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REMNANTS OF PERIGLACIAL MOUNDS IN THE HAUTES FAGNES (BELGIUM): STRUCTURE AND AGE OF THE RAMPARTS[1]

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ABSTRACT

Pissart, A. 1983 Remnants of periglacial mounds in the Hautes Fagnes, Belgium: structure and age of the ramparts. In: J. H. J. Terwindt & H. Van Steijn (eds): Developments in physical geography – a tribute to J. I. S. Zonneveld – Geol. Mijnbouw 62: 551-555.

Five new sections were cut through ramparts surrounding depressions of the Hautes Fagnes plateau. When earlier work of 1974 and 1980 is included, a total of seven sections have been studied. For six of the seven, the internal structure of the ramparts is similar to Fig. 3. The other section shows only solifluction lobes (Fig. 6).

A polyhedric structure which appe rs relat d to the growth of segregation lenses was seen in several sections. A new ^{14}C age determination sho hat a second mound grew during the last Dryas.

The facts suggest a periglacial genesis for the Hautes Fagnes depressions. They are not pingo scars but probably remnants of palsas without peat which are not yet well known today.

INTRODUCTION

Twenty six years ago, I interpreted depressions which are numerous on the Hautes Fagnes plateau, as pingo scars (PISSART, 1956). These depressions are surrounded by ramparts. The hollows sometimes are as much as 8 m deep and the ramparts 5 m higher than the original surface. Originally, I believed that these features were related to the growth of injection ice. Later, a better explanation seemed to be the formation of segregation lenses (PISSART, 1974). Probably these features are the remnants of mineralogic palsas, a type of periglacial mound recently described in Canada (PAYETTE ET AL., 1976; LAGAREC, 1978; DIONNE, 1978; PAYETTE & SEGUIN, 1979).

Two sections have been described recently that were cut through the ramparts (BASTIN ET AL., 1974; PISSART & JUVIGNÉ, 1980). Five new sections, excavated in 1981, are described here.

It is now possible to define the characteristics of the internal structure of the ramparts. It is known that they are older than Preboreal, because this is the age of the oldest peat in the depression. The palynological study made by BASTIN (1974) inferred that one depression appeared during the pleniglacial of the last glaciation. ^{14}C datation and tephrostratigraphical studies made in 1980 (PISSART & JUVIGNÉ) prove that another depression formed during the last Dryas time, since an Alleröd peat was discovered in the rampart. The new information concerning the age of these features is given not only here, but also in a separate paper by JUVIGNÉ (1983).

EXCAVATION SITES

The five new sections are all located not far from the Eupen-Monschau road, near the German border. They were cut in the forest between the Brackvenn and the Konnerzvenn, not far from the locations where the two previous sections were excavated. Figs 1 and 2 show the distribution of

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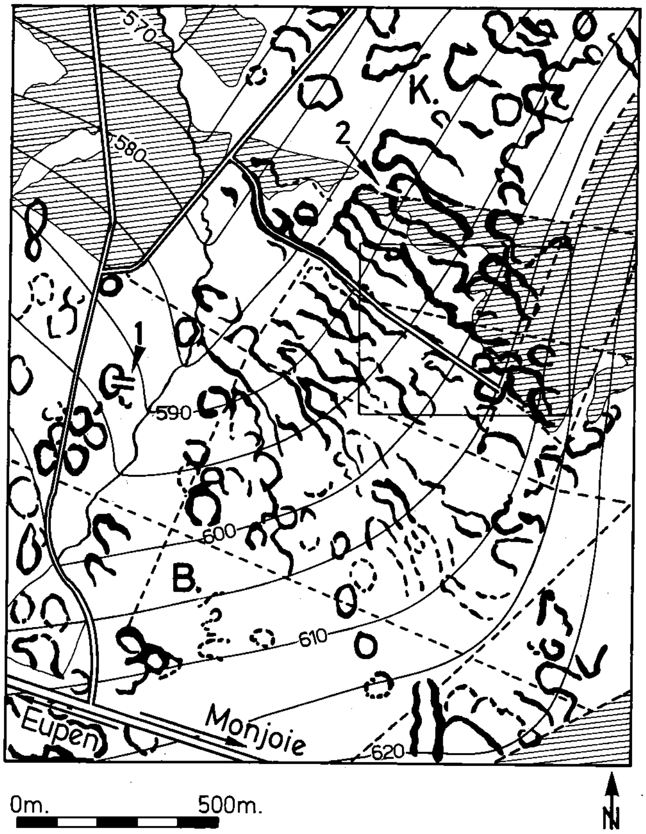

