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SEDIMENTOLOGICAL ASPECTS OF THE VALLEY FILL

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ABSTRACT

Under the flat surface of the flood plain, gravels were deposited rhythmically during distinct periods, that is the Late Glacial, the Middle Atlantic Period, the Subboreal Period, the Iron-Roman Age, the Early Middle-Ages, the turn of the Middle-Ages to the Modern Times and the 19th century. Below this complex lies a gravel of Wurmian age (Pleniglacial : 20 000-25 000 years B.P.). The different gravel units can be distinguished by sedimentological analysis.

RÉSUMÉ

CARACTÉRISTIQUES SÉDIMENTOLOGIQUES DU REMBLAIEMENT DES VALLÉES.

Sous le fond plat des vallées du Bassin du Rhin, se trouvent des nappes de graviers superposées, déposées pendant le Tardiglaciaire, l'Atlantique moyen, le Subboréal, l'Age du Fer, le début du Moyen-Age, le début des Temps modernes et le XIX^{e} siècle. Sous ce complexe, repose un gravier périglaciaire du Néowürm (20 000 - 25 000 B.P.).

1. Gravel units of the valley fill.

Many papers, some more than a hundred years old, contain indications or results that thick gravel layers of Holocene age lie below the floodplain. Till nowadays, however, we still find the opinion, that the gravel below the floodplain would be of Würmian age and the Holocene Period is documented only by a flood loam cover in the valley floor.

Investigations about the shares of Holocene and Pleistocene gravel in the valley ground carried out on several rivers of the Rhine catchment area proved that the greater part of the gravel below the floodplain – in areas not influenced by young tectonic movements – is of Holocene age (Schirmer, 1973, Becker & Schirmer, 1977, Schirmer, 1978 a and b). Within the valley fill there exist at least two gravel units lying in superposition. Within the upper unit several gravel series of different ages lie side by side. Sometimes they are morphologically separated by slight steps, but often they are not distinguished and burried under a scarcely differentiated flat floodplain. It has become evident that these floodplain gravels were deposited rhythmically during distinct periods, that is the Late Glacial, the middle Atlantic Period, the Subboreal Period, the Iron-Roman-Age, the early Middle Ages, the turn of the Middle Ages to the Modern Times and the 19th century.

Below this higher gravel unit down to the bedrock there lie gravel of Würmian age cut on top unconformably. In all cases observed their preserved thickness is smaller than the thickness of the Holocene gravel above them.

2. Dating the gravel of the valley fill.

By remnants of *Mammuthus primigenius,* drop soils and icewedges the lower gravel unit has proved to be cold-climatic. ^{14}C dates place it into the Würm Pleniglacial between 20 000 and 25 000 B.P.

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A small part of the higher gravel unit can be attached to the Late Glacial because it is overlain by floodplain sediments of Preboreal age. The main part of the higher gravel unit is proved to be of Holocene age by numerous plant remnants, especially Rannen (tree trunks) (cf. Schirmer, 1979), by layers of branches and leaves, rests of animals and human inheritances as pile constructions, dug-outs, implements and ceramics. Thus the dating of the gravel series into the different Holocene periods, mentioned above, has resulted from ^{14}C-dating, dendrochronology, palynology and archaeology.

This outline of the structure of the valley fill is a result of investigations on the rivers Main, Rodach, Regnitz, Lahn, Erft and Ruhr (see fig. 1).

3. Sedimentological separation of the gravel units of the valley fill.

In the beginning the superimposed gravel units outlined above were separated merely qualitatively, namely by climatic and dating indicators. But such finds are casual. Therefore a pure sedimentological separation of the different gravel units became desirable to get independant from casual finding of climatic and dating indicators and to effect an exact quantitative separation of the different gravel units.

Observing bare and complete vertical sections of the valley fill, a boundary between both gravel units appears, sometimes marked by different colours (greyer above, browner below), much better marked, however, by grain-size distribution : the gravel below the boundary is richer in sand, the gravel above the boundary is poorer in sand, richer in pebbles and has a larger pore space.

