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Guide to the archives of the Laacher See eruptions

W. SCHIRMER, A. IKINGER, J. SCHIERMEYER, U. SCHIRMER & G. WALDMANN

Field guide for the 20th Bog Excursion of the Geobotanisches Institut der Universität Bern: Germany 10.-19.10.1996

Late Würmian strata prior to the Laacher See eruptions (W. SCHIRMER)

Amongst the youngest volcanic events in Germany are the eruptions of the Laacher See volcano in the Eastern Eifel volcano field on the Mittelrhein dating into the Allerød interstadial at about 13, 000 cal BP. Recently the Laacher See event could be subdivided into two eruptions of Allerødian age, the older Pellenz eruption and the younger Meile eruption (W. SCHIRMER 1995a,b).

The two eruptions of the Laacher See volcano preserved two sedimentary and palaeobiological archives:

The **Pellenz eruption** preserved strata prior to the middle Allerødian. Generally, it is the humic **Mendig Soil,** a calcaric regosol whose formation was interrupted by the Pellenz eruption. Until now this soil underwent post-eruptive alterations by solutions pervading the tephra from the recent surface (IKINGER 1995, 1996). In small depressions this soil splits up into a more subdivided Late Würmian including the Meiendorf Interstadial - Older Dryas - Bølling Interstadial - Middle Dryas - early Allerød Interstadial (U. SCHIRMER 1995, W. SCHIRMER 1996) (Tab. 1, Fig. 8). They are topped by the middle Allerødian **Mendig palaeobiocoenosis** that indicates the oecological state of the first eruptional moment of the Pellenz eruption.

The **Meile eruption** preserved strata deposited between the Pellenz and the Meile eruption, the so-called **Breisig Interval** topped by the **Breisig Soil** (W. SCHIRMER 1996) with the Allerødian **Breisig palaeobiocoenosis** (WALDMANN 1995, 1996c). The duration of the Breisig Interval can only be estimated by the developmental stage of the Breisig palaeobiocoenosis and may embrace several decades of years.

Moreover, the Mendig flora and the Breisig flora differ in plant composition as well as season. This supports the geological evidence of two different Laacher See eruptions (WALDMANN 1996c).

Thus, both eruptions leave to us the inheritance of two oecological moments of the Allerød landscape with soils, vegetation and fauna.

The **Pellenz** landscape (Fig. 1) exhibits the tephra of the Pellenz eruption with the preserved underlying beds, the Mendig Soil and Flora. In some places the Pellenz tephra is cut by deep channels filled by a reworked second flora **(Barbara Flora)** and reworked tephra rich in silt. From stratigraphical point of view I assume that the Barbara Flora is an equivalent of the Breisig Flora and the reworked tephra belonging to is an equivalent of the Meile tephra.

The **Goldene Meile** exhibits reworked Pellenz tephra followed by the Breisig Soil with the Breisig biocoenosis that has been protected the Meile tephra.

		Goldene Meile	Laacher See area Pellenz	
Holocene		*luvisol (Parabraunerde)*	*luvisol (Parabraunerde)*	
		upper floodplain sediment		
Late Würmian	10 000			
	Younger Dryas		reworked silt-rich tephra	ULST
	10 800	Meile tephra		
	11 100	*Breisig Soil*	*Barbara Flora* ?	MLST
	Allerød	reworked Pellenz tephra	Pellenz tephra	LLST
	11 800			
	Middle Dryas Bølling Older Dryas Meiendorf	- - - - - - - - - - - -	- - - *Mendig Soil*	
	12 600			
Pleniwürmian	late Pleniwürmian	lower floodplain sediment	loess	
		channel deposit of the Schönbrunn aggradation (NT2)		

Table 1: Stratigraphy of soils and tephras on top of the Schönbrunner Terrace (NT 2) of the Goldene Meile/Mittelrhein in comparison with that of the Laacher See area

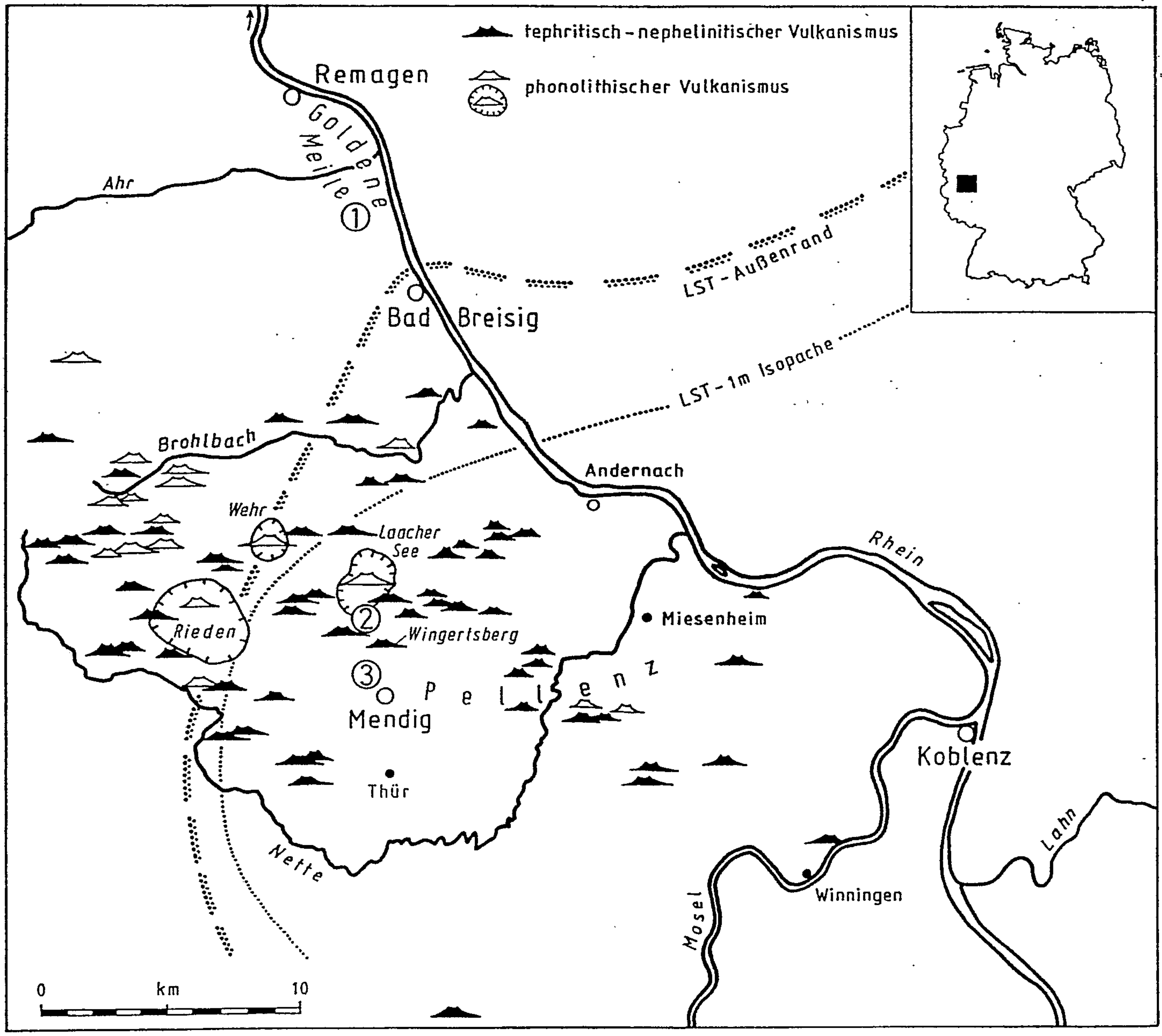


Fig. 1: Map of the Laacher See vulcano area and the Goldene Meile (Golden Mile). LST Außenrand = edge of continuous Laacher See tephra cover after AHRENS (1929: 292) and V. D. BOGAARD & SCHMINCKE (1990). LST-1m-Isopache = 1 m isopach of the Laacher See tephra after V. D. BOGAARD & SCHMINCKE (1984: 935)

The question remains whether the distal Laacher See tephra spreading over central Europe as thin ash layer (V.D. BOGAARD & SCHMINCKE 1985) belongs to the Pellenz or to the Meile tephra.

Field guide

Stop 1: The Goldene Meile (Golden Mile)
Stop 2: The Laacher See
Stop 3: The Pellenz

