uplift since the middle Middle Pleistocene caused renewed cutting down of the rivers. Climatically controlled alternating erosion and accumulation with preference of erosion formed the slope terraces cut into the Main Formation. In the Main and Rhine area they are called Mittelterrassen (Middle Terraces).

Slope toe terraces: During the later Middle Pleistocene the tectonic uplift died slowly down; that happened since about 340 ka BP (Schirmer 2010: 18). Hence rivers formed a flat terrace landscape at the toe of the slopes – the slope toe terraces, also called lower Mittelterrassen.

Valley bottom terraces: During the Upper Pleistocene and Holocene the river forms the valley fill and its floodplains ongoing up to now. A more detailed scheme of the valley fill of the Main River than in Fig. 0.4 is given in Fig. 4.1. The surface of the valley bottom along its outer rim shows a group of three Last Glacial (Würmian) terraces, the Reundorf, Schönbrunn and Ebing Terrace (Stop 3 Redwitz), also called Niederterrassen. They were accumulated since the beginning of the Upper Pleniglacial around 30 ka BP. Below these terrace bodies there locally occur basal parts of older Last Glacial river accumulations (see Stop 3 Redwitz). On the Upper Main River the Schönbrunn and Ebing Terraces belong to the floodplain terraces. The inner part of the valley ground is filled by seven Holocene floodplain terraces developed during maxima of fluvial activity of the meandering river (Stop 4 Trieb). This group of three Late Pleistocene and seven Holocene terraces occurs on all rivers in Central Europe (Schirmer 1988a: 3, 1995a: 33). Synchronous phases of alternating increased fluvial activity and quiescence on major and smaller rivers give proof of climatic control over the fluvial rhythmicity. Local forming by the individual river catchment does affect the texture, pattern, structure and floodplain soil types of the terrace sequences. Moreover, man's impact since the Neolithic Period modifies increasingly the natural valley-forming processes. But despite regional and human modification, the natural imprints remain visible and dominating (Schirmer 1995a: 27).

2 Excursion

Stop 1 Moenodanuvian plateau terrace gravel of the Frankenwald foreland at the Espich site

R 446421, H 555524, 471 m a.s.l. Topographical TK and geological map GK 25 5834 Kulmbach (Compare also excursion A, Stop 7 Zöller et al., this volume.)

Geological setting

The Espich site is situated 3.5 km outside the Franconian Fault (Fränkische Linie) (Fig. 02). This fault separates the Palaeozoic Variscan basement rocks in the northeast and the thick Mesozoic cover of the South German Block in the southwest. Along this fault the Bohemian Massif is lifted out up to 3,000 m over the Mesozoic foreland (Wagner et al. 1997). This foreland is block-faulted in a strip some tens of kilometres wide in distance from the Franconian Fault; it is the so-called Franconian Fault-Block Zone. The Variscan basement rises up along a remarkable fault-line scarp about 100 m over the Mesozoic foreland owing to easier erosion of the softer Triassic rocks (sandstone, claystone, limestone) in the foreland in contrast to harder rocks of the basement (diabase, quartzite, greywackes, radiolarite, gneiss, slate etc.). A certain amount of the difference in elevation is to be charged to tectonic movement along the Franconian Fault. It is estimated to be 30 m (Drexler 1980: 35), but may be more.

The Espich site

Our site is situated within a 2–4 km broad strip of outcropping limestone of the Middle Triassic Muschelkalk. This strip of Muschelkalk is flanked on the northeastern side by clay and sandstone of the Upper Triassic Keuper and on the southwestern side by sandstone of the Lower Triassic Buntsandstein. It is situated 160 m above the Main river system – here the Weißer Main and Schorgast River – representing a typical plateau gravel (see Fig. 0.4).

During the Createaceous and Tertiary tropical and subtropical climate the strip of Muschelkalk formed a 2–4 km wide valley owing to intense solution of its limestone. Consequently this subsequent valley acted as fluvial basin for the drainage of the higher situated basement hinterland in the northeast, the Frankenwald. Thus, this basin was filled by clayey, silty, mostly matrix-supported gravel, sand and clay. The fill was studied in two dredge-holes up to 6.8 m deep by Drexler (1980). The clay fraction contains 50–55% kaolinite, 20–25% illite/mica, 10% illite/vermiculite, 10% vermiculite and 5% quartz. Drexler deduces tropoid weathering with desilification in a humid and warm climate in the basement area (Frankenwald) prior to its erosion.

Pebble content

As Drexler found many pebbles in situ in strong weathered condition, it results that the pebble cover at the recent surface represents hard and fresher components only: From two quadrangles, each of 1 m², all pebbles >20 mm were collected, together 404 pebbles. The pebble density was 202 pebbles/m². The petrographic analysis is given in Tab. 1.1.

Therein 72.8 % radiolarite, 22.8 % quartz, 3.4 % Palaeozoic quartzite form 99,0% Palaeozoic basement proportion. The remaining proportion of 1% are light green-grey sandstone of the Upper Triassic Keuper that is outcropping at the foot of the basement scarp northeastern of the Muschelkalk stripe, furthermore red brown sandstone and quarzite of the Lower Triassic Buntsandstein, that crops out southwestern of the Muschelkalk stripe. It indicates that the sandy rocks seaming the Muschelkalk stripe formed higher situated rims on both sides of the elongated Muschelkalk basin. Thus they supply the basin with a certain small share of their rocks. Limonite pebbles are part of the matrix of the gravel, as recorded by Drexler (1980: 18); likewise limonite forms in most recent river gravels at the groundwater contact with air.

The largest block found in the analysed quadrangle was a lydite of 17 cm ∅, the largest one from around was a grey-green Palaeozoic quartzite of 20 cm ∅. Also this size is owing to the close source area of these rocks.

All radiolarites exhibit radiolarians. A lot of the radiolarites show a light weathering halo (see Tab. 1.1). The halo can be white, grey, greenish grey, olive, light brown, brown and red. Its thickness was found up to 7 mm. Sometimes several haloes on one pebble show concentric structure, for example, from the inside outward, from red to light brown to white. Sometimes the light weathering colour also penetrates into the rock of the pebbles on joints. As the haloes surround the whole pebbles they developed within the river deposit. Thus, this sediment was subject to strong weathering. Consequently, also radiolarite pebbles can be decomposed in situ.

This pebble assemblage is conspicuous for its extreme elemination of soft pebble components. It is nearly a pure silica selection – quartz, radiolarite and quartzite – of the original gravel. The very little proportion of softer rocks comes from the nearest surroundings and may have been embedded very quickly so that no further transporting selection could have happened. Fig. 1.1 demonstrates the contrast of a full non-decalcified gravel spectrum of the young Main River (Hochstadt 1), a strongly weathered gravel spectrum of the early Middle Pleistocene Main-Rodach River (Lettenreuth) and the extremely weathered silica spectrum of the pre-Quaternary plateau terrace of the Moenodanuvius at the Espich site. The diagram shows the drastic impoverishment of the spectra components from the left to the right side.