Fig. 1
Distribution of ramparts (in black) in the investigated area. K = Konnerzvenn; B = Brackvenn. 1. Section described by Bastin et al., 1974; 2. Section described by Pissart & Juvigné, 1980. The rectangle shows the area shown in Fig. 2. Contour interval: 5 m. Shaded areas = forest on 1959 aerial pictures.

the ramparts and the precise location of all the excavations.

RAMPART STRUCTURE

Quartzites and phyllites of Cambrian age form the bedrock of the Hautes Fagnes plateau. In places, borings have shown the presence of deep chemical weathering (PISSART, 1974; JUVIGNÉ & PISSART, 1979) which is related to Tertiary, or older, warm climates.

Including two sections described in 1974 and 1980 (sites 1 and 2 in Fig. 1), seven profiles have been carefully drawn. Five out of these seven sections have the same structure. Figure 3, which is the sketch of the section number 5 on Fig. 2, gives the most complete view of the relation between the different layers.

The most important layer (6) was the first deposited after the growth of the periglacial mound. It is a layer of silt, surely loess for the most part, which was reworked on the slope of the mound during the first stage of its growth. The overlying sediments are mainly solifluction deposits which contain stones, silt and clays. They form layers (5, 4 and 3) which are deformed in their upper parts as a result of mass movement (mainly frost creep). It is easy to understand the deformations of the overburden. Fig. 3 reconstructs the periglacial mound at its highest development. Such disposition was described before (PISSART & JUVIGNÉ, 1980) and, as shown clearly there, proves that the periglacial mound grew not only vertically but also laterally.

A similar bending of the surficial layers has been described for the slope of a pingo on Banks Island, Canada (PISSART & FRENCH, 1976). There, the axis of bending was at the top of the permafrost. By analogy, therefore, the active layer here was probably 60 cm thick when frost creep occurred.

In Fig. 3, between 11.50 and 15 m, the base of layer 6 is clearly deformed; it does not follow the gentle slope which was present before the growth of the mound and which is still the present ground surface outside the rampart. Between 11.50 and 13.30 m, the contact indicates uplift and lateral movement of the underlying layer (8), followed by vertical collapse after melting. This process is clearly demonstrated in Fig. 4.

Between 15 and 18 m, a number of solifluction lobes are visible which appear to have been dislocated by a kind of rocking motion. They are now inclined in a direction exactly opposite to the slope they had during the movement (compare the present and reconstructed cross sections in Fig. 3).

The section (Fig. 5), excavated at location 4 of Fig. 2, is similar to the profile discussed above. However, the picture is not so complete because the section did not dissect the entire rampart. The layer deposited just before the growth of the periglacial mound shows a clear reversed slope; at the outer edge of the rampart it is almost 1 m higher than in the middle of the excavation. This indicates that the slope was not straight before the appearance of the periglacial mound. It