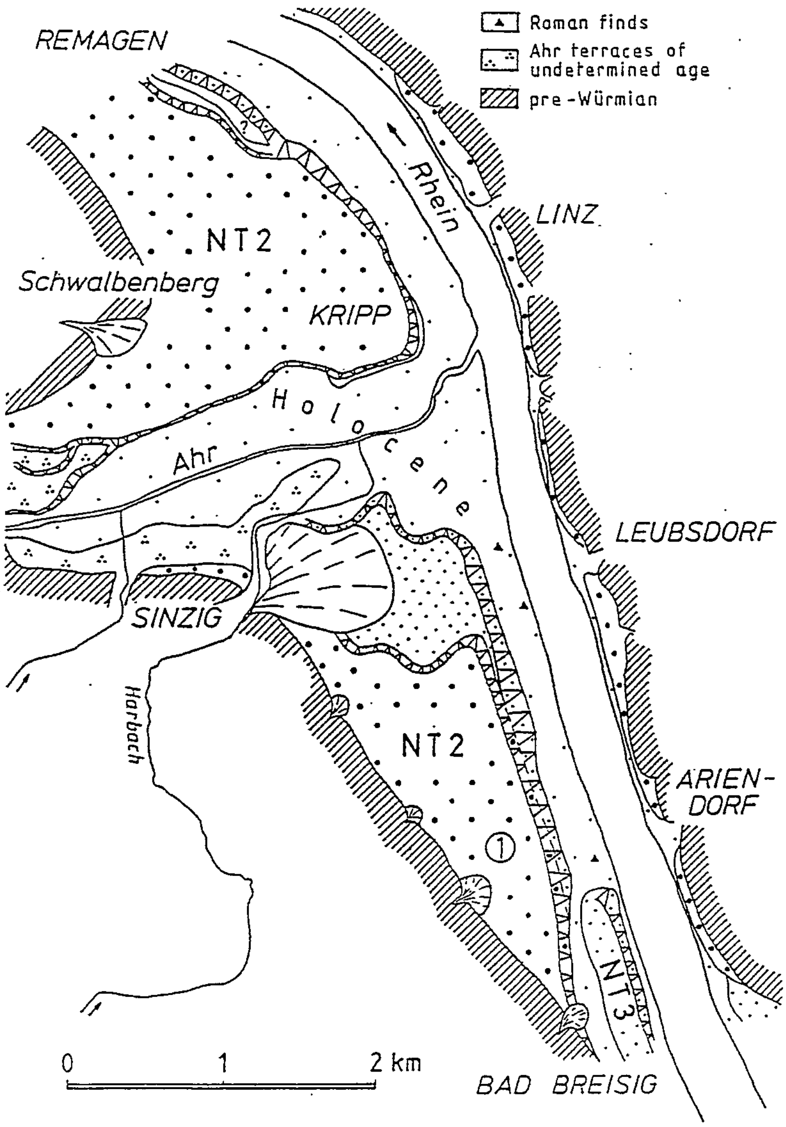


Fig. 2: Terrace map of the Goldene Meile (Golden Mile) (modified after W. SCHIRMER 1995a: 530)

Stop 1: The 'Goldene Meile'

Geomorphological and stratigraphical setting (W. SCHIRMER)

It is a fertile basin of a German geographical mile (= 7.4 km) in length, 140 m deep incised into the climatically rougher trough valley of the Rhein. It has been formed at the place where the left tributary, the Ahr, pushed the Rhein towards its eastern valley slope. Protected by the gravel cone of the Ahr river, a small valley bottom - the Goldene Meile - extends on top of the Niederterrassen and a couple of Holocene floodplain terraces (Fig. 2).

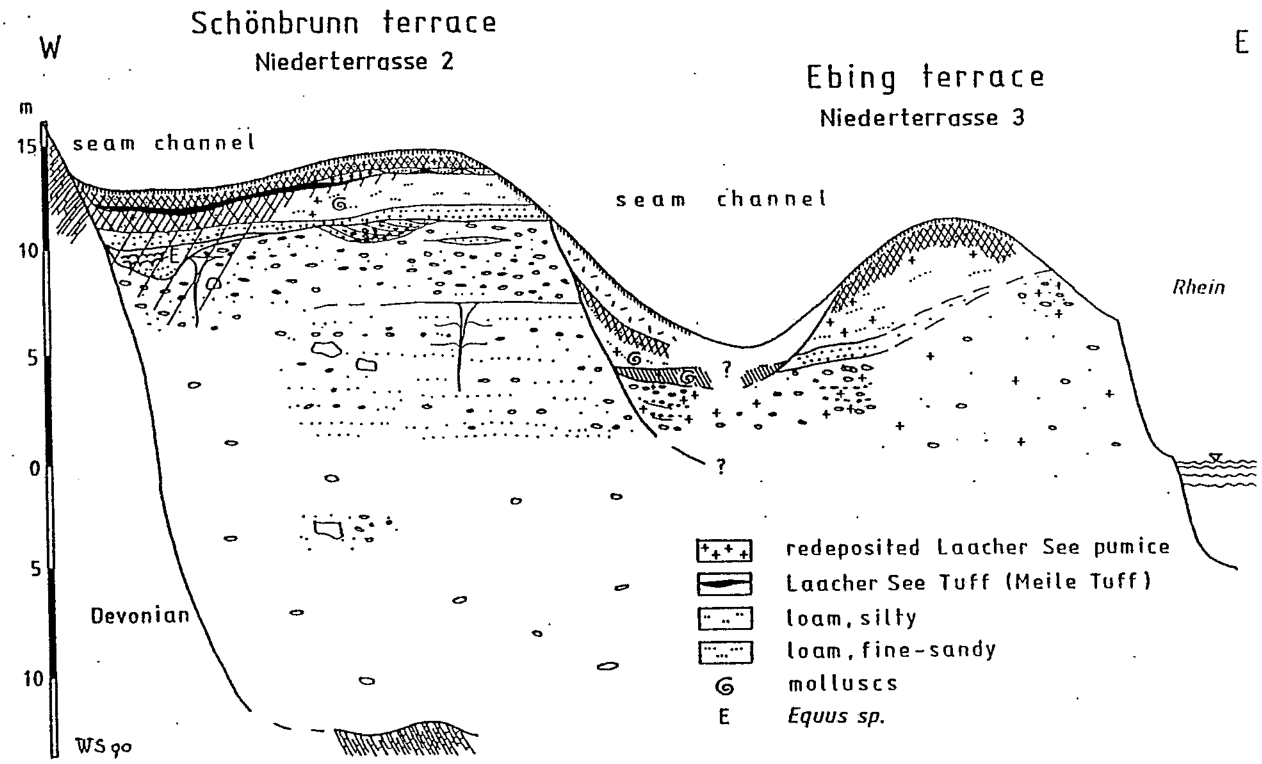


Fig. 3: Cross section of the valley bottom of the Goldene Meile (after W. SCHIRMER 1995a: 533)

As in whole central Europe, three Niederterrassen (NT) (Low Terraces) exist on the Rhein river (W. SCHIRMER 1995c). On the lower Mittelrhein the Maxiwürm Terrace (NT 1) lies on average 16 m above the river level, the Schönbrunn Terrace (NT 2) 14 m, the Ebing Terrace (NT 3) ca. 13 m. The NT 1 has a small sandy flood sediment and is free of loess. The NT 2 has a thick fine-sandy, silty flood sediment. Both the NT 3 channel and flood sediment bear small pebbles and grains of reworked Laacher See pumice from the Mittelrhein basin downstream.

In the Goldene Meile only the Schönbrunn Terrace (NT 2) and the Ebing Terrace (NT 3) are preserved (Fig. 2). On top of the NT 2 there is a flood deposit including clods of reworked Pellenz tephra (Fig. 4). Moreover, particles and burrow fills of Meile silt tephra indicate a certain vertical infill into the underlying flood sediment (W. SCHIRMER 1996). The Breisig Soil is an initial soil only marked by a slightly increased carbon content. It is represented much better by ist excellently preserved flora and fauna described by WALDMANN (1996c, see below). The Meile tephra preserving this soil exhibits in its basal layer of a decimeter a silty tephra, generally buff, but banded in different weak colours. Its homogenous structure allows well preservation of the flora and fauna enclosed. The higher silty tephra - up to 4 decimeters thick - is a fine laminated floodplain deposit.
Breisig Soil and Flora as well as Meile tephra are of Allerødian age. They do not overly the Ebing Terrace of Younger Dryas age. Consequently, the age is post-middle Allerødian and pre-Younger Dryas. According to the trees and well developed flora it should be some decades younger than the Mendig Flora and Pellenz tephra.