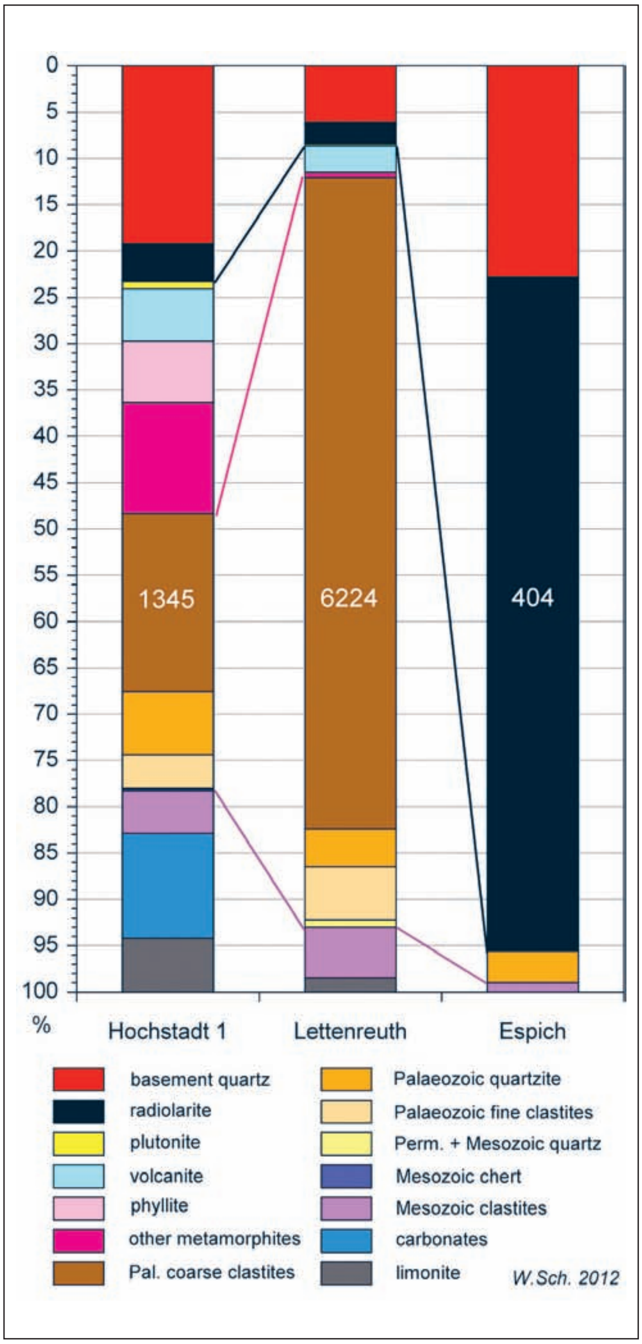

Fig. 1.1: Lithological pebble spectra of the young Main River (Hochstadt 1), the early Middle Pleistocene Main-Rodach River (Lettenreuth) and the pre-Quaternary Moenodanuvius (Espich) showing the impoverishment of the gravel spectra from a full carbonaceous gravel over a strong weathered gravel to a almost pure silica spectrum. White numbers = total amount of analysed pebbles.

Abb. 1.1: Lithologische Geröllspektren der jungen Mains (Hochstadt 1), des früh-mittel-pleistozänen Main-Rodach-Flusses (Lettenreuth) und des präquartären Moenodanuvius (Espich). Sie zeigen die Verarmung der der Spektren von einem vollen karbonatischen Schotter über einen stark verwitterten Schotter bis hin zu einem fast reinen Silica-Spektrum. Weiße Zahlen = analysierte Gesamtgeröllzahl.

Age of the Espich sediment

The age of this deposit was estimated to be Pliocene since Emmert (1953). As indicated in Schirmer (1986: 15) this Frankenwald Foreland River is part of the Moenodanuvius River and may be an upper course of one of the Moenodanuvian branches preserved on top of the Northern Franconian Alb, perhaps of the Kulmbach Moenodanuvius (Fig. 0.2). The age of this gravel bearing Moenodanuvius may range principially from Upper Cretaceous through Tertiary. A late Cretaceous to earlier Tertiary age is more probable than a late Tertiary age, because the Moenodanuvian terraces of the Northern Franconian Alb are included into the tectonic bending.

Tab. 1.1: Gravel spectrum of the Moenodanuvian plateau gravel from Espich west of Untersteinach. # = single pebbles found outside the statistically collected quadrangle.

Tab. 1.1: Geröllspektrum des moenodanubischen Plateau-Schotters im Espich westlich Untersteinach. # = Einzelgerölle außerhalb des statistisch beprobten Quadrates gefunden.

Rock type	>63 mm	63–40	40–20	sum	sum (%)	halo (%)
milky quartz	2	4	42	48	11.9	
milky quartz+rock appendage		4	27	31	7.7	
quartz, grey, yellow, reddish		4	9	13	3.2	
quartz, total	2	12	78	92	22.8	
ferriferous quartz				#	#	
diabase				#	#	
Palaeozoic quartzite, light grey				#	#	
Pal. quartzite, grey to green	1	3	7	11	2.7	
Palaeozoic quartzite, red			3	3	0.7	
Palaeozoic quartzite, total	1	3	10	14	3.4	
radiolarite, black (lydite)	15	46	126	187	46.3	16.0
radiolarite, grey to white		3	54	57	14.1	54.4
radolarite, light brown		9	32	41	10.1	70.7
radiolarite, red			2	2	0.5	50.0
radiolarite breccia	1	3	3	7	1.7	
radiolarite, total	16	61	217	294	72.8	34.0
basement rocks, total	19	76	305	400	99.0	
sandstone, light green-grey			1	1	0.25	
sandstone, red to brown		2		2	0.5	
Mesozoic quartzite, brown			1	1	0.25	
limonite+limonitic sandstone				#	#	
Mesozoic rocks, total		2	2	4	1.0	
total pebble amount	19	78	307	404	100.0	
total pebble amount (%)	4.7	19.3	76.0		100.0	
weight (kg)	8.308	5.275	5.617	19.2		
weight (%)	43.3	27.5	29.2		100.0	

Stop 2 Main Formation of the Marktzeuln Palaeomeander in the Lettenreuth gravel and sand pit

R 44406, H 556, 305 m a.s.l. Topographical TK and geological map GK 25 5833 Burgkunstadt

Geological and geomorphological setting

Near the junction of the Main and Rodach River the gravel and sand pit Schramm in Lettenreuth in the area Marktzeuln-"Schallhölzer" is situated in a wide palaeomeander (Figs. 0.1 and 2.1). The palaeomeander lies about 30 m over the Main-Rodach valley ground. It exhibits the Main Formation as a stack of fluvial accumulations with alternation of filling and cuttig periods (Schirmer 2007b: 113, and in press). The geological environment of the palaeomeander is sandstone and claystone of the lower Sandsteinkeuper (Upper Triassic). The versants surrounding the palaeomeander are built of Burgsandstein, the deeper parts of the palaeomeander may cut into Coburg-Sandstein or even Blasensandstein. The accumulation of the palaeomeander has been preserved within a deserted loop that is separated from the recent Main valley by a flat hill called Kulbitz. This cut-off meander spur consists of sandstone and dolomite of the Lower and Middle Burgsandstein (Upper Triassic). The top of the hill overtops the fluvial accumulation up to 6.8 m and the recent Main-Rodach valley ground up to 30 m.

The vertical section of the Main Formation

The top of the fluvial accumulation (Fig. 2.2) rises 37 m above the Main river level. Its thickness is exposed up to 25.5 m; but there is an unknown stretch down to the base of the accumulation. The exposed accumulation comprises a fluvial staple of five fluviatile series (A–E) – each starting with a coarse lag facies, upward followed by sandy gravel merging into sand and, in series D and E, topped by a sandy-silty floodplain deposit. The upper part of such a fluviatile series often is truncated by the following fluviatile series. The series A, B, D, E exhibit vertical accumulation structure (V gravel), series C lateral accumulation structure (L gravel) with its typical skeleton gravel – a characteristic structure of a meandering river. In the fluviatile series D and E frost cracks and drop soils (Fig. 2.3) occur as cold climate indicators. Moreover, in series D huge streaks of brown layers of loamy sandstone breccia occur in the