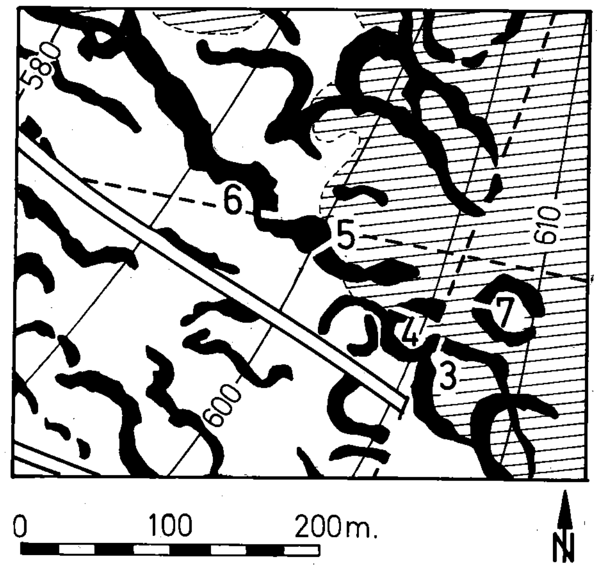

Fig. 2
Location of the five new excavations. The sections described in Figs. 3, 5 and 6 are near to numbers 5, 4 and 7 respectively. Contour interval: 5 m. Shaded areas = forest on 1959 aerial pictures.

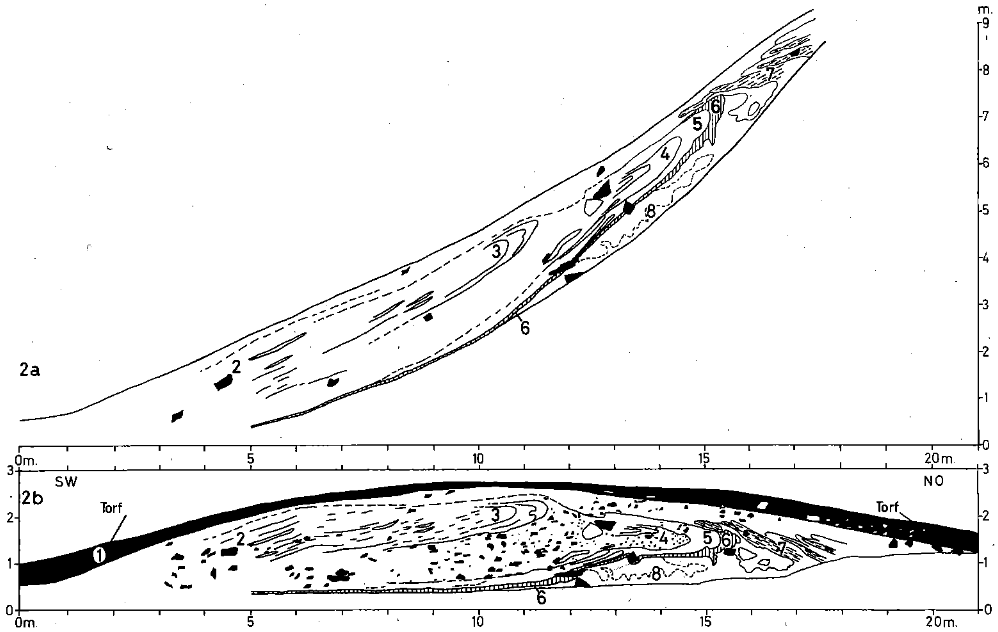

Fig. 3
Lower part: Structure of the rampart. Upper part: Reconstruction of the probable slope of the periglacial mound. This drawing gives the most typical and complete section seen so far through a rampart. Location: site 5 on Fig. 2. See description in the text.

was not possible to see if this irregularity of the slope is the remnant of an older periglacial mound.

Fig. 5 presents fabrics observed at different places of the rampart. At each site the orientation of 30 pebbles was measured in a horizontal plane. In the external part of the rampart, the pebbles lie parallel to the slope, in the inner part, perpendicular. There is a progressive change in orientation from one end to the other. The parallel orientation is clearly due to solifluction on the slope of the mound. It indicates that the slope was continuous when the movements occurred. It is proof that upheaval was not just limited to the central part of the mound. The perpendicular orientation in the inner part is not understood completely. It is possible that it may be the result of compression of the layer in the concavity at the edge of the mound.