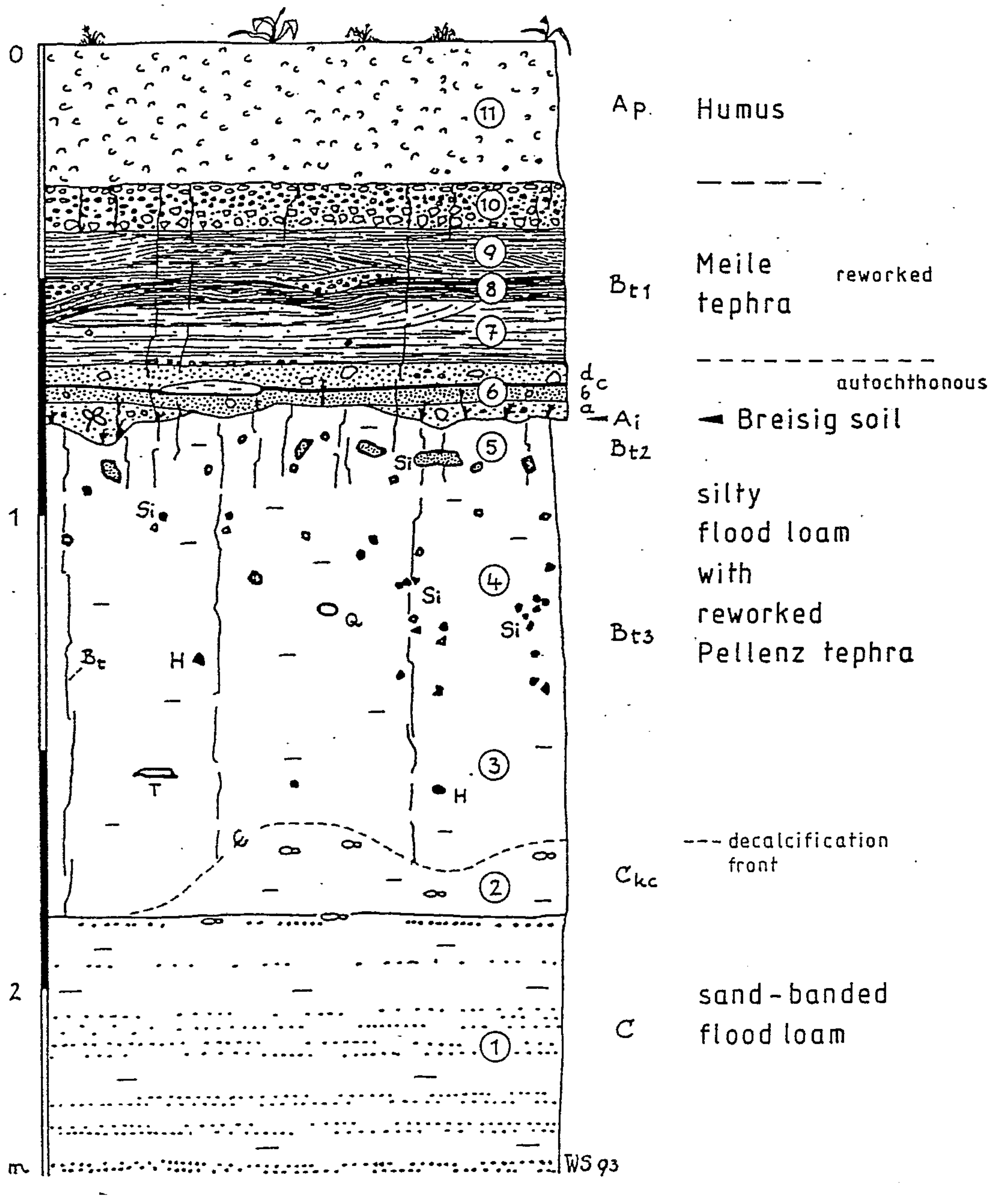


Fig. 4: Section Goldene Meile 9-5 (gravel pit SCHMICKLER). Floodplain deposits and Laacher See pyroclastic deposits overlying the late Pleniwürmian Schönbrunn Terrace (Low Terrace 2) of the Rhein. 1 = sand-banded flood loam, 2 = silty flood loam, 3 = silty flood loam decalcified, 4 = silty flood loam with reworked Pellenz tephra and some amounts of infilled Meile tephra, 5 = Breisig Soil, 6-10: Meile tephra, 11: humus topsoil. E = decalcification front, H = pores filled with redbrown clay, Q = Paleozoic quartzite pebble, Si = clods of silt tuff and pumice grains, T = slate slab (modified after W. SCHIRMER 1995b: 91)

Breisig palaeobiocenosis (G. WALDMANN)

Tephrobiology: new methods to reconstruct the pumice-covered Middle Rheinish landscapes of the Laacher See volcano 13,000 cal BP

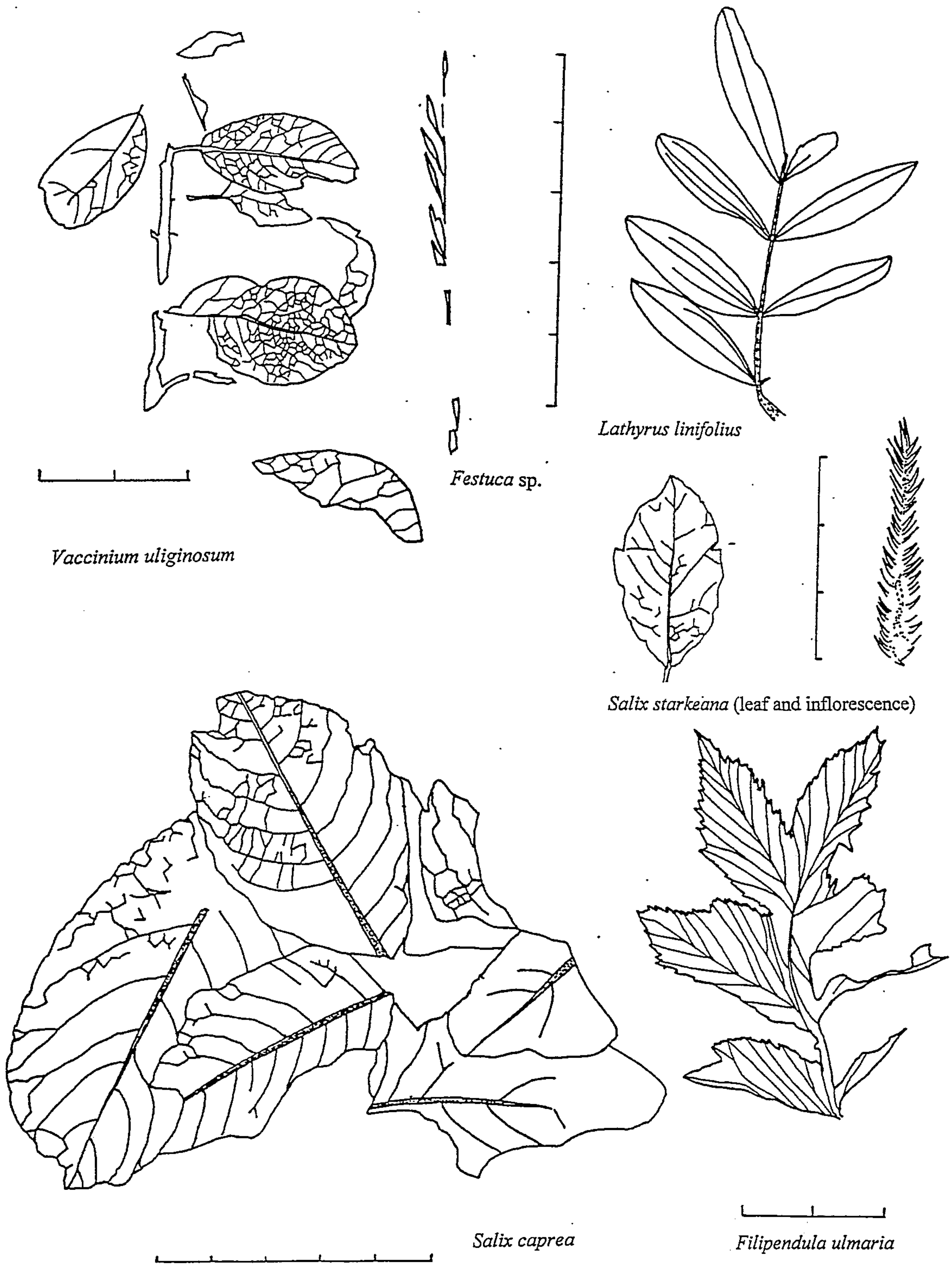


Fig. 5: Tephrofossils from Mendig and Thür (Mendig Soil) (WALDMANN 1996c)

The unique source of information from volcanogenic thanatocoenoses has been used only sparingly as a way of reconstructing the paleoecology of a region.

The Breisig flora in the Goldene Meile was discovered in April 1990 by W. SCHIRMER. First exploratory excavations began in June with full-scale work commencing in September of that year. Today, 50 square metres of pumice-covered landscape have been surveyed and 6 tons of tephra analyzed for their fossil contents (WALDMANN 1994, 1995a,b, 1996a,b,c).

Examination of the Breisig material and a fresh look at botanical and zoological tephrafossils held in museums confirm the field-geological evidence of W. SCHIRMER (1995a,b) that the Laacher See volcano erupted not once, but at least twice during the Allerødian interstadial. The first eruption, the Pellenz eruption, and the second, the Meile eruption, are separated by some decades called the Breisig Interval. Using evidence from the tephra fossils, the Pellenz eruption appears to have taken place at the end of June or early July, commencing during daylight hours. The Meile eruption probably took place on the 20th of May (plus/minus seven days), with initial ash-fall probably starting during the night.

The profile of the Goldene Meile contains remnants of two lahar incidents, the Pellenz lahar and the Meile lahar, which accompanied each eruption. Until now, tephra from the Laacher See volcano was viewed as being a singular isochrono-stratigraphical marker horizon within a number of late glacial profiles. The tephrobiological analysis gives additional support to revise this, and to have wider implications for the periodization of the Allerødian in central Europe.

Various Laacher See pyroclastics have long been used industrially. Trass quarrying began in Neolithic times and has continued to the present without interruption. Pumice has been used since the Middle Ages, if not earlier. Both activities have lead to the exposure and discovery of botanical and zoological fossils as well as human artifacts during the Allerødian interstadial.

The first tephrobiological collection dates from 1790. Botanical macrorests were the basis for the first attempt in 1863 to date the last activity of the Laacher See volcano. For a century, the flora conserved in LST has been considered to be post-glacial. A systematic search and archeological catalogue of has yet to be undertaken.

The study of the leaf imprints of decidous trees and weedy plants from tephra has been confined to the Eifel area and has not been employed in palaeo-ecological surveys even in Germany.

In identifying fossils, I assumed that a comparison with specimen found today in Northern Europe was appropriate. Botanical and zoological collections were compiled from two field trips to Sweden and Norway at different times of the year.

Utilizing the indicator values of plants in Central Europe of ELLENBERG ET AL. (1992) for the analysis of the fossil record and contemporary specimen, the following profile for the Allerødian Mittelrhein area was generated: the region was densely forested before the Pellenz eruption. Although all vegetation was destroyed by this eruption, it regenerated during the Breisig Interval, at least in the vicinity of the Rhine river to a species-enriched, possibly denser flood plain forest. Towards the end of the Breisig Interval, the relative irradiance intensity of the ground seems to have decreased, which indicates denser forestation. Flora recoverd from the Pellenz tephra of the Neuwied Basin contains 60% of warmth indicators, whereas the Meile tephra contains 80% of warmth indicators. This seems to indicate a continous rise in temperature in the Mittelrhein area during the Breisig Interval. This is born out in the composition of plant species. Cold indicators seem to have vanished towards the end of the Breisig Interval. At this time, the vegetation displays a significantly more atlantic character than at the time of the Pellenz eruption. The carbonate content should have more than doubled according to the indicator values; likewise an increase in nitrogen supply is indicated.