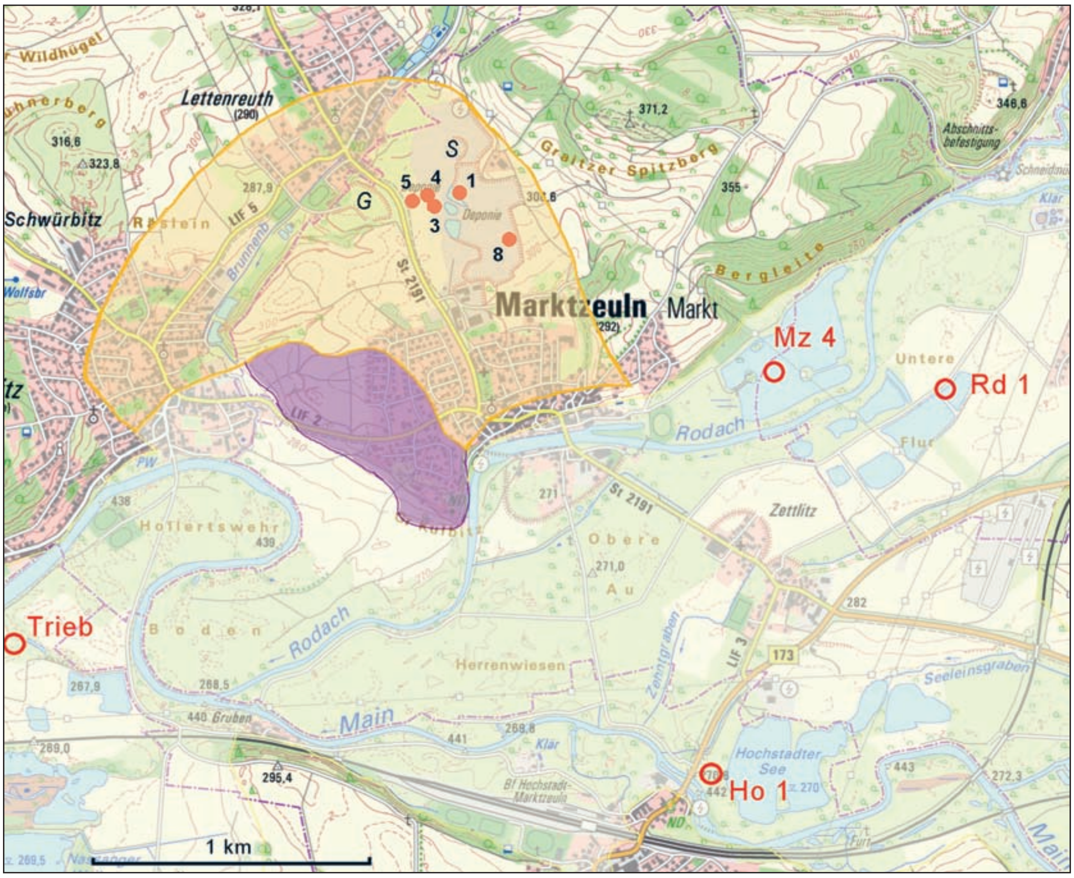

Fig. 2.1: Location map of the Marktzeuln Palaeomeander and the river junction of Rodach and Main. Orange = Marktzeuln Palaeomeander (early middle-Pleistocene Main Formation). Violet = Kulbitz cut-off meander spur (Upper Triassic Burgsandstein). Map area lightened up = late middle-Pleistocene to Holocene river deposits. Red dots within the the Main Formation: Profiles of the gravel pit Lettenreuth. G = pit "Grasiger Weg". S = pit "Schallhölzer". Red circles in the floodplain: Ho 1 = gravel analysis Hochstadt 1, Mz 4 = gravel analysis Marktzeuln "Oberes Wehr" 4, Rd 1 = profile Redwitz "Untere Flur" 1. Map basis: Top 25 Bayerische Vermessungsverwaltung 2010.

Abb. 2.1: Karte des Marktzeulner Paläomäanders und der Mündung von Rodach und Main. Orange = Marktzeulner Paläomäander (frühmittelpleistozäne Main-Formation). Violett = Kulbitz-Umlaufberg (Burgsandstein). Aufgehellter Kartenteil = Spätmittelpleistozäne bis holozäne Flussablagerungen. Rote Punkte in der Main-Formation: Profile der Grube Lettenreuth. G = Grube „Grasiger Weg". S = Grube „Schallhölzer". Rote Kreise in der Aue: Ho 1 = Schotteranalyse Hochstadt 1, Mz 4 = Schotteranalyse Marktzeuln-„Oberes Wehr" 4, Rd 1 = Profil Redwitz-„Untere Flur" 1. Kartengrundlage: Top 25 Bayerische Vermessungsverwaltung 2010.

eastern part of the pit (Fig. 2.4). There the wall is close to the undercut slope where the debris of Triassic sandstone and clay comes from. Frost activity and lack of vegetation may stimulate this debris supply at the sandstone slope. The top of fluviatile series E is preserved with a floodplain channel filled with gley and mud soil (phaeozem). This mud soil is the highest preserved part of the fluvial stack of the Main Formation. Thus, the original floodplain surface of the Main Formation should have been several decimeters or few meters higher, at least at 304 m a.s.l., i.e. 37 m above the recent Main River level.

The Main Formation within the Marktzeuln Palaeomeander – deposited by the Rodach River or Rodach and Main River?

As the palaeomeander is close to the recent junction of the Main and Rodach River the question arises whether the meander fill originates from the Rodach or from both merged rivers. For this the gravel of the accumulation was analysed from base to top by 16 continuously taken samples. The sampled strata are indicated in Fig. 2.2, profiles 4 and 5. The 16 gravel spectra are rather similar. Therefore in Fig. 2.5 a generalized Lettenreuth spectrum was summed up from the 16 spectra. In Fig. 2.5 it is flanked on the right side by three spectra of the Main river upward from the river junction (the Burgkunstadt Upper Main) and on the left side by three spectra of the Rodach river upward from the river junction.

While the Lettenreuth spectrum is of Middle Pleistocene age and consequently completely decalcified, the other spectra are of Upper Pleistocene to Holocene age and carbonaceous. To make the spectra comparable, the limestone share of the younger spectra was extracted from the calculation.

At first sight the Lettenreuth spectrum approaches the Rodach spectrum more than the Main spectrum. However, it contains distinct Main River shares indicated by a higher rate of basement quartz, metamorphites, post-Varistic quartz and limonite pebbles. In addition, a small rate of 0.2% of plutonites is present, too small to appear in the diagram. These Main River components occur in all the 16 single spectra.

The small share of metamorphites in Lettenreuth compared to the spectra of the Burgkunstadt Upper Main is

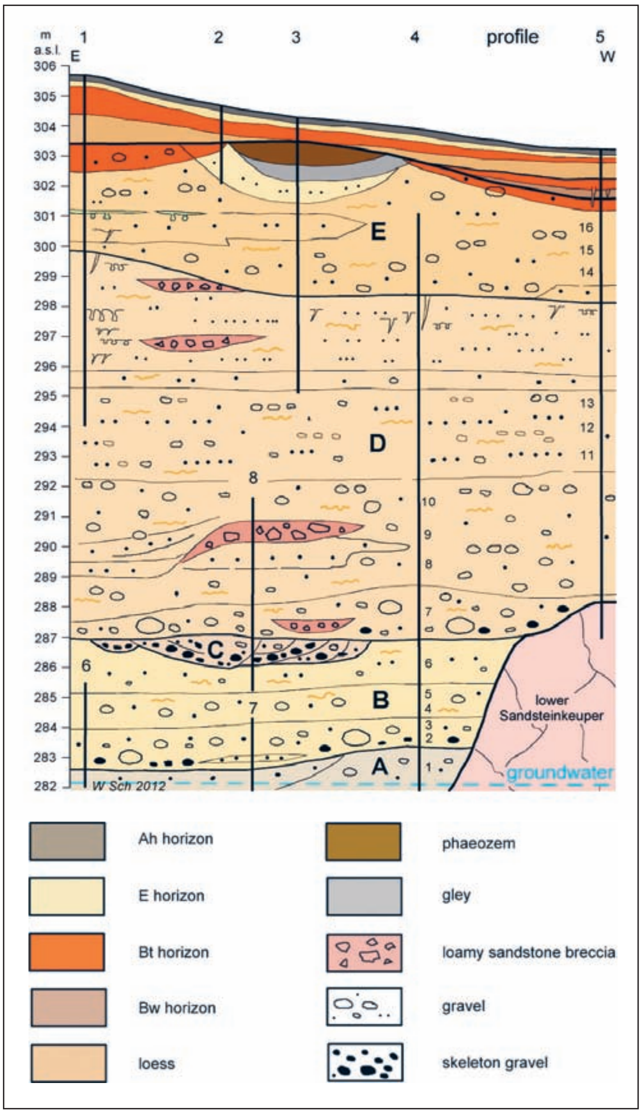

Fig. 2.2: Schematical sketch of the Lettenreuth gravel and sand pit with positions of the profiles 1–8. The numbering 1–16 along the profiles 4 and 5 marks the beds where gravel samples were taken from. A–E indicate the fluvial units of the sedimentary stack.

Abb. 2.2: Schematische Aufschlussskizze der Sand- und Schottergrube Lettenreuth mit Lage der Profile 1–8. Die Nummern 1–16 an den Profilen 4 und 5 markieren die Entnahmeschichten der Geröllproben. A–E kennzeichnen die Fluviatilen Serien des Stapels.

Fig. 2.3: Gravel pit Lettenreuth. Drop soil within the fluviatile series D. Photo: W. Schirmer 30.04.1988.

