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SOLIFLUCTION AND COLLUVIATION ON THE ICE-PUSHED RIDGES OF UELSEN, KREIS GRAFSCHAFT BENTHEIM, GERMANY

R.H.G. BOS,[1]) P.D. JUNGERIUS[1]) AND A.J. WIGGERS[2])

ABSTRACT

The erosional history of the ice-pushed ridges of Uelsen is reflected in correlative slope deposits. Würmian processes lowered the gravelly summits of the hills and produced the characteristically unsorted solifluction deposits. These include remnants of an Eemian (?) soil. In contrast, Holocene erosion only affected the fine-grained soils on the flanks of the hills. It acted so slowly that well-developed humus podzols could be preserved on the eroded slopes, as well as on sites of colluvial deposition. The colluvium is strongly sorted because many small mineral grains were transported in humic aggregates of modal size.

INTRODUCTION

Glaciers pushed the late-Tertiary and early-Pleistocene strata of the Uelsen area into a repetative succession of gravelly and non-gravelly materials (Richter, Schneider and Wager, 1951). The shape of the original surface of the resulting ice-pushed ridges is largely a matter of conjecture, but the present relief is due mainly to differential erosion during Eemian or early-Würmian times (Jungerius and Wiggers, 1971). Erosion was slow on outcrops of sandy gravels, which now protrude as ridges and elongated hills. The present intervening depressions are the result of carving out of the non-gravelly strata which are more sensitive to erosion by water.

This relief was reduced somewhat at the end of the Würmian when the summits of the ridges and hills were lowered by solifluction, and cover sands accumulated on the sides and bottom of the depressions. However, in the Holocene differential erosion resumed its dominant role.

Much of the geomorphic history of this landscape may be reconstructed by studying the deposits left by slope-forming processes. Two of these deposits, Würmian solifluction material and Holocene colluvium respectively, are discussed in this paper.

THE SLOPE DEPOSITS

An unsorted mixture of sand and scattered gravel, occasionally found on upper and middle slopes, has all the characteristics of solifluction material, and it has been interpreted as such. Organic matter is absent and no preferred orientation of the pebbles is visible; de Jong (1955) observed an orientation of pebbles parallel to the slope in similar deposits. – The material under consideration was produced by mass-movements affecting the gravelly crests of the ridges and the hills at a time when the vegetation cover was sparce. The resulting lowering of the summit areas, often referred to as altiplanation, is a common feature of Pleistocene periglacial areas (Davies, 1969).

During the Holocene, soil erosion by slope wash was the dominant slopeforming process. In contrast to solifluction, it left the coarse gravel on the summits largely untouched but eroded the sandy flanks of the ridges and hills. The eroded material accumulated at protected places at the foot of slopes as a sandy colluvium containing very little gravel

[1]) Laboratory of Physical Geography and Soil Science, University of Amsterdam.

[2]) Institute of Earth Sciences, Free University, Amsterdam.

(J u n g e r i u s and W i g g e r s, 1971) The study of this colluvium reveals the specific nature of the erosional processes in the Uelsen area.

The normal picture of Holocene soil erosion in the hilly areas of humid western Europe, is one in which the disturbance of the natural vegetation cover by man has resulted in the interruption of soil forming processes, on the lower-slope positions, in which no more than very immature soils have been formed.

In the Uelsen area, the picture is somewhat different, mainly because soil formation is relatively rapid and can easily keep pace with erosion and colluvial deposition, which are obviously slow processes on the very pervious, sandy soils. The humus podzols on the eroded slopes maintained complete profiles, so that the material detached by erosion was derived solely from the humic upper horizon. Humus podzols have also developed where colluvial material was slowly added to the soil surface at the foot of the slopes. However, these differ from normal humus podzols in having thicker A horizons which sometimes contain buried humic A1 horizons in the dark grey leached A2 horizon.

The continuous soil cover suggests that soil erosion and colluviation processes in this area are not necessarily restricted to slopes bared of vegetation, but could equally well proceed under coniferous forest and heather vegetation. In this case, the colluvium would correspond to the 'geologic norm' of soil erosion (S t r a h l e r, 1969 p. 418). It may be due to the high permeability of the soils around Uelsen, that the soil erosion was not accelerated much when man interfered with the vegetational cover.

THIN SECTIONS

Additional information of the nature of slope-forming processes is provided by the study of thin sections of undisturbed soil samples. Apart from the low degree of sorting, the presence of pebbles scattered in a sandy matrix and the absence of organic matter, these thin sections show features which are not detectable in the field (fig. 1). One of these is the presence of rounded, but otherwise

