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OBSERVATIONS CONCERNING LATEGLACIAL SLOPE-DYNAMICS IN CENTRAL EUROPE

Abstract

In the Lateglacial on slopes as well as in small and large valleys a general reintensification of the morphodynamic activity took place. This activity had nearly come to a stillstand in the Upper Würm Pleniglacial with the exception of extensive deposition and removal of loess on slopes. Quantitatively speaking the lateglacial morphodynamic activity on slopes and valleys was not very significant as compared with other periods of degradation during the Würm. Its importance lies in the fact that it extended to almost all areas. The only exception are areas developed in coarse grained Laacher pumice, where, owing to its specific properties, entire new dellen systems developed during the Younger Dryas.

The Lateglacial, as the transitional period between the Glacial proper and the Holocene has been given particular attention for quite a long time because of its specific morphodynamic tendencies. So far, very many questions have been left unanswered, since, unfortunately, a clear stratigraphical delimination has been possible only in a few cases.

Because of this, the present paper will deal primarily with observations made in such sections as can be reasonably dated on account of the Laacher Bims, a trachytic pumice, which originated in the middle Alleröd.

The overall tendency of the morphodynamics of the last Glacial can be summed up as a decrease in slopewash and an increase in solifluction followed by loess sedimentation. However, in the case of the lower slope of the Muschelkalk/Röt-escarpment (Fig. 1), which, owing to its heterogeneous origin and the characteristics of the particular slope sediments lends itself extremely well to a detailed analysis, we are confronted with the following bicyclic composition of the sedimentary series if we take into consideration the climatic oscillations of the second order: $R_1 — M_1 — L_1/R_2 — — M_2 — L_2$. Cycle 1 dates back to the Early and Middle Würm; however, as the Early Würm is predominantly represented by unconformities, these sediments belong for the main part to the

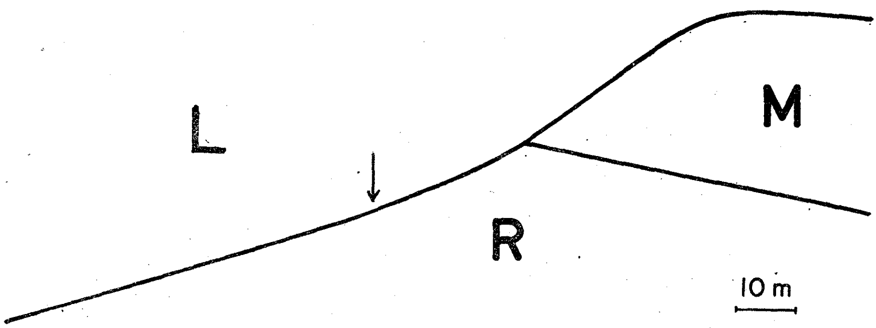

Fig. 1. Muschelkalk—Röt Escarpment
M — Muschelkalk; R — Röt Upper Buntsandstein; L. — loess

Middle Würm. Cycle 2 originated in the Upper Würm after the Paudorf interstadial. Röt solifluctional sediments point to relatively humid periods resulting in degradation mainly in the lower part of the escarpment. This leads to backwearing of the escarpment. Muschelkalk solifluctional sediments tend to develop in relatively dry periods which give rise to accumulation on the lower slope sections — that means downwearing — whereas loess deposition is due to even more arid conditions, during which there is no movement of coarse material. Both cycles are thus characterized by a climatic change from relatively humid to relatively dry periods. Judging from the varying thickness of the corresponding solifluctional sediments, cycle 1, taken as a whole, was relatively humid. This agrees with the frequent occurrence of slopewash deposits within R_1. On the other hand, the Upper Würm, in its totality, was a considerably drier period. The driest period with the least degradation intensity of the entire Würm but extensive loess accumulation even on fairly steep slopes falls just before the Lateglacial.

The manifestations of this highly arid pleniglacial period can be found even in the most extreme habitats such as the Kondertal site (Fig. 2, Pl. 1) in the basal area of a high, steep and straight schist slope. The bottom layer is made up of small schist fragments with a matrix consisting of calcareous loess. The second layer is a loess deposit, about 50 cm thick, and completely free from schist debris. This suggests a complete discontinuity of rock weathering. The third layer is again made up of small schist fragments with a loess matrix. Next comes loess-free coarse schist debris, Laacher pumice and finally a 1 m thick debris cover (*Deckschutt*) from the Younger Dryas, consisting again of a loess-free deposit of small schist fragments. The alternation in grain size of the debris particles (fine—coarse—fine) is probably a result of the varying frost weathering intensities of the three main stages of the Lateglacial (Oldest and Older Dryas—Alleröd—Younger Dryas). From this it follows, that the coarse debris layer originated probably in the early Alleröd still before the pumice sedimentation took place.