Abb. 2.3: Kiesgrube Lettenreuth. Tropfenboden in der Fluviatilen Serie D. Foto: W. Schirmer 30.04.1988.

Fig. 2.4: Gravel pit Lettenreuth. Brown layer of a loamy sandstone breccia within fluviatile series D. Line is 40 cm high. Photo: W. Schirmer 25.04.2012.

Abb. 2.4: Kiesgrube Lettenreuth. Braune Sandsteinbrekzienbank in der Fluviatilen Serie D. Linie hat 40 cm Höhe. Foto: W. Schirmer 25.04.2012.

owing to strong weathering of the phyllite, quartz-phyllite and amphibolite pebbles (Fig. 2.6).

All in all, the diagrams indicate a joint Main-Rodach river passing the Marktzeuln Palaeomeander prior to its cut-off.

Conclusion

The special feature of this outcrop is the Marktzeuln Palaeomeander, a deserted loop containing a rather complete archive of the fluvial stack of the Main Formation. This archive exhibits five stacked fluviatile series, four series of a braided river and between the second and third series one of a meandering river. The lower three fluviatile series are considerably truncated, the upper two series are rather complete. The outcrop shows that during the Main Formation there was a vertical alternation of fluvial filling and cutting with preference to filling. Also a lateral change by local cutting within the valley plain modelled the structure.

The Main Formation can be followed downstream to the junction with the Rhine River. In most outcrops it exhibits a smaller amount of fluviatile series than in the Marktzeuln Palaeomeander. The reason for the differing amount of fluvial series from place to place is the change of cut and fill processes both in its vertical intensity and in its lateral place of action within the palaeo valley. The base of the Main Formation lies generally few meters below the recent Main River level. Its top is varying between 37 and 55 m above the river level (Schirmer, in press). The Lettenreuth outcrop shows that the fluvial stack embraces at least four glacial periods and one interglacial period. Downriver great parts of the stack were dated to the Cromerian Complex at famous places with fauna and flora, for example those from Würzburg-Schalksberg for its fauna (Rutte 1987: 95), Marktheidenfeld for its flora (Schirmer 1988b, Stuckenbrock 1988), Mosbach for its fauna (Keller 2007: 317f.) and Mauer on the Neckar River for the locus typicus of *Homo heidelbergensis* (Wagner et al. 2007, Schirmer 2007b).

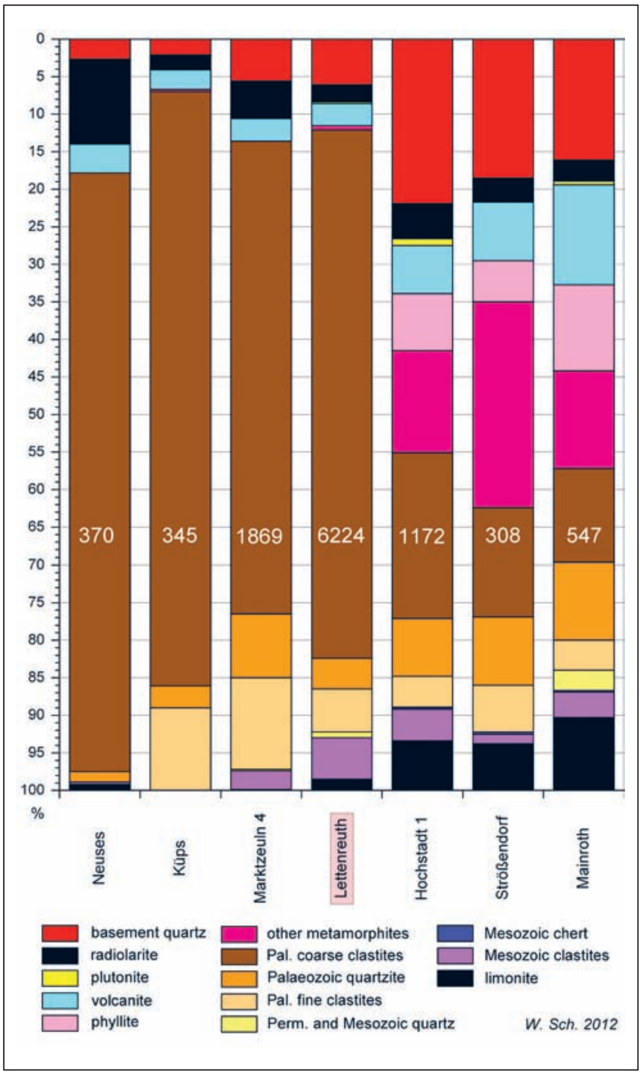

Fig. 2.5: Gravel spectrum Lettenreuth in comparison to spectra of the Burgkunstadt Upper Main River (Mainroth, Strößendorf, Hochstadt 1) and the Rodach River (Neuses, Küps, Marktzeuln "Oberes Wehr" 4). White numbers = total amount of analysed pebbles.

Abb. 2.5: Geröllspektrum Lettenreuth im Vergleich zu Spektren des Burgkunstadter Obermains (Mainroth, Strößendorf, Hochstadt 1) und der Rodach (Neuses, Küps, Marktzeuln-„Oberes Wehr" 4). Weiße Zahlen = analysierte Gesamtgeröllzahl.

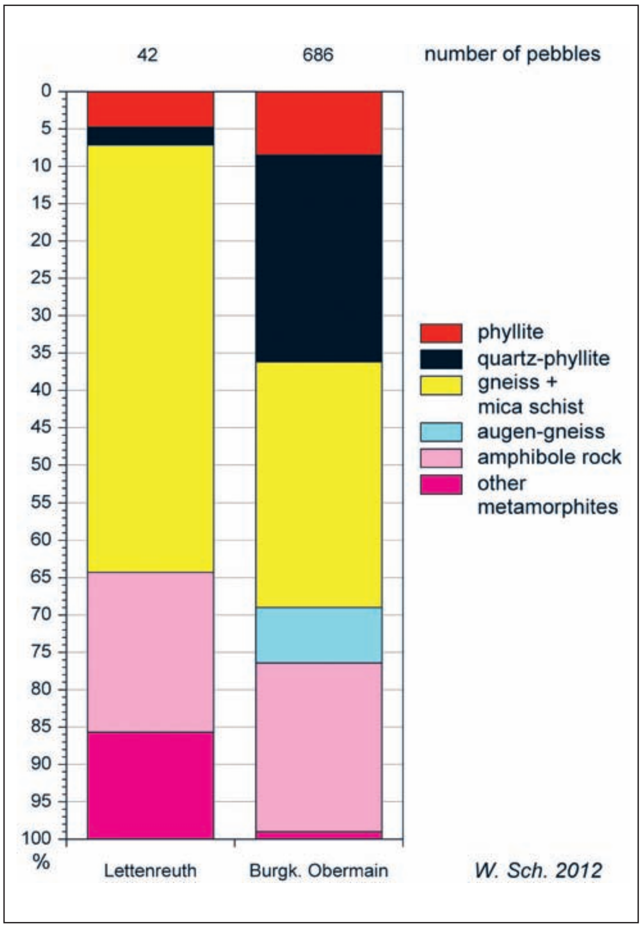

Fig. 2.6: Comparison of gravel spectra of metamorphite pebbles of the Burgkunstadt Upper Main valley ground with the Main-Formation in Lettenreuth.

Abb. 2.6: Vergleich der Metamorphit-Geröllspektren des Burgkunstadter Obermain-Talgrundes mit dem der Main-Formation in Lettenreuth.

Stop 3 Late Glacial Ebing Terrace in the Rodach valley ground near Redwitz [Wolfgang Schirmer, Michael Friedrich, Maria Knipping, Bernd Kromer & Uwe Abramowski]

R 444226, H 555935, 273 m a.s.l. Topographical TK and geological map GK 25 5833 Burgkunstadt

Geological and geomorphological setting

Location 3, Redwitz-Untere Flur 1, is situated within the Rodach floodplain (Figs. 0.1 and 2.1), 1.3 km upstream from the Main floodplain respectively 3.0 km upstream of the junction with the Main River. Valley and joining versants are formed by Upper Triassic Lower Sandsteinkeuper (Blasensandstein, Coburg-Sandstein, Burgsandstein). The floodplain is 900 m wide, 600 m width are of Holocene age, 300 m width of Latest Weichselian age (Weichsel-Spätglazial) represented by the Ebing Terrace.