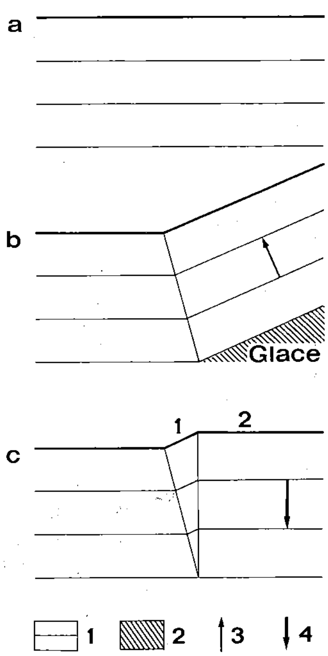

Fig. 4
Diagram showing rampart morphology resulting from the growth and thaw of a periglacial mound (without any slope deposit). Heaving is not only vertical but also lateral; sinking is vertical.

Fig. 6 is a view of section 7 on Fig. 1. It is the only section where a rampart has a different structure. It is clearly formed by big solifluction lobes. This kind of structure was probably influenced by the presence of big boulders which did not allow slow and continuous displacement of the upper layer off the ground.

GRANULOMETRY

Very often, the material of the rampart has a large loess fraction. The granulometric curves usually show a mode around 30 μm which is typical of most of the eolian deposits in Belgium. The amount of clay is variable. This fraction results from the chemical weathering of the Cambrian bedrock. In the section given as Fig. 5, the upper layers (3, 4 and 5) are very clayey (between 30 and 50% of the fraction under 2 mm). They consist of typical weathered material from below and do not contain loess.

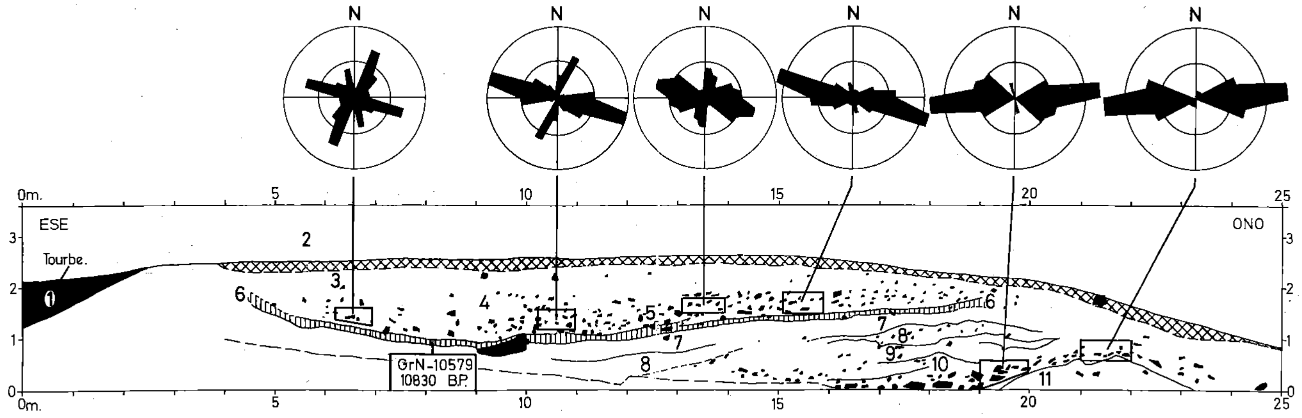

Fig. 5
Structure of the rampart located near site 4 of Fig. 2. Layer 6 was the first deposited in relation to the growth of the periglacial mound. It indicates that the slope was not linear before the appearence of the mound.

EVIDENCE OF SEGREGATION ICE

Inside different ramparts (especially in the section shown in Fig. 3, between 10 and 18 m, at 2 m depth), there is a clear polyhedric structure. It is enhanced in some places by ferruginous precipitates which are located between the different polyhedrons. This precipitate is associated with the circulation of ferruginous ground water from numerous springs on the Hautes Fagnes plateau. When there are no ferruginous deposits, the structure is still obvious if the sample was subject to traction. Voids, which may be a few millimetres broad, are sometimes related to this phenomenon.