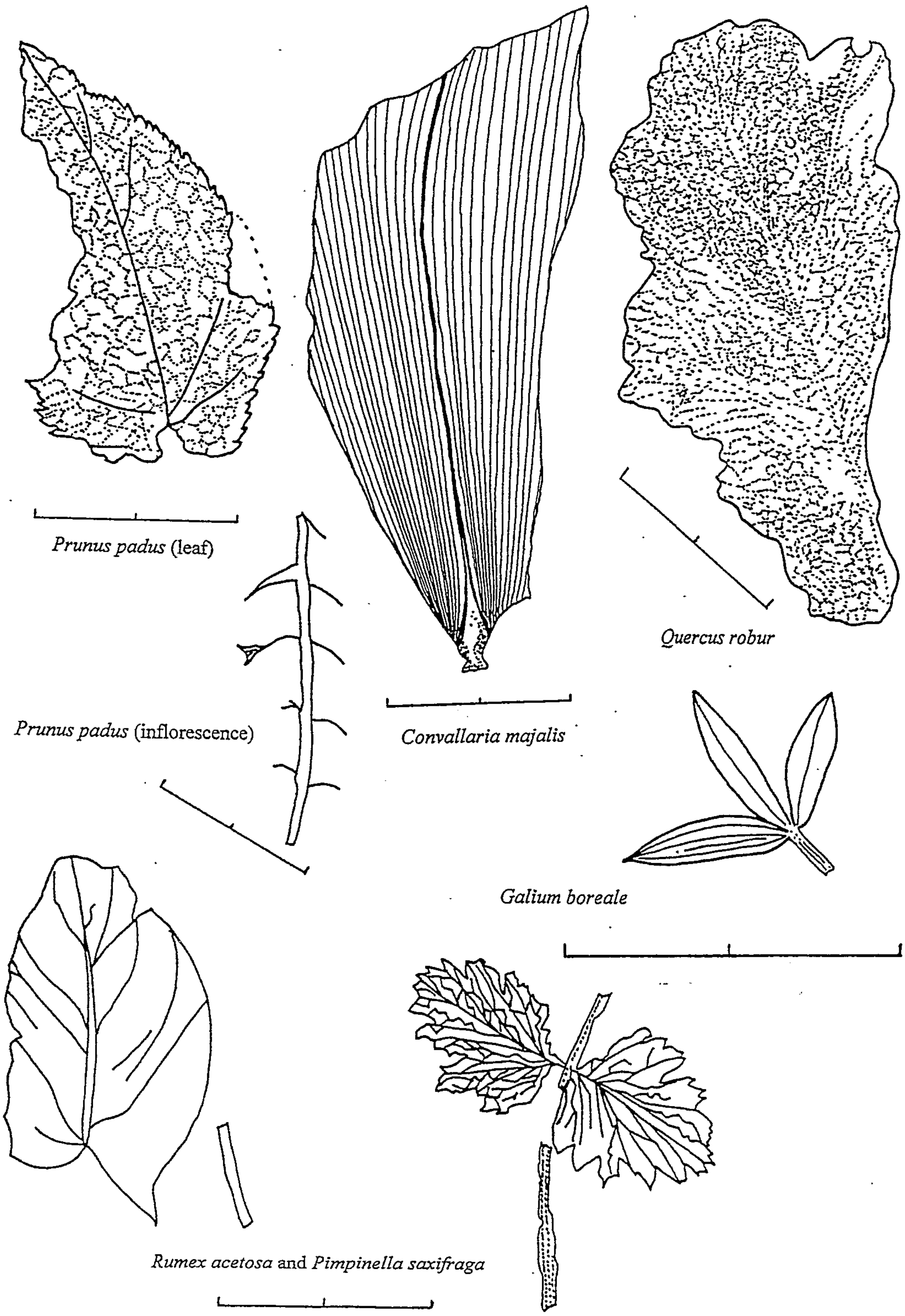


Fig. 6: Tephrofossils from Sinzig and Bad Breisig (Breisig Soil) (WALDMANN 1996c)

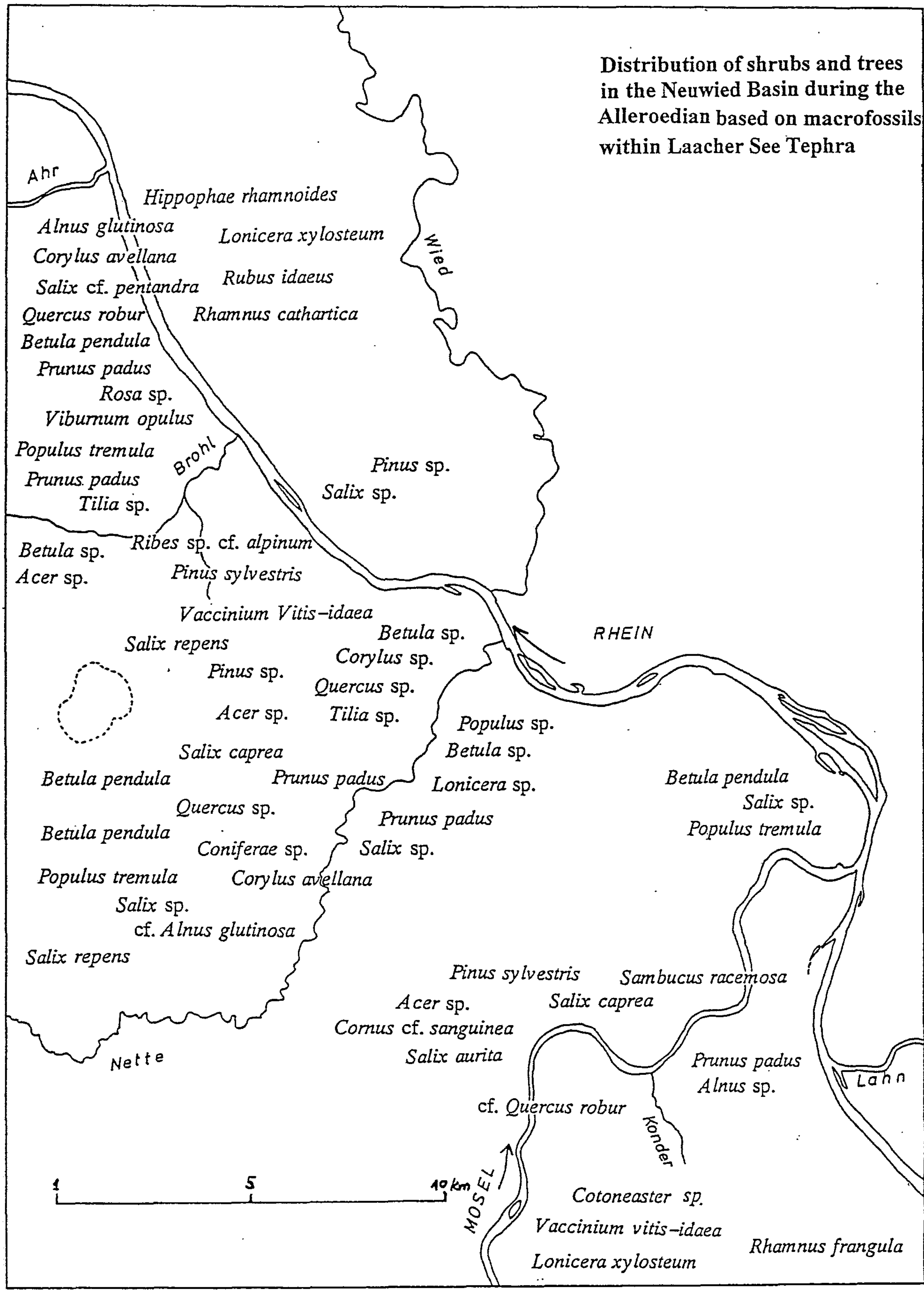

Distribution of shrubs and trees in the Neuwied Basin during the Alleroedian based on macrofossils within Laacher See Tephra
Ahr
Hippophae rhamnoides
Alnus glutinosa
Lonicera xylosteum
Corylus avellana
Salix cf. pentandra
Rubus idaeus
Quercus robur
Rhamnus cathartica
Betula pendula
Prunus padus
Rosa sp.
Viburnum opulus
Populus tremula
Prunus padus
Tilia sp.
Brohl
Wied
Pinus sp.
Salix sp.
Betula sp.
Acer sp.
Ribes sp. cf. alpinum
Pinus sylvestris
Vaccinium Vitis-idaea
Salix repens
Betula sp.
Corylus sp.
Pinus sp.
Quercus sp.
Acer sp.
Tilia sp.
RHEIN
Populus sp.
Betula sp.
Salix caprea
Betula pendula
Prunus padus
Lonicera sp.
Quercus sp.
Prunus padus
Betula pendula
Coniferae sp.
Salix sp.
Populus tremula
Corylus avellana
Salix sp.
cf. Alnus glutinosa
Salix repens
Betula pendula
Salix sp.
Populus tremula
Nette
Pinus sylvestris
Sambucus racemosa
Acer sp.
Salix caprea
Cornus cf. sanguinea
Salix aurita
Prunus padus
Alnus sp.
Lahn
cf. Quercus robur
Konder
1
5
10 km
MOSEL
Cotoneaster sp.
Vaccinium vitis-idaea
Lonicera xylosteum
Rhamnus frangula

Fig. 7

An almost species-identical flora in Uppland/Central Sweden today suggests that the present climatic conditions there are comparable to the Mittelrhein area in the Allerødian interstadial. The average temperature throughout the year is 5.5 °C in Ultuna (near Uppsala) whereas today's average temperature at Laach is 8.2 °C. This suggests a general rise in temperature of 2.7 °C in the Mittelrhein area between the Allerødian and present day.

The recent comparison site Ultuna is characterized by hemiboreal mixed forests, containing, among others *Acer platanoides, Quercus robur, Populus tremula, Betula* spp., *Rhamnus cathartica, Tilia cordata, Salix* spp., *Ulmus glabra, Corylus avellana, Lonicera xylosteum* and *Pinus sylvestris*.