The valley ground of the Main River and tributaries embraces three terraces of Last Glacial age, besides the Holocene terraces (Tab. 3.1, see also Fig. 0.4).

The Ebing Terrace is the youngest of them and morphologically the lowest and rises above some decimeters over the Holocene terraces.

Vertical valley section

The profile Redwitz-Untere Flur 1 provides a vertical section through the whole valley fill from the floodplain top down to the bedrock (Fig. 3.1). The bedrock is sandstone and red and green marl of the lower Sandsteinkeuper. Above the bedrock follow four fluviatile series, three light coloured lower series and one dark coloured upper series, the Ebing Terrace.

The three lower series

1. The first and lowest one is preserved by a 0.3 m thick sandy lag facies of a vertical accumulated gravel (V gravel).

2. The second one above it is 0.8 m thick and represents a typical lateral accretion gravel (L gravel) with typical skeleton gravel near the base of the diagonal bedding planes. It indicates a meandering river.

3. The third fluviatile series, 1.8 m thick preserved, is again a sandy V gravel. An OSL age from the upper sandy layer (Fig. 3.2) yielded 24.3±2.0 ka (Abramowski et al., in prep.), a Weichselian Upper Pleniglacial age. It is the socle of the Reundorf Terrace.

The disconformable upper boundary of the third fluviatile series is the boundary between the light coloured lower channel deposits and the darker upper channel deposits (Fig. 3.3), i.e. between the Weichselian Upper Pleniglacial deposits (Jüngeres Hochglazial) and the Latest Weichselian deposits (Spätglazial), the Ebing Terrace. This boundary sometimes is lying even within the outcrop (as in Fig. 3.3), sometimes also channel-like.

Upper series, the Ebing Terrace

1. *Hippophaë* channel: The Upper series starts with a floodplain channel cut 1.6 m deep into the third series, the Reundorf Terrace. The basal channel fill is a 0.4 m thick loam, at its very base silty, weakly clayey, above it fine sandy, silty (Fig. 3.4). In the deepest part of the fine sandy layer a wood remnant (sample Main 3295) gave a ^{14}C age of 12,127±34 BP (14,035–13,895 calBP using IntCal 09); that points to the early Late Glacial period.

A column of six samples from this 0.4 m flooplain loam has been palynologically analysed by Maria Knipping (Tab. 3.2). The pollen spectra show a lot of reworked palynomorphs of pre-Quaternary and Quaternary types. Beside this reworked badly preserved taxa autochthonous pollen could be separated; they show a quite better preservation. Pollen of Poaceae, Cyperaceae are frequent and *Salix, Pinus, Hippophaë* and *Betula* occur regularly in the pollen spectra. Though the samples are contaminated with a lot of reworked taxa it seems likely that the sediment was built during the *Hippophaë* phase in the early Late Glacial.

Tab. 3.1: Last Glacial terraces of the valley ground in central Europe.

Tab. 3.1: Letztglaziale Terrassen des Talgrundes in Mitteleuropa.

Terrace name	Synonym	Age
Reundorf Terrace	Niederterrasse 1	30,000–24,000 years BP, Upper Pleniglacial
Schönbrunn Terrace	Niederterrasse 2	23,000–14,500 years BP, late Upper Pleniglacial
Ebing Terrace	Niederterrasse 3	(14,500-) 12,800–11,560 years BP, Late Glacial

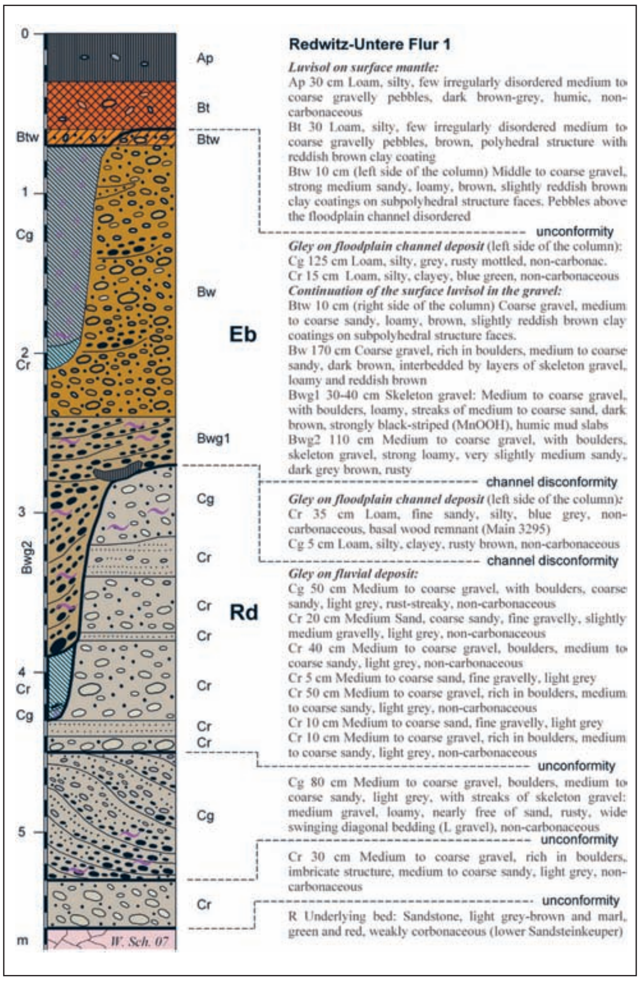

Fig. 3.1: Profile Redwitz–Untere Flur 1. Soil horizon designations after FAO-UNESCO (1990). Eb = Ebing Terrace, Rd = socle of the Reundorf-Terrace.

Abb. 3.1: Profil Redwitz–Untere Flur 1. Boden-Horizontbezeichnungen nach FAO-UNESCO (1990). Eb = Ebing-Terrasse, Rd = Sockel der Reundorf-Terrasse.

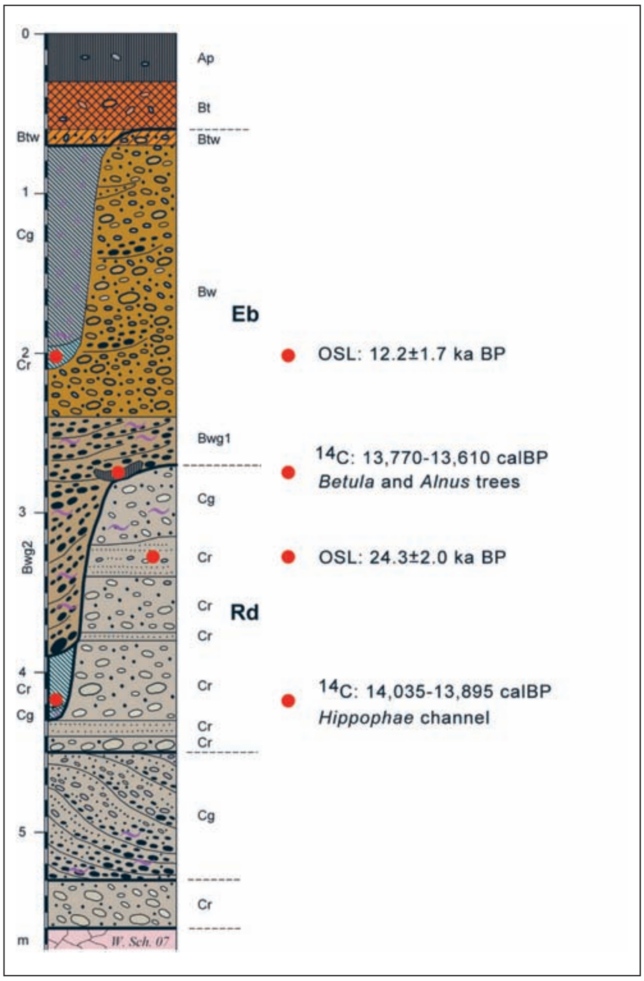

Fig. 3.2: Profile Redwitz–Untere Flur 1 with finds and ages. Eb = Ebing Terrace, Rd = socle of the Reundorf-Terrace.

Abb. 3.2: Profil Redwitz–Untere Flur 1 mit Funden und Altersangaben. Eb = Ebing-Terrasse, Rd = Sockel der Reundorf-Terrasse.

Thus, the channel cutting into the Reundorf Terrace happened in the late Upper Pleniglacial or at the transition to the Late Glacial forming in this lower level an early Late Glacial floodplain with the *Hippophaë* channel.