4. Grain-size distribution within the vertical section.

Fig. 2 presents the gravel profile of Hochstadt 5 as an example wherein the Würm Glacial gravel is superposed by an Iron-Roman Age gravel. On top of the truncated Würm gravel, beyond the boundary Würm/Holocene the considerable decrease of the matrix (fraction < 2 mm Ø) and, corresponding to it, the increase of the coarse pebble fraction (here 50-20 mm Ø) is very striking. Within the matrix, the pelite content only amounts to about 1 % of the total gravel spectrum. That

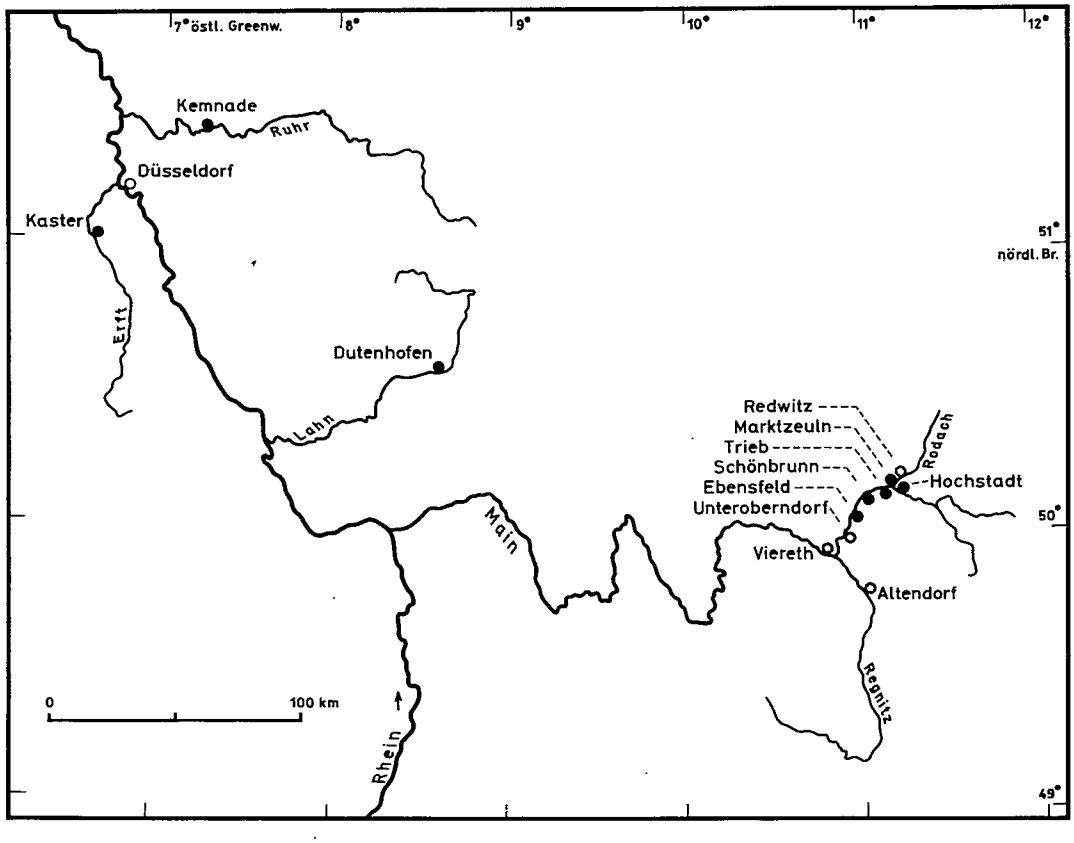

Fig. 1. – Sites where the superposition of Würmian gravel by those of Holocene resp. Late Glacial gravel has been proved quantitatively. Localities with black dots are evaluated in fig. 3.

Fig. 1. – *Sites où la superposition d'un gravier würmien par ceux de l'Holocène ou du Tardiglaciaire a été prouvée quantitativement. Les localités sont indiquées par des points noirs sur la fig. 3.*

means nearly the total portion of the matrix consists of sand. The predominating sand fractions are the fractions around the boundary medium to coarse sand.