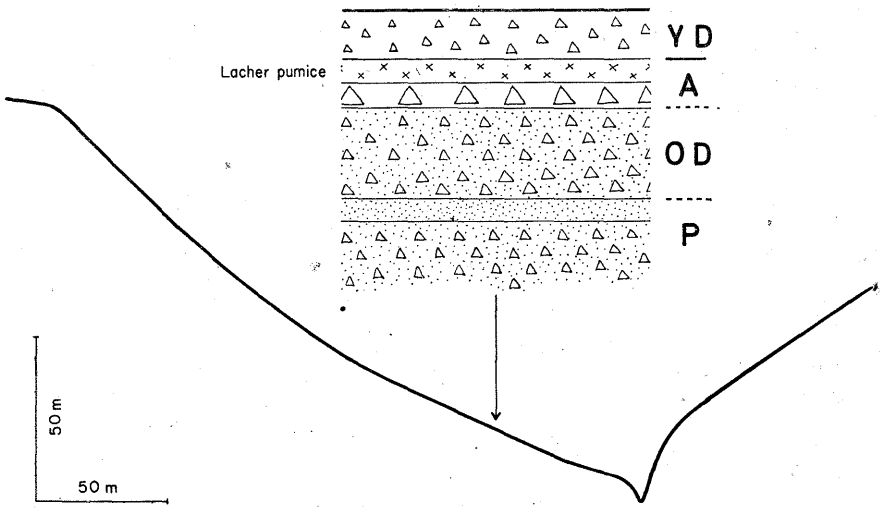

Fig. 2. Kondertal. Foundation excavation Arens, Dieblich—Kondertal, Hunsrück
YD — Younger Dryas; A — Alleröd; OD — Oldest and Older Dryas; P — Upper Würm Pleniglacial

Thus the Lateglacial saw a general renewed increase in weathering and degradation even in sites, which are normally less exposed to degradation than the Kondertal-site, ranging from the Mittelgebirge down to the lowland, as shown by the studies of Stöhr, Semmel and Plass. These, as distinct from the tripartite Lateglacial Kondertal series have only a single Lateglacial debris cover (*Deckschutt*), which, judging from the sections containing the Alleröd pumice, should be assigned to the Younger Dryas. According to Semmel this *Deckschutt* has an average thickness of 30—40 cm and has moved up to 50 m. From the quantitative point of view, therefore, it is not very significant but is remarkable only insofar as it was preceeded by a period of morphodynamical stagnation in the uppermost Pleniglacial. The significance of the

Deckschutt lies in its omnipresence in debris slope areas, where it is absent only from areas with Holocene soil erosion.

In basaltic rocks, which yielded little of fine matter through frost weathering, partial washing resulted in either a debris cover lacking fines or in a block field of the Younger Dryas, dependant only on the grain size of the basaltic fragments (*cf.* the Eltersberg quarry NE of Giessen, Pl. 2).

These slope changes also affected small valleys during the Würm glacial period. In these small valleys, apart from increased activity shortly after the Paudorf interstadial, the Pleniglacial morphodynamical stagnation sets in earlier than on the slopes, leading, as a rule, to an accumulation as a result of solifluction. Thus, V-shaped valleys were frequently transformed into dellen and smaller ones filled up completely. In the Lateglacial small valleys too experienced a reintensification of their morphodynamic activities as can be seen at the Bischhausen site (Pl. 3). Here, in a Buntsandstein solifluction deposit in a V-shaped valley, a box-like incision developed which later on was filled up with loess. A thin layer of the Alleröd pumice provides evidence for the fact, that this filling goes back to the Lateglacial and probably as a whole to the Alleröd. At least the top part of this loess deposit must be derived from the loess covers of the neighbouring slopes, since there was no general loess deposition in the Younger Dryas, whereas judging by the Kondertal site a loess deposition in the Older Dryas may be assumed. It is quite possible, that there was a renewed incision in Bischhausen in the Younger Dryas, for next to the buried incision a younger V-shaped gully has developed. On the other hand this younger incision may as well be of Holocene age and due to soil erosion.