2. The higher part of the channel fill and the base layer of the darker gravel outside the channel fill is a skeleton gravel of 1.5 m in thickness. It bears smaller and larger slabs up to 50 cm thick of black humic mud (Fig. 3.3). Some of these mud slabs contained wood remnants. A ^{14}C age of one of this wood remnants is 11,820±25 BP (13,770–13,610 calBP). Among these remnants were 26 trunk pieces of alder (*Alnus* c.f. *viridis*) and birch (*Betula* c.f. *pendula* / *pubescens*) (Fig. 3.5), the largest one 60 cm long and 30 cm in diameter with well preserved bark. Preliminary dendrochronological studies on 16 of those birch and alder trees revealed that it is possible to cross-match most of the birch series and construct birch tree-ring chronologies. At most other sites with Late Glacial wood remnants, pine (*Pinus sylvestris*) is the most frequent tree species with preserved wood. Therefore a number of Late Glacial–Early Holocene tree-ring chronologies of pine exist in Central Europe and northern Italy (Friedrich et al. 1999, 2004, 2010, Kaiser et al. 2012). In contrast to pine, which is a well suitable species for tree-ring analysis, for hardwood species like birch, poplar, or alder only a very few and short tree-ring series of subfossil wood exist in Central Europe (i. e. Friedrich et al. 1999, Friedrich et al. 2010). Additionally, chronology construction is more elaborate, as the individual series of those species are short, the wood is poorly preserved and absent rings frequently occur. So far 10 birch trees could be combined to form a 81-year floating tree-ring width chronology that can be predated by ^{14}C to 13,770–13,610 calBP. Another single tree is predated to 12,127±34 BP (14,040–13,890 calBP). According to these dates the trunks are remnants of a Bølling-Allerød birch (-alder) forest. According to the ^{14}C date it could correlate to the Greenland Isotope Interstadial 1c in mid-Late Glacial (Björck et al. 1998).
For more than 40 years most of the gravel pits in the Main catchment area has been observed intensively and more than 3000 trees and tree remnants have been sampled and studied dendrochronologically. 2750 oak trees have been combined to form the major oak chronology for Central Europe (Becker 1993, Friedrich et al. 2004) (Fig. 3.6). But in contrast to the other river valleys Rhine and Danube where Late Glacial/Early Holocene (pine) wood is found frequently, no tree trunks older than 10,350 calBP could be found through all these years in the Main catchment.
Therefore this new site with Late Glacial tree remnants is of special interest. This birch forest turnes out to be the oldest forest within the floodplain of the Main catchment area.

3. Above this basal skeleton gravel follows 1.8 m thick dark brown, slightly reddish, coarse and loamy gravel, badly sorted and irregularly orientated, with interbedded skeleton gravel streaks, the main corpus of the Ebing Terrace.

Fig. 3.3: Gravel pit Redwitz-Untere Flur 1. Unconformity between the light coloured lower channel deposits (Weichselian Upper Pleniglacial) and the darker upper channel deposits (Late Glacial Ebing Terrace). At its base occur reworked dark blue mud slabs containing wood fragments. Photo: W. Schirmer 11. 07. 2009.

Abb. 3.3: Kiesgrube Redwitz-Untere Flur 1. Diskordanz zwischen dem hellen unteren Flussbettsediment (Jüngeres Hochglazial) und dem dunkleren oberen (spätglaziale Ebing-Terrasse). An deren Basis sind umgelagerte dunkelblaue Muddeschollen eingearbeitet, die Holzreste enthalten. Foto: W. Schirmer 11. 07. 2009.

Fig. 3.4: Gravel pit Redwitz-Untere Flur 1. At the base of the darker coloured Ebing Terrace an orange arrow marks the early Late Glacial mud channel (Hippophaë channel). Photo: W. Schirmer 14. 09. 2007.

Abb. 3.4: Kiesgrube Redwitz-Untere Flur 1. An der Basis der dunkler gefärbten Ebing Terrasse liegt eine Früh-Spätglaziale Mudderinne (Hippophaë-Rinne), markiert durch einen orangen Pfeil. Foto: W. Schirmer 14. 09. 2007.

4. This gravel again is cut by a 1.5 m deep floodplain channel filled with blue green and grey silty loam of a gley soil. An OSL dating from the base of this gley channel yielded an age of 12.2±1.7 ka (Abramowski et al., in prep.). That means a Younger Dryas age (Greenland Isotope Stadial 1 = GS1).

5. A silty loam bed of 0.6 m in thickness is overlaying the gravel bed as well as the floodplain channel. It is the floodplain deposit of the Ebing Terrace ending at the recent surface of the valley bottom. A luvisol has developed on this surface, in some depressions also a stagnic luvisol.

Conclusion

The vertical valley section is covered by the Late Glacial Ebing Terrace. At its base the socle of the Reundorf Terrace has been preserved. The L gravel below it might belong to

Tab. 3.2: Gravel pit Redwitz-Untere Flur 1. Pollen analysis from the Hippophaë channel (M. Knipping).

Tab. 3.2: Kiesgrube Redwitz-Untere Flur 1. Pollenanalyse aus der Hippophaë-Rinne (M. Knipping).

Redwitz-Untere Flur 1 Pollen analysis: M. Knipping																														
Pollen grains:	arboreal pollen							nonarboreal pollen																	reworked taxa					
sample	Pinus	Betula	Salix	Juniperus	Hippophae	Ephedra fragilis type	Ephedra distachya type	Poaceae	Cyperaceae	Artemisia	Chenopodiaceae	Thalictrum	Epilobium	Rubiaceae	Cichoriaceae	Apiaceae	Brassicaceae	Varia	Pediastrum	Botryococcus	monolete Spore	Botrychium	Ophioglossum	Equisetum	Indeterminata	corroded (reworked)	sum prequaternary taxa	sum arboreal pollen	sum arboreal + nonarboreal	total sum
M 3288	3		6		4			12	15						2	2	1	1	2		1			1	64	32	48	14	47	194
M 3290	7		15	4	3			44	34	1	1	6		10				3	1	2		1		2	77	103	42	29	128	356
M 3291	5	1	1		1	1		42	16	1		1	1	1	1			1	2	1					49	19	51	10	74	196
M 3292	6	1	4		2			48	34	1		5		5				7	1					1	90	37	25	13	113	267
M 3293	15	3	26	7	11			62	61	3		4		15	1		1	9	2	3		2		1	142	97	29	64	222	496
M 3294	11	1	6	1	9		1	50	41	1					4	1	1	3	2	2	5		1		143	36	39	30	131	359
Pollen percentages:																														
M 3288	6,4		12,8		8,5			25,5	31,9						4,3	4,3	2,1	2,1	4,3		2,1			2,1	136,2	68,1	102,1	29,8	100	412,8
M 3290	5,5		11,7	3,1	2,3			34,4	26,6	0,8	0,8	4,7		7,8				2,3	0,8	1,6		0,8		1,6	60,2	80,5	32,8	22,7	100	278,1
M 3291	6,8	1,4	1,4		1,4	1,4		56,8	21,6	1,4		1,4	1,4	1,4	1,4			1,4	2,7	1,4					66,2	25,7	68,9	13,5	100	264,9
M 3292	5,3	0,9	3,5		1,8			42,5	30,1	0,9		4,4		4,4				6,2	0,9					0,9	79,6	32,7	22,1	11,5	100	236,3
M 3293	6,8	1,4	11,7	3,2	5,0			27,9	27,5	1,4		1,8		6,8	0,5		0,5	4,1	0,9	1,4		0,9		0,5	64,0	43,7	13,1	28,8	100	223,4
M 3294	8,4	0,8	4,6	0,8	6,9		0,8	38,2	31,3	0,8					3,1	0,8	0,8	2,3	1,5	1,5	3,8		0,8		109,2	27,5	29,8	22,9	100	274,0

fluvial deposits of the Middle Pleniglacial period (MIS 3), the basal gravel to older Weichselian deposits.