Towards the top of the Holocene gravel serie, the matrix content increases considerably corresponding to the decrease of the coarse pebbles. The cobble content (> 50 mm ∅) runs similar to the

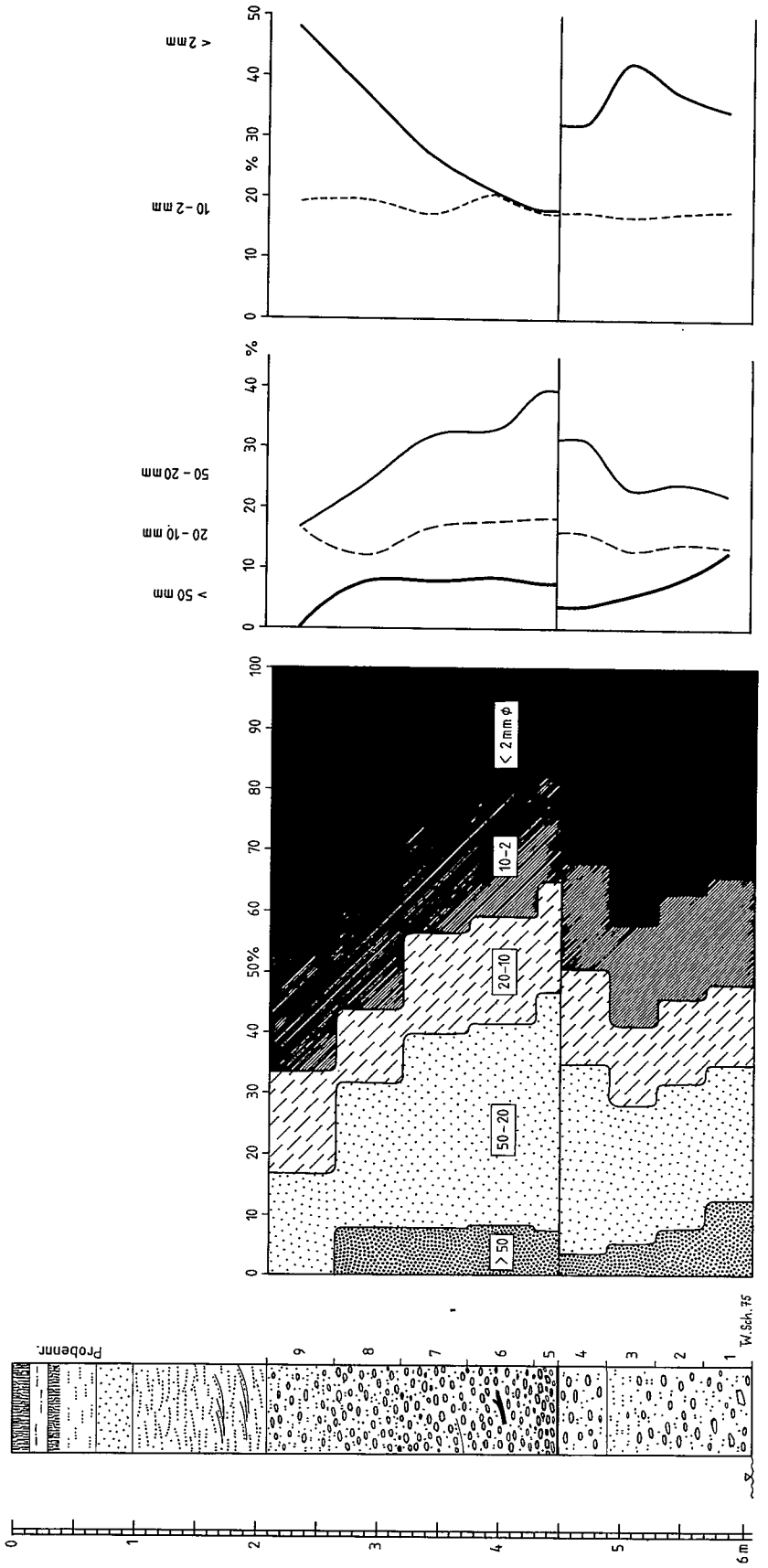

Fig. 2. – **Section Hochstadt 5.** A Würm gravel (sample no. 1-4) is superposed by an Iron-Roman Age gravel (sample no. 5-9). The grain size diagram shows very strikingly the sedimentological boundary between both gravel bodies.