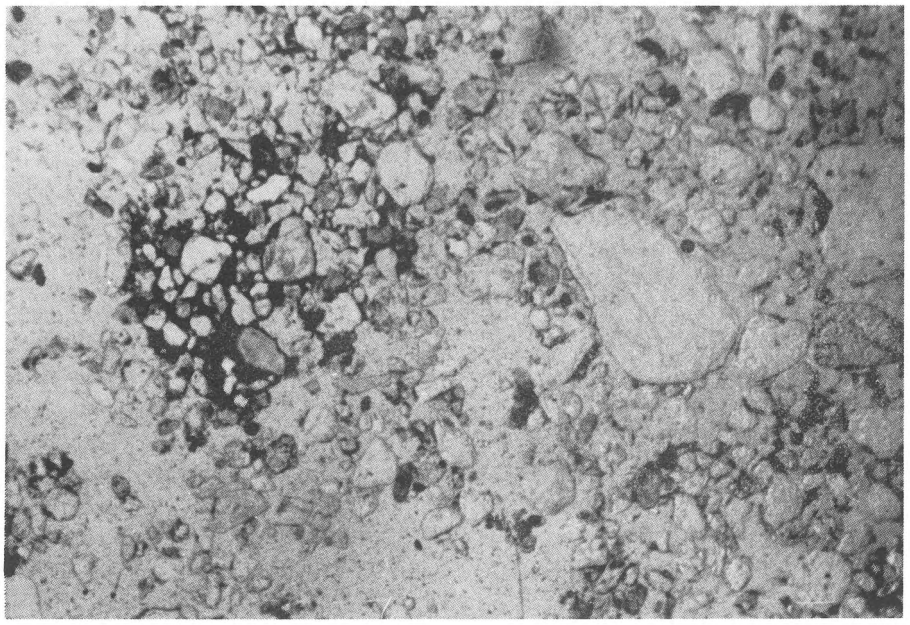

Fig. 1
Thin section of Weichselian solifluction material deposited on middle slope of hill, 10 km W of Uelsen. Magnification 60 X. Note low degree of sorting and absence of humus. Rounded dark spot on left side of picture represents transported remnant of B horizon of Eemian (?) soil with strong clay illuviation.

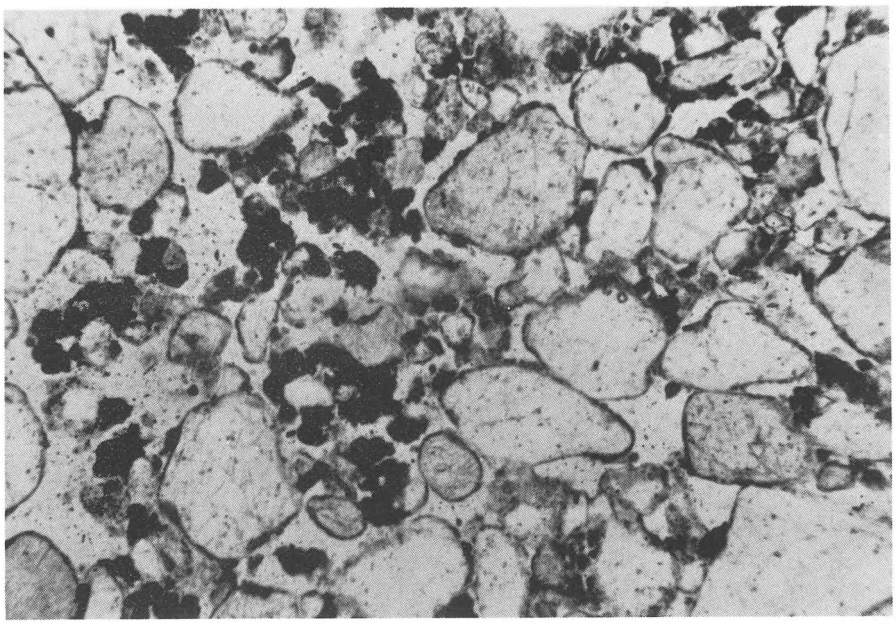

Fig. 2
Thin section of Holocene colluvial material deposited at base of hill slope, 3 km south-east of Uelsen. Magnification 95 X. Material is derived from humus podzol in cover sand. Note rounded aggregates of humus particles and small mineral grains on left side of picture, indicating high sorting effect of soil erosion processes.

intact, remnants of a B horizon with clay illuviation (ferri-argillans) derived from soils that were present higher up the slope presumably during the Eemian. Such textural B horizons are commonly formed in soils under deciduous forest in humid temperate climates.

The sandy gravels exposed in the upper slope and summit areas of the hills and ridges near Uelsen contain barely sufficient clay to allow the formation of textural B horizons. Therefore, it is assumed that the clay originated from a thin till cover of Saalian age which has subsequently disappeared from the higher parts of the ice-pushed ridges.

Thin sections of the Holocene colluvium (fig. 2) also reveal interesting evidence of alternating phases of landscape stability and instability. Much of the organic material is of a depositional nature. It is detached from upper-slope soils, transported downwards and deposited at the foot of the slope as definite aggregates, composed of small mineral grains and humic particles. These aggregates are of the same size as the sand grains in the modal classes. Sorting is, therefore, much stronger than in the cover sand from which the colluvium was derived. This would not be evident from the normal grain-size analysis of the colluvial material because the humic particles would be destroyed during pretreatment and the embedded mineral grains released.

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