The dellen in the extremely thick and coarse grained Alleröd pumice near Niedermendig (Eifel) are particularly impressive and can easily be dated back to the Younger Dryas. As can be seen from the numerous pumice quarries, V-shaped gullies and dellen developed on flat slopes at irregular distances. On slopes with medium inclinations, regularly formed dellen systems developed (Pl. 4) which brought about a considerable degradation on the interfluves as well, so as to develop an entirely new relief. At the first stage of the Younger Dryas V-gullies or small valleys developed which towards the end of the Younger Dryas were converted to dellen through partial accumulation. There was very extensive gullying and later on complete filling up of the gullies on steep slopes (Pl. 5).

The marked intensity of pumice erosion is due to the fact that it moves very easily. Since pumice is highly permeable this development must have been accompanied by permafrost or long lasting seasonal ground frost. This assumption is supported by sporadic finds of ice wedges in the pumice which date back to the Younger Dryas (Pl. 6). Fluvial activity in small valleys in the Younger Dryas can be observed in the pervious Mittlerem Buntsandstein as well, for instance in the Rauschenberg sand quarry where a small incision can be seen in the fill of an older and wider slope delle (Pl. 7). But the morphodynamic activity in the Buntsandstein was considerably weaker than in the pumice near Niedermendig because here, out of four dellen spaced at regular intervals along the slope only one showed activity in the Lateglacial.

In the course of the Upper Würm, there was as well considerable decrease of fluvial activity in the large valleys. A case in point is the extraordinarily wide lower terrace (*Niederterrasse*) of the river Leine in the Leinetalgraben, where in the latest part of the Upper Würm Pleniglacial loess deposition proved possible over vast areas. In the Lutter valley in the Goettingen area, an incision in the alluvial gravel fan is pre-Alleröd. There we find under a layer of Laacher pumice a layer some 50 cm thick of loess--derived loam. In order to pass a correct judgement on the morphodynamic activity during the Younger Dryas it is essential not to overlook the fact, that there was no renewed movement of gravel in this section of the Lutter valley. The same applies to several side valleys of the river Lahn near Giessen. As far as the main valleys are concerned, fluvial activity during the Younger Dryas must have been restricted to a much smaller area as compared to the Glacial proper.

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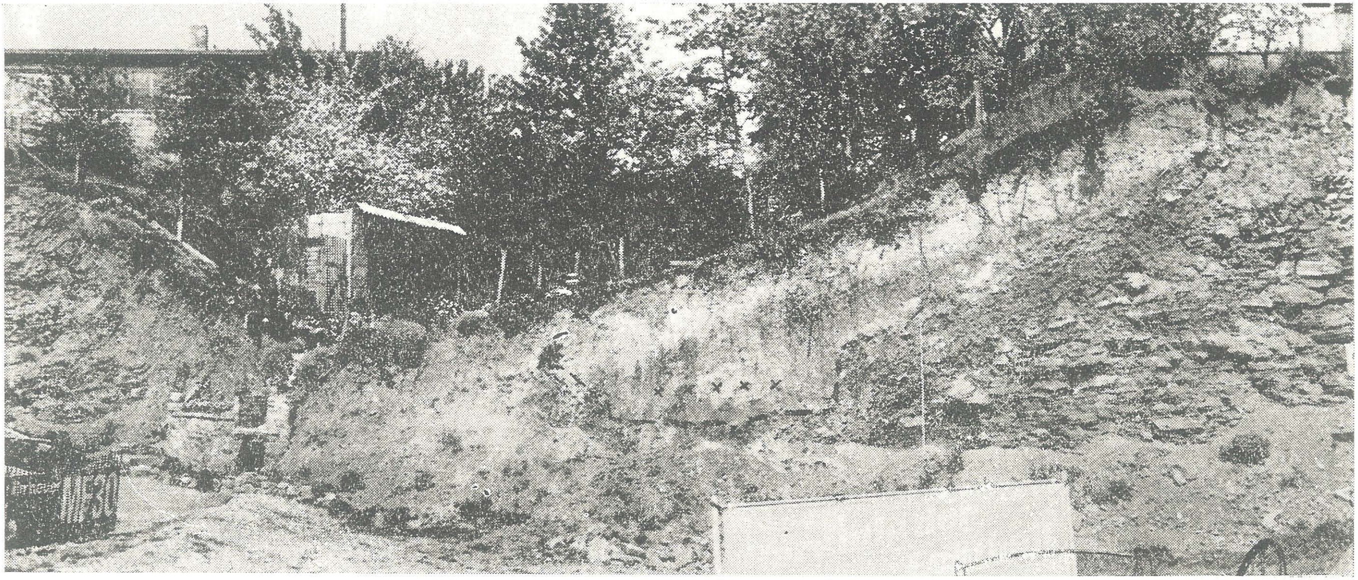
Pl. 1. Kondertal. See arrow in fig. 2