From my own observation, plant successions in the Neuwied Basin and the Goldene Meile during the Breisig Interval may be comparable to successions after recent tephra incidences in North America and Northern Japan.

No human artifacts from the time of the Breisig Interval have yet been found. This indicates a disruption of human habitation in the Laacher See area during that time. Due to continuous post-eruptive lahar incidents, which persisted over several decades, the Middle and Lower Rhineland area, despite of the richness of floral species, became unsuitable for human settlement. I have witnessed a similar population shift of aboriginal people in lahar areas of the Philippines in recent times.

List of identified species excavated as macroremnants within the Allerødian Laacher See tephra (systematic after OBERDORFER, 1994)

Species from the Goldene Meile near Sinzig and Bad Breisig

Achillea millefolium L.
Alnus glutinosa (L.) GAERTN.
Bellis perennis L.
Betula pendula ROTH
Campanula glomerata L.
Campanula cf. *rapunculoides* L.
Cardamine pratensis agg. L.
Carex cf. *acutiformis* ERH.
Centaurea cf. *jacea* L.
cf. *Chaerophyllum bulbosum* L.
Convallaria majalis L.
Corylus avellana L.
Equisetum cf. *fluviatile* L.
Filipendula ulmaria (L.) MAXIM.
Galium aparine L.
Galium boreale L.
Galium cf. *uliginosum* L.
Geum urbanum L.
Glechoma hederacea L.
Glyceria cf. *maxima* (HARTM.) HOLMBG.
Hippophae rhamnoides L.
Hypericum cf. *maculatum* CRANTZ
Knautia arvensis (L.) COULTER
Lamium album L.
Lonicera xylosteum L.
Lysimachia nummularia L.
Lysimachia vulgaris L.
Peucedamum palustre (L.) MOENCH.
Pimpinella saxifraga L.
Plantago lanceolata L.
Poaceae sp.
Polygonatum odoratum (MILL.) DRUCE
Populus tremula L.
Primula veris L.
Prunus padus L.
Quercus robur L.
Ranunculus cf. *acris* L.
Ranunculus cf. *auricomus* L.
Ranunculus cf. *repens* L.
Ranunculus cf. *sceleratus* L.
Rhamnus cathartica L.
Rosa cf. *canina* L.
Rubus idaeus L.
Rumex acetosa L.
Rumex aquaticus L.
Salix pentandra L.
Scrophularia nodosa L.
Stachys cf. *silvatica* L.
Symphytum sp.
Thalictrum flavum L.
Valeriana dioica L.
Verbascum nigrum L.
Veronica chamaedrys L.
Viburnum opulus L.

Lythrum salicaria L.
Malva cf. *alcea* L.
Melandrium rubrum (WEIGEL) GARCKE
Vicia cf. *cracca* L.
Viola cf. *reichenbachiana* JORD.

Species from Thür, Mendig and the Nette valley

Alnus glutinosa L.
Arctostaphylos uva-ursi (L.) SPRENG.
Betula sp.
Bryophyta sp.
Corylus avellana L.
Festuca sp.
Filipendula ulmaria (L.) MAXIM.
Galium sp.
Geranium cf. *sylvaticum* L.
Lathyrus linifolius (REICH.) BOSSL.
Poaceae sp.
Populus tremula L.
Rumex sp.
Salix caprea L.
Salix starkeana WILLD.
Scrophularia sp.
Ulmus sp.
Vaccinium uliginosum L.
Viburnum opulus L.

Species of the Brohl valley

Acer cf. *platanoides* L.
Achillea millefolium L.
Alnus incana (L.) MOENCH
Anthyllis vulneraria L.
Artemisia cf. *campestris* L.
Betula pendula ROTH
Betula pubescens EHRH.
Carex cf. *acuta (Carex gracilis* CURT.)
Carex pseudocyperus L.
Centaurea jacea L.
Centaurea scabiosa L.
Cornus sanguinea L.
Eupatorium cannabinum L.
Galium aparine L.
Galium boreale L.
Galium mollugo L.
Galium odoratum (L.) SCOP.
Galium verum L.
Heracleum sphondylium L.
Hypericum montanum L.
Inula salicina L.
Knautia arvensis (L.) COULTER
Lathyrus linifolius (REICH.) BOSSL.
Leontodon hispidus L.
Lycopus europaeus L.
Phragmites australis (CAV.) TRIN.
Onopordion acanthium L.
Pinus silvestris L.
Plantago major L.
Poaceae sp.
Populus tremula L.
Potentilla argentea L.
Prunus avium L.
Prunus padus L.
Quercus cf. *robur* L.
Ranunculus acris L.
Ribes cf. *alpinum* L.
Rhamnus cathartica L.
Rosa sp.
cf. *Rubus idaeus* L.
Rumex sp.
Salix caprea L.
Salix cf. *pentandra* L.
Salix repens L.
Scrophularia sp.
Sparganium erectum L.
Stachys cf.*silvatica* L.
Tilia cf. *cordata* L.
Typha latifolia L.
Urtica dioica L.
Valeriana officinalis L.
Verbascum nigrum L.
Viburnum opulus L.
Vicia cracca L.

Species of the upper Mosel valley at Winningen and Merl

Acer sp.
Alnus sp.
Betula pendula ROTH
Betula pubescens ROTH
Cotoneaster sp.
Frangula alnus MILL.
Lonicera xylosteum L.
Picea abies (L.) H. KARSTEN
Populus tremula L.
Prunus avium L
Prunus padus L.
Prunus spinosa L.
Sambucus racemosa L.
Salix aurita L.
Salix caprea L.
Salix cinerea L.
Quercus cf. *robur* L.
Vaccinium vitis-idaea L.

Species of the Mainzer Sand area in Mainz

Calamagrostis epigeios (L.) ROTH
Pinus silvestris L.

Stop 2: Laacher See (W. SCHIRMER)

The Laacher See is a crater lake of barely 2.5 km diameter. Its level is at 224 m, its base at -50 m a. s. l. The eruption happened around 11,000 yr BP, resp. 13,000 y cal BP, during the Allerødian interstadial, in midst of a couple of young Pleistocene scoria cones the relics of which are surrounding the present lake basin. The eruption obviously used the place of an older crater belonging to the framing young Pleistocene volcanism. The form of the lake of two intermittent circles (Fig. 1) indicates a change of the vent. The southern crater was used during the Lower Laacher See tephra, the northern since the Middle Laacher See tephra (SCHMINCKE ET AL. 1990). Recent activity is restricted to weak gas production close to the eastern bank of the lake (CO_2 derivable from the earth mantle due to high $^3He/^4He$ ratio; SCHMINCKE ET AL. 1990: 155). Before 1852 the lake was larger. In the 12th and 19th century monks of the cloister Maria Laach lowered the lake level by more then 6 m, draining it by a tunnel at its southern bank in order to yield more arable land (FRECHEN 1976: 154).
The hauyn-phonolitic magma has its chamber at a depth of 2-5 km. About 5 km^3 dry rock mass has been thrown out spreading over central Europe (SCHMINCKE ET AL. 1990). The eruption is mostly of Plinian type and therefore estimated to have happened within a few days. As I found recently, the Laacher See eruption took place by two events, the second being separated from the first by a time-lag of some years or a few decades of years resulting in the following stratigraphical sequence of the Laacher See eruption:

Meile tephra Breisig interruption Pellenz tephra	} middle Allerød Period
Mendig Soil	Meiendorf to Allerød Period

The first event produced the major part of the Laacher See tephra, the Pellenz tephra, named after its thickest occurrence in the Pellenz (Fig. 1). The second, the Meile event, produced a much smaller tephra amount well exposed in the Goldene Meile, burying there the Breisig flora (see Stop 1). The Meile tephra may correspond to the highest part of the Upper Laacher See tephra of Schmincke's subdivision or it succeeds it.

Stop 3: The Pellenz

Geomorphological and stratigraphical setting (W. SCHIRMER)

The Pellenz is the most vivid part of the tectonic Mittelrhein Basin, a volcanic landscape surmounted by big volcanic scoria cones of Late Pleistocene age. The small basins in between are drained by the Nette river and tributaries (Fig. 1). The subsided tectonic Mittelrhein Basin exhibits above Devonian slate a depositional stack ranging from marine Lower Oligocene through terrestric Pliocene with hiatuses. Hence follows a terrace stair case of the Rhein and Mosel terraces. The terrace landscape is interfingered and capped by Middle to Late Pleistocene volcanic lava flows and tephra. Finally, the whole landscape is covered by a several meter thick veneer of the Allerødian Laacher See tephra (LST) thinning off the vent from 50 to 4 m (V. D. BOGAARD 1995). In a small lake basin of the locality Miesenheim-„Auf der Holl" (Fig. 1) the Mendig Soil buried by the LST splits up into a detailed lake deposit stratigraphy (Fig. 8) that embraces a fairly complete early Late Würmian (U. SCHIRMER 1995). Thus, it yields evidence that the Mendig Soil has formed since the beginning of the Late Würmian (W. SCHIRMER 1996). In some places the LST is cut on its top by channels deeply incised and filled