Fig. 2. – ***Coupe de Hochstadt 5.*** *Un gravier würmien (éch. 1-4) est recouvert par un gravier de l'Age du Fer (éch. 5-9). Le diagramme granulométrique montre clairement la limite sédimentologique entre les deux.*

coarse pebbles. The medium pebbles (20-6 mm ∅) trace weakly the course of the coarse pebbles. The fine pebbles (6-2 mm ∅) are indifferent. (In fig. 2, the lower medium pebbles (10-6 mm ∅) are added to the fine pebbles).

Sometimes moreover, more than two gravel series are superimposed, e.g. a younger Holocene gravel lies over an older Holocene gravel which itself overlies the Würmian gravel. The base of any of the overlying gravel series shows the same characteristics as mentioned above : decrease of matrix, increase of coarse pebbles.

5. Regional validity of the results.

The matrix contents of 16 sections of several valleys of the Rhine catchment area (see fig. 1) are integrated in fig. 3. It is evident, that on rivers with an average gravel content as the Upper Main, the Rodach, the Lahn, the Erft and the Ruhr, the matrix rate of the lower gravel unit increases from 20-40 % at the base up to 30-50 % at the truncated top. At that top, the rate is higher than 30 % in any case. There against the matrix rate at the base of the upper gravel unit begins with 10-25 %. Thus it is lower than the final, uppermost rate of the gravel unit below. The more of the lower gravel unit has been preserved (e.g. the higher the discontinuity-line is lying in the section) the more distinctly both gravel spectra become separated. On average the matrix content in the higher gravel unit is 10 % lower than in the lower gravel unit. In both gravel units, the matrix content increases from the base to the top, but that of the Holocene gravel increases more rapidly than that of the Würmian gravel.

On rivers rich in sand as the Regnitz, the striking decrease of the matrix is evident, too, the rates of the matrix, however, generally are higher than on rivers with normal gravel content, as recorded above.

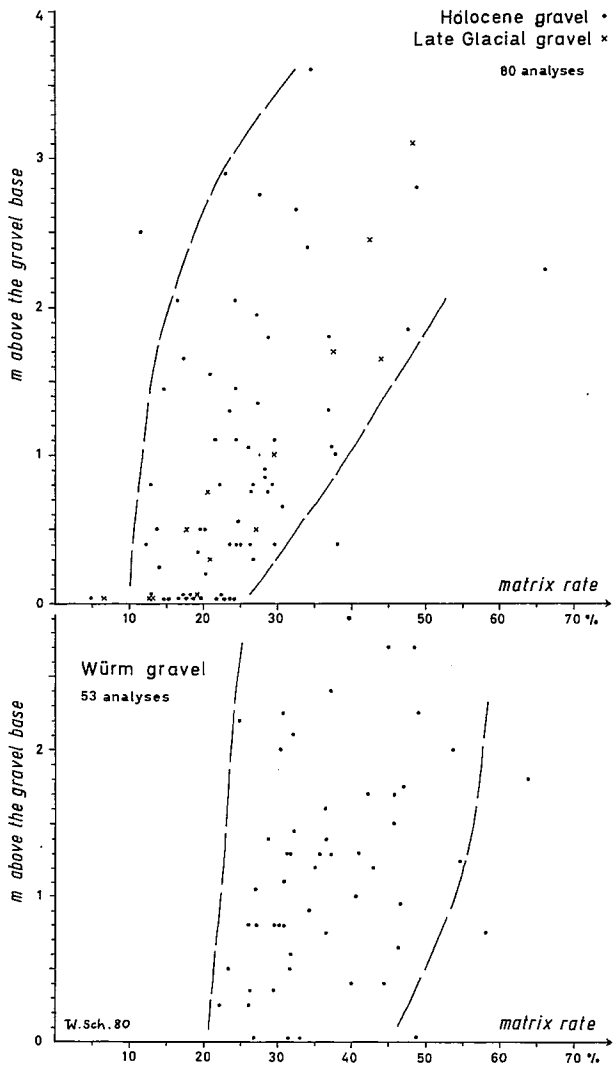

Fig. 3. – Matrix contents (grain size < 2 mm ∅) of 16 sections of the Rhine catchment area (see fig. 1). In each section a Holocene gravel (black spots in the upper diagram) or a Late Glacial gravel (small crosses in the upper diagram) overlie a Würmian gravel (spots in the lower diagram). The discontinuity line between both gravel bodies ranges from 0,75 to 3,0 m (as shown in the diagram) above the Würmian base. In any case the strong break between both gravel bodies becomes well visible by the matrix content.