The Ebing Terrace indicates by the *Hippophaë* channel that its age starts with the beginning of the very early Late Glacial (about 14,035–13,895 calBP) within a lower level than that of the ending Reundorf Terrace. During the deposition of its thick gravel accumulation the river passed a floodplain with floodplain channels of middle Late Glacial age (about 14,000–13,600 calBP). In this floodplain grew a birch and alder forest, the oldest forest hence found in the Main catchment area. By eroding this floodplain the river incorporated into its gravel mud slabs of this floodplain together with the tree remnants of its forest – possibly in frozen state (gelisolum slabs). It follows that the lowest gravel in the channel between 3.9 and 2.8 m depth should be older than 14,000–13,600 calBP. The gravel above the slabs is younger than mid-Late Glacial and older than Holocene owing to the Younger Dryas age of the OSL-dated gley channel on top of the gravel. Thus, the main gravel bed is of Younger Dryas age (Greenland Isotope Stadial 1). Along the lower Rhine River this gravel deposition has Laacher See pumice of 12,900 aBP (GI 1a/b) as indicator constituent. The Redwitz Younger Dryas gravel again is cut by a 1.5 m deep floodplain channel of Younger Dryas (GS1) age. This phenomenon was likeweise found at the locus typicus of the Ebing Terrace downstream close to Bamberg (U. Schirmer & W. Schirmer 1988). It shows that the gravel deposition of the Ebing Terrace tapered off distinctly before the end of the Younger Dryas. It happens likewise to the gravel accumulation along the River Rhein (Schirmer 1990a: 28).

Thus, the Ebing Terrace starts with the beginning of the Late Glacial, but the bulk of gravel layer was deposited during the earlier Younger Dryas (GS1) cooling period (Schirmer 2010: 20). This by the way corresponds to results from the Danube area (Schellmann 2010, Gesslein & Schellmann, 2011: 408).

Stop 4 Holocene terraces in the Main valley ground at Trieb

R 44386/7, H 55582, 268 m a.s.l. Topographical map TK 25 5832 Lichtenfels.

Geological setting

The River Main valley adjoining to Trieb was often subject to intensive research of the valley ground (Becker & Schirmer 1977, Schirmer 1978, 1979, 1980, 1983, 1990b, 1991, 1995a, 2007d). It offers the favour that here the gravel pits in the valley ground are pumped out to be excavated down to the gravel sole, to the bedrock. The bedrock here is the Upper Triassic Feuerletten, a deeply red clay. Above it the pits exhibit complete vertical sections of the valley fill. These sections show mostly two fluviatile series: the socle of the Upper Pleniglacial Reundorf Terrace unconformably superimposed by any of the nine floodplain terraces shown in Fig. 4.1. At Stop 3 the Reundorf Terrace was superimposed by the Ebing Terrace. In the Trieb valley stretch the Reundorf Terrace is superimposed by Holocene terraces. In this context some important phenomena can be studied:

Fig. 3.5: Birch trunc from the gravel pit Redwitz-Untere Flur 1, deposited within a reworked mud slab at the base of the Ebing Terrace. Its age is about 13.5 ka, i.e. middle Late Glacial. Photo: W. Schirmer, 02. 06. 2007.

Abb. 3.5: Birkenstammstück aus der Kiesgrube Redwitz-Untere Flur 1. Es stammt aus einer in die tiefsten Teile der Ebing-Terrasse umgelagerten Muddescholle. Alter: ca. 13,5 ka, mittleres Spätglazial. Foto: W. Schirmer, 02. 06. 2007.

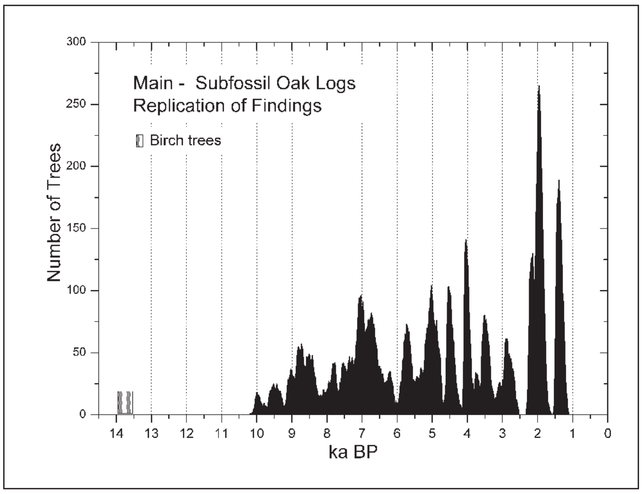

Fig. 3.6: Replication (number of trees through time) of the oak chronology from the River Main and tributaries (Friedrich et al. 2004). The white bar indicates the time range of the new birch chronologies from Redwitz/Rodach.

Abb. 3.6: Belegung der Eichenchronologie des Mains und seiner Nebenflüsse (Friedrich et al. 2004). Der weiße Balken gibt den Zeitraum der neuen Birkenchronologie von Redwitz/Rodach an.

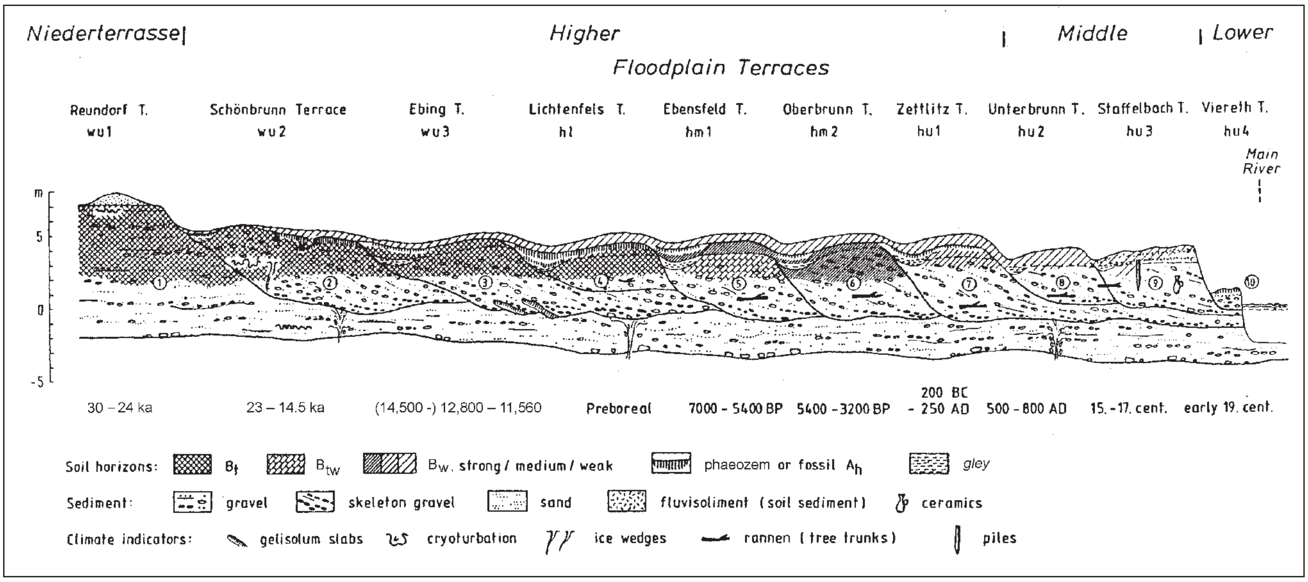

Fig. 4.1: Scheme of the terrace sequence of the valley bottom of the river Main (Schirmer 1995b: 1447, modified).

Abb. 4.1: Schema der Talgrund-Terrassen des Mains (Schirmer 1995b: 1447, verändert).

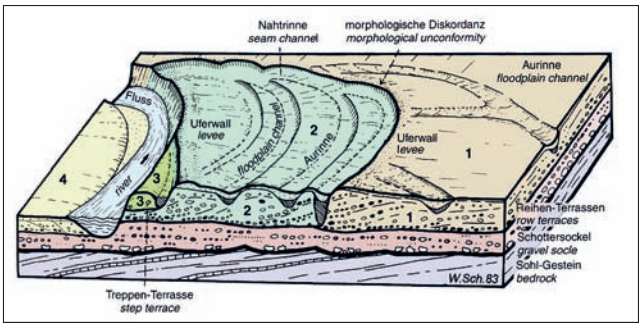

Fig. 4.2: Block diagram showing a floodplain sceme with gravel socle and floodplain terraces (1= oldest, 4 = youngest floodplain terrace) (Schirmer 1983: 29, slightly modified).

Abb. 4.2: Blockdiagramm eines schematischen Auenbereiches mit Sockelschotter und Auenterrassen (1 = älteste, 4 = jüngste Auenterrasse) (Schirmer 1983, 29, leicht verändert).