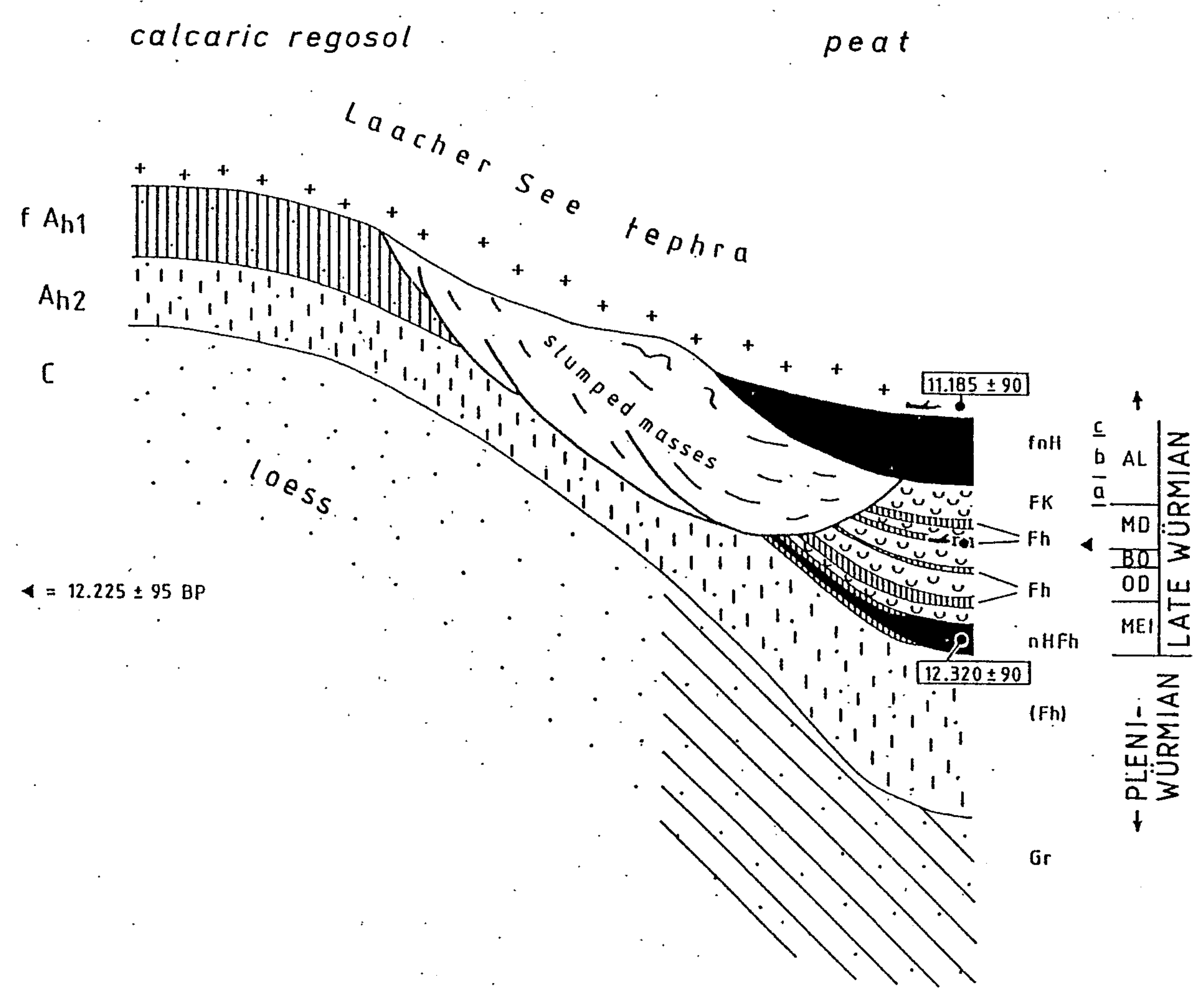


Fig. 8: Section Miesenheim - „Auf der Holl". Transition from lake sediments (right) to the Mendig Soil (left) (modified from W. SCHIRMER 1996: 54)

with reworked tephra and the reworked Barbara Flora close to ist base (Fig. 9) - a presumable equivalent of the Breisig Flora.

The Mendig-Barbara quarry (W. SCHIRMER)

In the Mendig-Barbara quarry thick columnal tephrite is exploited in the depth, pumice tephra in a higher floor. The rough section of the quarry is the following:

6 m	Channel fill incised into the ULST: Reworked and well-bedded buff silty tephra and green sandy tephra. In the lower part full of leaf imprints; mould of a log of 12 cm in diameter and more than 1 m long **(Barbara Flora)**.
2 m	ULST = Upper Laacher See tephra
12 m	MLST + LLST = Middle + Lower Laacher See tephra
0.6 m	BLST = Basal Laacher See tephra: Greenish fine-grained ash with big boulders of tephrite and Tertiary clay. In the basal part plant imprints **(Mendig Flora)**
0.35 m	humic **Mendig Soil**, calcaric regosol, developed on loess
1.7 m	loess and loess derivates (Upper Würmian)
2.0 m	stream gravel and solifluctive loess
5.0 m	agglomerated volcanic scoria
Base:	Mendig lava flow (columnar tephrite) (Würmian)

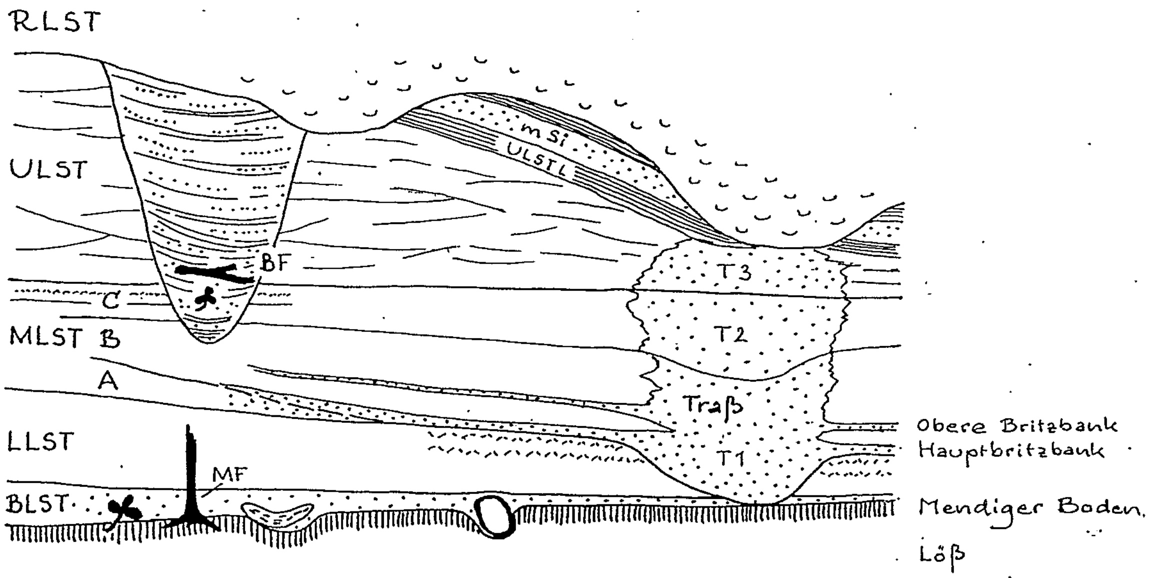


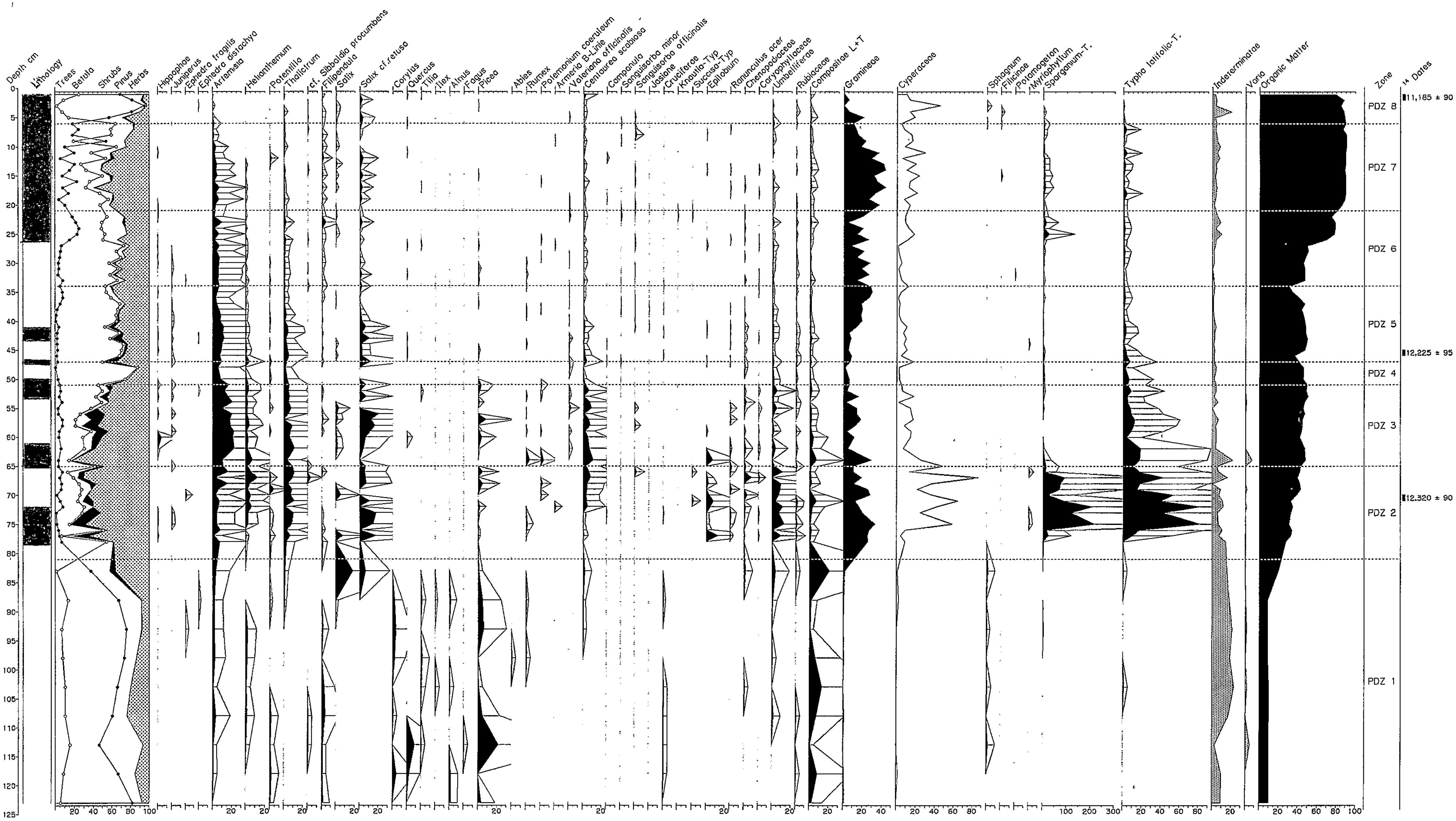
Fig.9: Simplified section of the Laacher See tephra (LST) in the Pellenz area. BLST = Basal LST, LLST = Lower LST, MLST = Middle LST, ULST = Upper LST, ULSTL = Laminated ULST, msi = massive silts, MF = Mendig Flora, BF = Barbara Flora, RLST = Reworked LST. Tephra stratigraphy based on v.D. BOGAARD (1995: 32)