1. Laacher pumice (Alleröd); 2. loess free coarse schist debris (probably early Alleröd); 3. small schist fragments with loess matrix (Older Dryas)

Pl. 2. Eltersberg. Basalt quarry, NE of Giessen

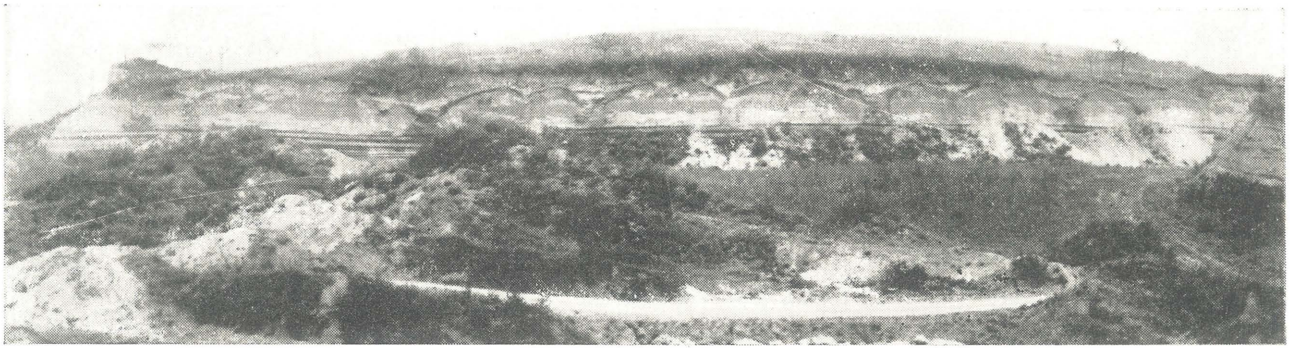
L — Upper Würm Pleniglacial loess; D — Lateglacial cover debris "Deckschutt"; for scale see Polaroid Camera (max. 20 cm)



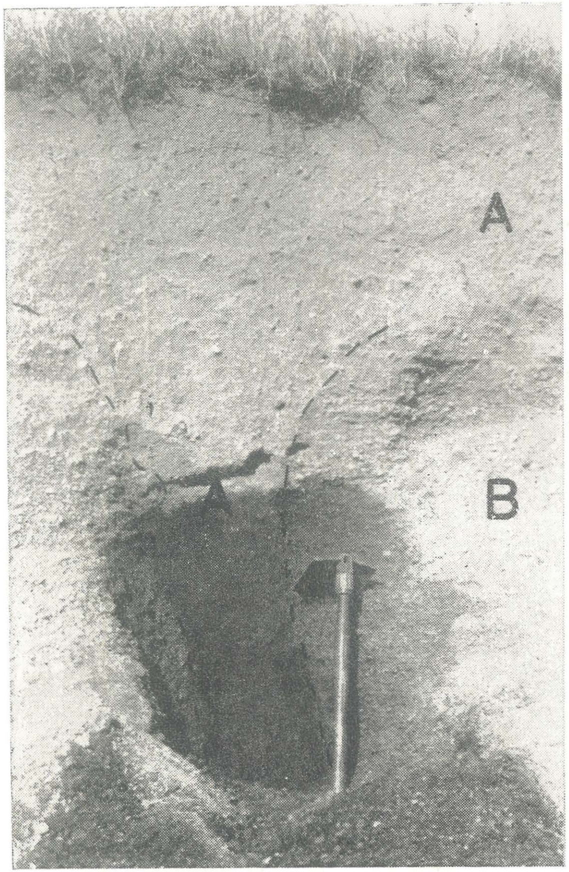
Pl. 3. Bischausen, SW of Eschwege/Werra

crosses indicate Laacher pumice; scale = 2 m

Pl. 4. Pumice quarry Schwall, E of Niedermendig (Eifel)



Pl. 5. Pumice quarry, N of Kruft (Eifel)



Pl. 7. Rauschenberg sand quarry, NE of Marburg

1. unconformity (lateglacial incision); 2. Laacher pumice; (hoe = 50 cm)

Pl. 6. Ice wedge, NE of Ochtesdung (Eifel)

A — redistributed pumice Younger Dryas; B — original Laacher pumice (Alleröd); (hoe = 50 cm)