This structure is analogous with that in palsas, and is related to the development of segregation lenses below the surface. The segregation lenses are located between polyhedric aggregates which are strongly compressed by expulsion of water in relation with the feeding of the lenses. Experimental research has shown that such a structure is very stable and is only destroyed by complete dessication. At the depth where the observations were made, dessication never existed and the structure has been preserved for thousands of years. The voids probably formed during thawing of the periglacial mound. They appeared bacause some polyhedric aggregates did not occupy the same position after melting as before the growth of segregation lenses.

It is worthwhile remarking that the polyhedric structure does occur not only below the original surface, but also in the solifluction layers on the slope of the mound. This indicates that permafrost was aggrading on the slope of the mound at the same time as the solifluction material accumulated.

AGE OF THE PERIGLACIAL MORPHOLOGY

^{14}C age dating

Within layer 6 (see Fig. 5), a darker layer, a few millimetres thick, is visible between 7,5 and 12,5 m. It contained organic matter and locally plant macro-fossils. This layer was dated by Professor W. G. Mook from Groningen University who gives number and age as

Gr N-10579, Konnerzvenn K 35 = 10.830 (± 45) BP

Professor Mook makes the following comment: 'According to the type of material, I consider it possible that a slight contamination has decreased the age. Therefore, Alleröd seems very likely'.

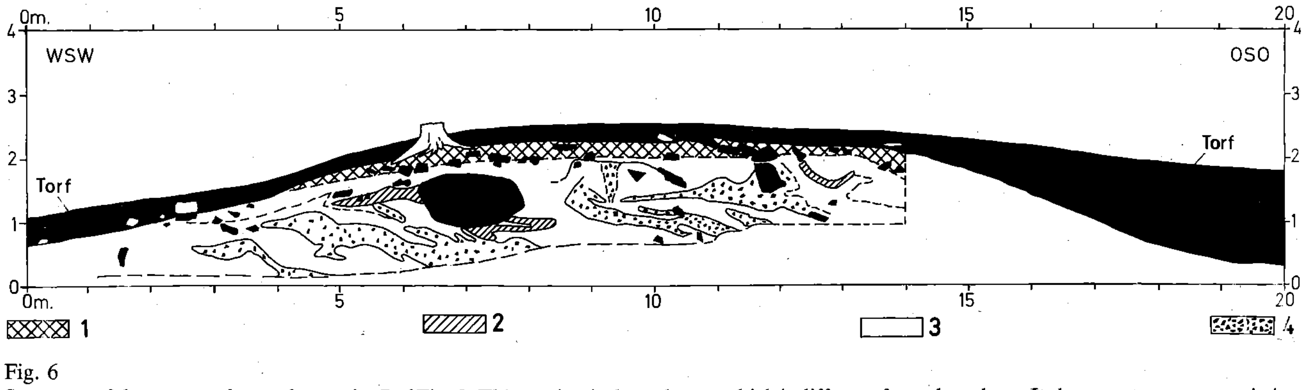

Fig. 6
Structure of the rampart located near site 7 of Fig. 2. This section is the only one which is different from the others. It shows a structure consisting of solifluction lobes only.

Palynology

Some samples were taken by Bastin (Louvain) for a palynological study. The results will be published separately.

Tephrostratigraphy

JUVIGNÉ (1983, this volume) gives the results of a heavy mineral study. He shows that all 5 sections for which we have indications of age, including the section described in 1974 by BASTIN ET AL., were formed furing the last Dryas.

CONCLUSIONS

The present study shows the typical structure of remnants of periglacial mounds of the Hautes Fagnes plateau.

Present day periglacial features identical to those described have not been recorded to date. It is now unquestionable that segregation lenses existed in the mound and that many of these features grew during the last Dryas. Rarely was peat at the surface when the mounds began to grow. Because, as I indicated in 1974, there is no possibility in a number of locations where remnants exist to have water under pressure by either freezing or hydraulic action, it seems clear that the mounds have grown by suction of water to form segregation lenses. The various morphologies of periglacial mound remnants are similar to the variety of shapes described by AHMAN (1977) for palsas. It now seems to me that these features were probably similar to 'palses minérales' described by DIONNE (1978) in Canada.

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