Main evidence of this pit is that two fossil floras are superimposed separated by more than 15 m of Pellenz tephra. Consequently, in no case the Barbara Flora could represent a reworked Mendig Flora. After burying the Mendig Soil and Mendig forest by 20 to 40 m thick tephra in the Mendig area, there is no chance for redeposition of tree trunks and well preserved leaf assemblages. Thus, the Pellenz tephra was repopulated by a new forest vegetation that anew has been buried by thick tephra. Again, similar to the Goldene Meile, it is a tephra with appreciable shares of buff silt tephra well contrasting to the dark ULST below. From their stratigraphical positon and facies the Barbara Flora and embedding tephra fit to the Breisig Flora and Meile tephra.

Studies of the Mendig Soil in detail

Pollen stratigraphy below the Pellenz tephra (U. SCHIRMER)
The spreading of the vegetation from the Würmian Pleniglacial to the Allerødian Laacher See tephra is well recorded by the Miesenheim pollen diagram (Fig. 10). First results have been presented on the INQUA field trip A 9 in 1995 (U. SCHIRMER 1995). At this locality (Fig. 1) a lake deposit starts with an thick Pleniwürmian loess fill poor in pollen content. The pollen spectra (Pollen diagram zone PDZ 1) show a mixture of heliophilous herbs (semiauthochtonous) and thermophilous trees (allochthonous) which is what we expect from wind transported sediment. The values for organic matter range below 10%.

The sedimentation continues with a Late Würmian sequence of alternating lime precipitation and organic intercalations (PDZ 2-6). The organic matter ranges around 50%. An Allerødian peat (PDZ 7-8) follows with organic matter percentages up to 90%. The sequence is topped by the Laacher See tephra (Pellenz tephra), which provides a reliable time marker.



Analysis: U.SCHIRMER 1995

PDZ 2 reflects the situation of the Meiendorf Interstadial (c.f. BOCK ET AL. 1985) with *Betula* percentages already ranging from 10 to 50 % . Most probably a certain share of shrub birch is involved as the values of dwarf willow (cf. *Salix retusa*) are high and the pioneer shrubs *Hippophaë* and *Juniperus* are present. *Artemisia, Helianthemum, Potentilla, Thalictrum* and *Polemonium coruleum* are the nonarboreal pollen types of importance. The radiocarbon age of a piece of wood dates this interstadial to 12,320 ± 90 BP (Hv 18,442).

PDZ 3 gives proof of the climatic deterioration known as Older Dryas Period by its increase of nonarboreal heliophilous pollen types most of all *Artemisia* and *Thalictrum* which reach their absolute maxima. The increase of *Betula* and *Salix* may be caused by their shrub shares.

PDZ 4 features a short and distinct Bølling Period with its full expansion of arboreal *Betula* (absolute maximum) and minimal percentages of NBP corresponding.

PDZ 5 records the Middle Dryas Period with an increase of NBP. *Artemisia* shows its secondary maximum as well as *Salix retusa* and constant *Juniperus* values are remarkable. The radiocarbon age (wood) dates the beginnig of this period to 12,225 ± 95 BP (Hv 18,443).

PDZ 6 (Allerød a) shows a new peak of the *Betula* values followed by the first expansion of *Pinus*. This is the *Betula* dominated part of the Allerød Interstadial.

PDZ 7 (Allerød b) presents the mutual approach of *Betula* and *Pinus* which is accompanied by an increase of Gramineae that built up the highest values within the diagram.

PDZ 8 in the profile top (Allerød c) is characterized by the final expansion of *Pinus* which in most middle European pollen records precedes the event of Laacher See tephra. A radiocarbon analysis of wood dates the top of the profile to 11,185 ± 90 BP (Hv 18,444). This age fits perfectly to the presence of the topping LST.

Mollusc stratigraphy below the Pellenz tephra (J. SCHIERMEYER & W. SCHIRMER)
Stratified sampling of molluscs extends from the upper contact of the Mendig Soil downward into the loess in steps of five centimeters (M II 1-M II 7). The question was, whether there is a continuous transition of the Pleniwürmian loess fauna into the interstadial Allerød fauna or an abrupt change between both. Moreover, a continuous fauna transition could indicate a gradual aggradation of the soil from its base to its upper contact during the Late Würmian. Likewise it can result from later bioturbation from the top of the Mendig Soil.

As Tab. 2 and Fig. 11 and 12 indicate the bulk of the mollusc assemblage increases in number of individuals from the loess to the top of the Mendig Soil. A small number of taxa only shows a distinct augmentation in the horizon M II 5, the lower part of the Mendig Soil. This are *Arianta arbustorum* (L.), *Vitrea crystallina* (MÜLL.), *Pupilla muscorum* (L.), *Cochlicopa lubrica* (MÜLL.), Limacidae.

We think the M II 5 horizon reflects a certain stillstand in the depositional aggradation - perhaps with initial soil formation and perhaps with climatic improvement. Bioturbation may have happened but could not cause this peak. The peak is presumed to be one of the pre-Allerødian interstadial phases within the Late Würmian.

← Fig. 10: Late Glacial pollen record of Miesenheim- „Auf der Holl"

	Arianta arbustorum (L.), 2 W(M)(+)	*Vitrea crystallina* (MÜLL.), 2 W(M)(+)	*Pupilla muscorum* (L.), 5 O+	*Vertigo pygmaea* (DRAP.), 5 O	*Vallonia costata* (MÜLL.), 5 O(W)(+)	*Cochlicopa lubricella* (PORRO), 6 X	*Cochlicopa lubrica* (MÜLL.), 7 M(+)	*Cochlicopa sp.* RISSO	*Euconulus fulvus* (MÜLL.), 7 M(+)	Limacidae, 7 M(+)	*Nesovitrea hammonis* (STRÖM), 7 M(+)	*Punctum pygmaeum* (DRAP.), 7 M(+)	*Trichia hispida* (L.), 7 M+	*Clausilia parvula* FÉR., 7 Mf(+)	*Succinea oblonga* DRAP., 8 H+
M II 1	7	55	11	27	1326	13	30	49	11	43	147	14	10	20	6
M II 2	3	45	17	12	1210	6	7	39	2	29	117	1	6	8	0
M II 3	3	12	44	15	856	2	6	37	1	29	65	1	5	4	0
M II 4	7	5	50	5	677	0	4	20	1	24	24	0	3	1	0
M II 5	2	7	70	4	581	1	9	35	0	33	21	0	2	0	0
M II 6	3	4	46	3	242	0	0	21	0	29	5	0	1	0	0
M II 7	1	3	9	0	43	0	0	3	0	3	1	0	0	0	0

Table 2:
Number of individuals in 10 kg sediment of samples M II, ecological data refer to LOŽEK.

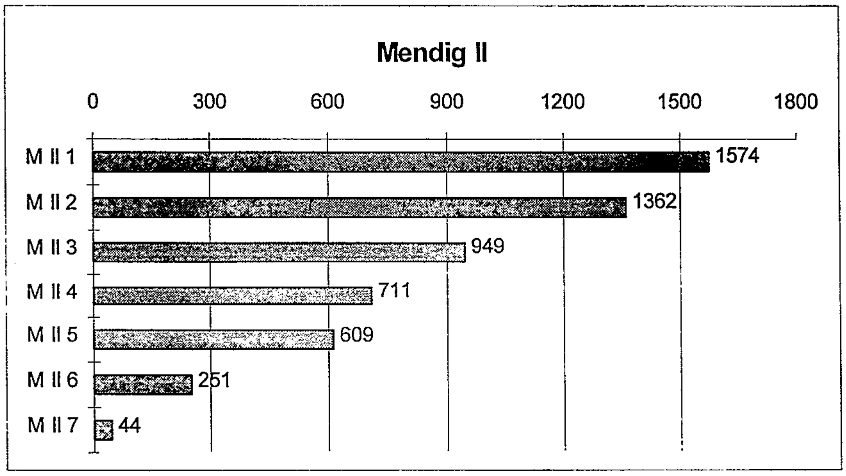


Fig. 11: M II - Total number of individuals in 10 kg sediment of all species with peaks only in samples M II 1-2 and M V 1-2. These are: *Vertigo pygmaea* (DRAP.), *Vallonia costata* (MÜLL.), *Cochlicopa lubricella* (PORRO), *Euconulus fulvus* (MÜLL.), *Nesovitrea hammonis* (STRÖM), *Punctum pygmaeum* (DRAP.), *Trichia hispida* (L.), *Clausilia parvula* FÉR., *Succinea oblonga* DRAP.