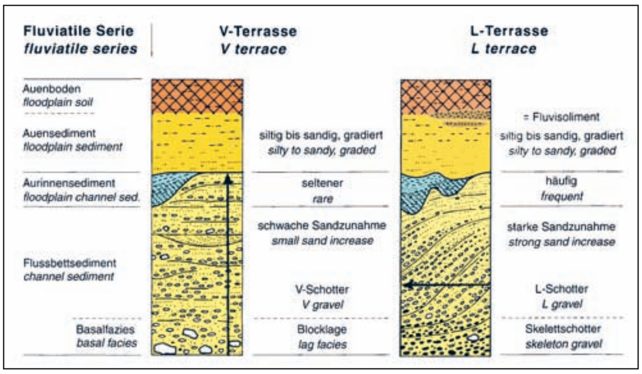

Fig. 4.3: Scheme of the fluviatile series. Arrows mark the direction of sediment growth (Schirmer 1983: 25, slightly completed).

Abb. 4.3: Schema der Fluviatilen Serie. Pfeile zeigen den Sedimentaufwuchs bzw. -anwuchs an (Schirmer 1983: 25, leicht ergänzt).

The boundary between the lower fluviatile series (socle gravel) and the upper fluviatile series (floodplain gravel)

This boundary is figured out in Figs. 4.1 and 4.2. In Fig. 4.2 the socle gravel is drawn pink, the floodplain terraces 1–4 above show different coloures. The older gravels below the unconformity have been preserved only by their basal parts (so-called socle gravels). The unconformity between the socle gravel and the overlying gravel is marked by different sediment colour: the socle gravel is lighter in colour than the superimposed gravel. This is owing to the higher sand content of the socle gravel and the lesser sand content and higher loam proportion of the matrix in the upper gravel. The reason for it is the different bedding of both sedimentary bodies: The lower gravel is a vertical accumulated gravel, a V gravel. The upper gravel is a lateral accretion gravel, a L gravel (Fig. 4.3). In Fig. 4.4 the superposition of V and L gravel results in distinct different grading of both gravels: the matrix proportion of the lower gravel is high at the base (20–45%) and only slightly increasing upward. The matrix rate above the unconformity is much lower (5–25%) and stronger increasing upward. By sieving vertically from the V gravel sole through the unconformity upward to the L gravel top a curve break becomes visible, at which the matrix moves to the left, to lower values. The same type of unconformity, L gravel above V gravel, we saw at Stop 2 in Lettenreuth between fluviatile series B and C, and at Stop 3 in Redwitz between the Reundorf Terrace sediments and the Ebing Terrace.

Here in Trieb both fluviatile series contain, moreover, different climate indicators: The lower one exhibits vertical gravel filling into former ice wedges (Fig. 4.5), the upper one exhibits fossil wood remnants, sometimes as fossil tree trunks, so-called rannen (Fig. 4.6). Those rannen at Stop 3 were birches in the Late Glacial Ebing Terrace. In the Holocene terraces additionally occur oak, ash, alder, elm, poplar, willow and beech. The great advantage of dating these terraces is the dendrochronological dating of the rannen. Fig. 3.6 shows all rannen dated up to now from the River Main and its tributaries.

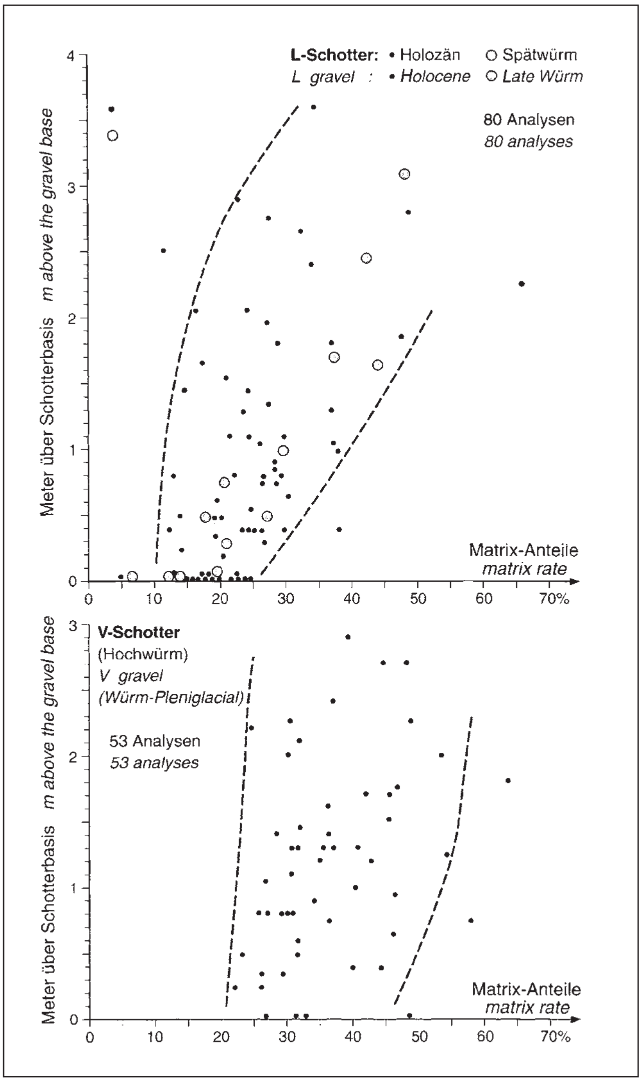

Fig. 4.4: Proportions of matrix (< 2 mm) in V and L gravels from several locations of the Rhine River catchment. V and L gravels are arranged here in superposition as seen in Fig. 1 ("gravel socle below row terraces") (Schirmer 1983: 33).

Abb. 4.4: Matrixgehalte (< 2 mm) von V- und L-Schottern verschiedener Lokalitäten des Rheineinzugsgebietes. V- und L-Schotter sind hier als Stapel angeordnet wie in Fig. 1 („Schottersockel unter Reihen-Terrassen") sichtbar (Schirmer 1983: 33).

Relative soil dating of the floodplain terraces

While the truncated socle gravel exhibits only the lower part of the fluviatile series, the upper fluviatile series above the unconformity is complete as Fig. 4.2 shows. Thus, on top of the floodplain sediment the floodplain soil is preserved. After the rule — the older a floodplain sediment is, the longer is the soil development on top, the more intensive is the soil — a soil catena (Fig. 4.1) has developed in the Main valley: a luvisol on the Würmian Reundorf, Schönbrunn and Ebing and the Preboreal Lichtenfels Terrace, a weak luvisol on the Atlantic Ebensfeld Terrace, a strong cambisol on the Subboreal Oberbrunn Terrace, a medium cambisol on the early Iron-Roman age Zettlitz Terrace, a weak cambisol on the early Medieval Unterbrunn as well as on the Staffelbach Terrace (14th–18th century, central part 15th–17th centunry), a regosol on the Viereth Terrace (early 19th century).

As the exploitation of the Trieb gravel pit is very quick, a proper site will be chosen short before the excursion.

Fig. 4.5: The basal Reundorf Terrace is as V gravel sandy and therefore light in colour and cut by a former vertical ice wedge with gravelly fill. Above the unconformity a Holocene L gravel (Zettlitz Terrace) is poorer in sand, richer in loam, therefore darker, and shows its lateral bedding dipping gently from left to right. Gravel pit Trieb/Upper Main River. Photo: W. Schirmer 12.10.1972.

Abb. 4.5: Die basale Reundorf-Terrasse ist ein V-Schotter, ist sandig und damit hell, und von einer verfüllten Eiskeilspalte vertikal durchzogen. Ein holozäner L-Schotter (Zettlitz-Terrasse) legt sich auf halber Bildhöhe diskordant darüber hinweg. Er ist sandärmer, lehmreicher, daher dunkler und seine großbogige Schrägschichtung (Lateralschichtung) taucht flach von links nach rechts im Bild deutlich ein. Kiesgrube Trieb/Obermain. Foto: W. Schirmer, 12.10.1972.

Fig. 4.6: Ranne in the pit Trieb/Upper Main River. They represent obstacles for the gravel quarrying. Photo: W. Schirmer, 25.07.1973.

Abb. 4.6: Ranne in der Kiesgrube Trieb/Obermain. Sie stellen Hindernisse für den Abbau dar. Foto: W. Schirmer, 25.07.1973.

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