***Fig. 3. – Nature de la matrice** (< 2 mm) de 16 coupes dans le bassin du Rhin (Cf. fig. 1). Dans chaque coupe un gravier holocène (taches noires en haut du diagramme) ou un gravier tardiglaciaire (petites croix en haut du diagramme) recouvrent un gravier würmien (taches en bas du diagramme). La surface de discontinuité entre les deux graviers se trouve entre 0,75 et 3 mm au-dessus de la base du gravier würmien. Dans tous les cas, la discontinuité entre les deux graviers est soulignée par la nature de la matrice.*

6. The « fluviatile series »

The fluviatile sediment bodies of different age show a typical sediment sequence. At the base of the Würm Age gravel there is a layer of residual blocks and coarse gravel. The base of the Holocene gravel is characterized by a « skeleton gravel » (Schirmer, 1978 b), i.e. a gravel extremely poor in matrix and consequently of a high pore space, in which the skeleton, the coarser fractions, are quite predominant. Towards the top of the sequence, the matrix content increases and in the transitional zone between the channel sediments and the flood-plain sediments it reaches up to 100 %. Sometimes a gravel consists of several sediment rhythms which are distinguished by a matrix decrease and

an increase of the skeleton. The sediment body is topped by floodplain sediments, which generally become finer upward, too. On top of the accumulation body a floodplain soil has developed. This whole sediment sequence is called here "fluviatile series".

Accordingly in the valley fill, there is a fluviatile series of Würm Age preserved only in its basal parts. It is inconformably overlain by several complete fluviatile series of Late Glacial to Holocene age lying side by side. The erosional base of the fluviatile series deposited since the Middle Ages, however, reaches in no case observed the base of the older Holocene series.

7. Gravels of different genetic types in the valley fill.

The general feature of grain-size distribution of all fluviatile series of the valley fill is caused by the trend of grain-sorting: coarse below and fining upward. The knowledge of the age and the climatic type of different gravel series gives the explanation for the different grain-sorting. The cold climate river receives fresh and unsorted material for its gravel freight to a high rate from slopes and tributary valleys. The braided river being overloaded piles up its freight in the valley ground.

There against the Holocene river scarcely receives fresh material, which surely is somewhat enlarged by man-made revival of slope erosion. The formation of Holocene gravel is mainly the result of reworking the available – so far existing – gravel of the valley fill caused by continuous shifting of the meandering file of the river.

Accordingly in the Holocene river often there occurs point bar bedding as large-dimensional cross-bedding. Within such a stratum, the gradation being coarse in the channel and fining towards the floodplain is the result of a short-time and coincident deposition.

Shifting of the river, e.g. meandering, causes lateral accretion. Thus, the sequence in a vertical section corresponds to the change within a stratum from the channel to the floodplain. The vertical sorting of a section reflects the horizontal sorting from the river channel to the floodplain. The good sorting of the Holocene vertical profile is due to the strong current of the relatively narrow channel, in which the matrix is carried off (skeleton gravel) to be deposited the more the higher the position in the bar is.

In the Würm age gravel there against thin superimposed sediment layers prevail. The poorer vertical sorting is more a result of a steady slow vertical aggradation due to a gradual weakening of the transporting energy.

The grain size frequency within the gravel of the valley fill gives prove of the complex structure of the valley ground. Superimposed fluviatile series of different ages and different genetic types can be separated very sharply. This method gives a good possibility to reveal the history of the valley-ground in detail.

The possibility to identify fluviatile series of different genetic types should be applicable to older fluviatile series, too, and could make contributions to their difficult climatic interpretation.

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