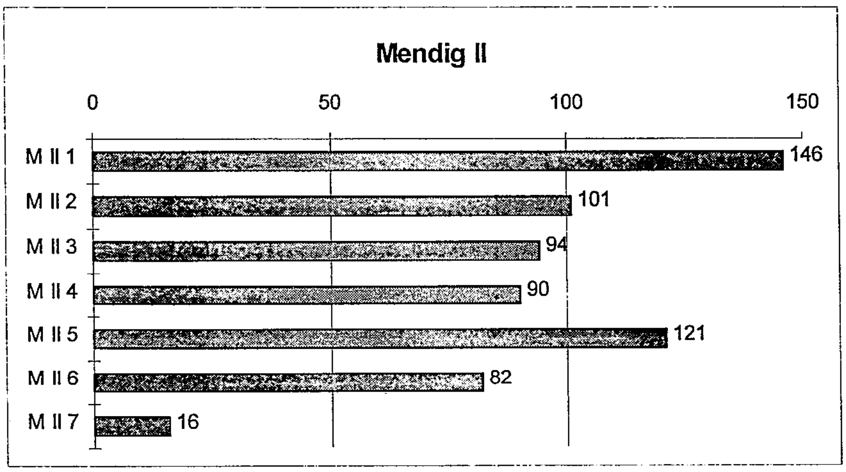


Fig. 12:
M II - Total number of individuals in 10 kg sediment of all species with peaks in samples M II 3-5 and M V 3-5. These are: *Arianta arbustorum* (L.), *Vitrea crystallina* (MÜLL.), *Pupilla muscorum* (L.), *Cochlicopa lubrica* (MÜLL.), Limacidae.

1) TERRESTRIAL SOILS
2) Soiltype: Calcaric Regosol
3) Subtypes: - typical Calcaric Regosol
- brown weathered Calcaric Regosol
4) Subtypes with motteled horizons due to wetness
5) Subtypes: - Cambisol
- Cambisol with banded weathering features
6) Cambisols with motteled horizons due to wetness
7) Subtypes: Luvisol
some with: - illuvial banded clay
- adhesive water influence
- motteled horizons due to wetness

8) SEMITERRESTRIAL SOILS
9) Subtype: Mollic Gleysol - some with motteled horizons due to wetness
10) Subtype: Umbic Gleysol
11) Para-Brown earth (Gleysol)
12) turfy moulder Gleysol

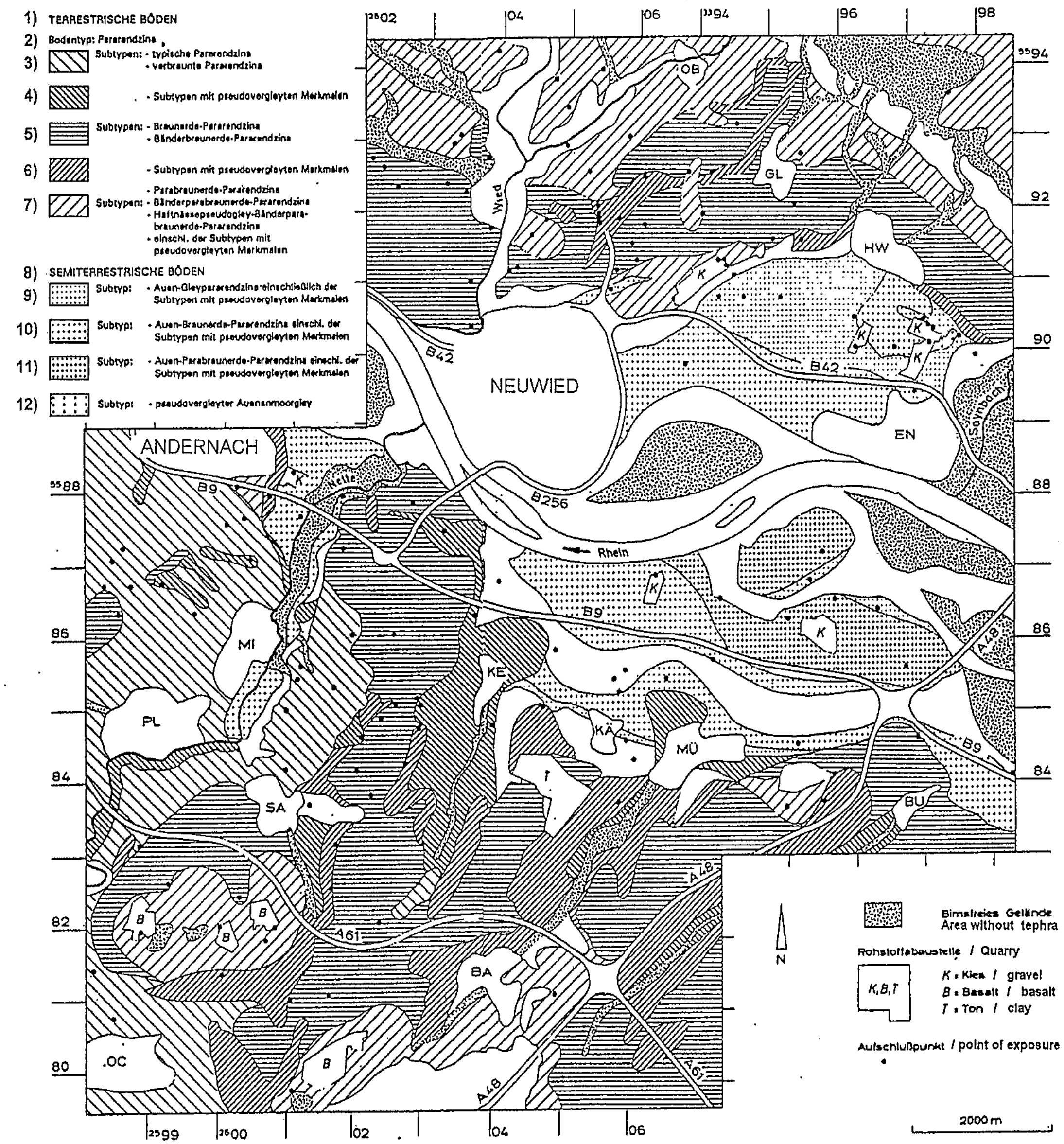


Fig. 13: The present soils below the Laacher See tephra

(from IKINGER 1996: 236-237)

Micromorphology of the Mendig Soil (A. IKINGER)

In the second half of the Allerødian the tephra of the Laacher See volcano covered the landscape and the soils of the Mittelrhein Basin with a hugh layer of differing thickness. Before the soils were buried the landscape included only 6 soil types: calcaric regosols, turfy moulders (warp-soils), gyttjen, peats, mollic fluvisols and mollic gleysols (shallow warp-soils). Although the Allerød-dated soils were buried, their development went on in morphological and mineralogical manner during the end of the Allerødian and the Holocene. The calcaric regosol for example changed either to soils with brown weathering horizons or to soils with residual clay and argillic horizions or to completely different soil types.

Fig. 13 shows the great variety of soils that can be found nowadays under the Laacher See tephra. Most common are luvisols (Parabraunerden), cambisols (Braunerden) and calcaric regosols (Pararendzinen). They very often show mottled horizons that developed due to wetness in the humic horizons as a result of pressure and compaction by the overlying tephra and by following groundwater influences. In other cases they have features of an influence by adhesive water.

The most typical, unchanged, pre-eruptive soil was a calcaric regosol (Fig. 14), the so-called Mendig Soil named after the locus typicus Mendig. It is an A-C soil with a calcareous, greyish-black coloured humic A horizon of a thickness up to 40 cm (including an AC-transition horizon of 15 cm). The following C horizon is very calcareous and owns traces of biological activities reaching to a depth of 65 cm. It often includes secondary calcium carbonate.

The micromorphology of the Mendig Soil shows a beginning weathering of the upper part of the A horizon. This is indicated by a lightbrown and loamy groundmass that is coating the mineral grains.

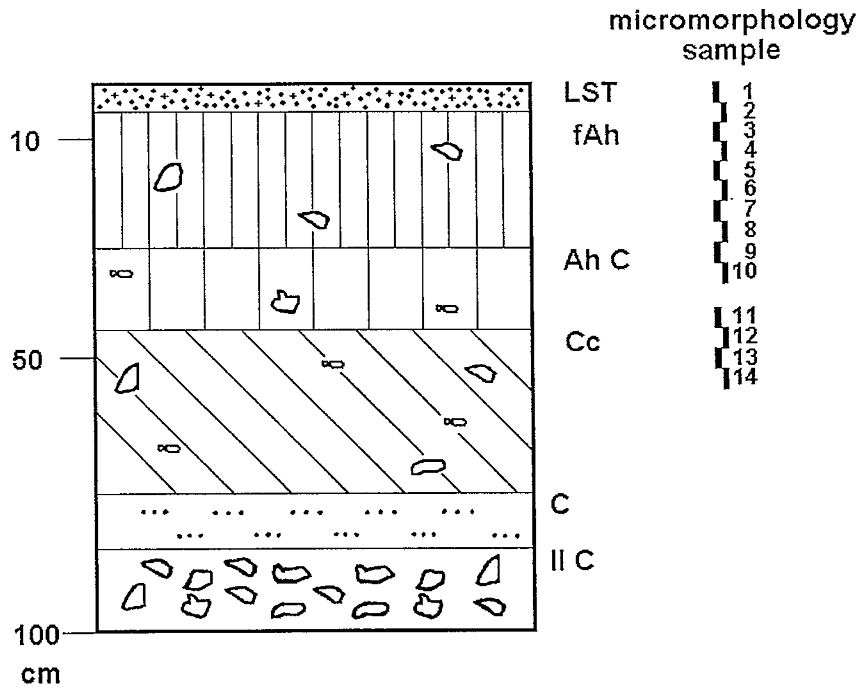


Fig. 14: Example of the Mendig Soil, a calcaric regosol, from Wingertsberg (Fig. 1) south of the Laacher See.

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