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PILLAR CHANNELS, A SYNGENETIC PERIGLACIAL STRUCTURE IN PLEISTOCENE COARSE TERRACE DEPOSITS

Abstract

Pillar channels are a sedimentary structure characterising the older Pleistocene terrace deposits in the River Scheldt Basin (Belgium and N. France). The author gives a morphological and sedimentological description and puts forward a genetic interpretation. He stresses their value as an indicator for the fluvio-periglacial nature of the terrace deposit and as an aid to stratigraphic interpretation.

Résumé de l'auteur

Les chenaux-à-piliers forment une structure sédimentaire qui charactérise de nombreux dépôts de terrasses fluviatiles du Pléistocène inférieur et moyen dans le Bassin de l'Escaut (Belgique et Nord de la France). L'auteur présente une description morphologique et sedimentologique et il avance une interprétation génétique. Il souligne leur valeur comme argument pour la mise en place sous conditions fluvio-periglaciaires et leur signification pour une interprétation stratigraphique.

INTRODUCTION

Most of the northern part of Belgium and part of Northern France (mean geographical position about 51° N Lat., 1° E Long.) belong to the basin of the river Scheldt.

One of the striking features of its geomorphology are fluviatile terraces. Morphological terraces occur at different levels above the present valley bottoms. Very often they occupy an interfluve position. In the lower part of the basin, post-Holstein terraces are mainly buried underneath the Vistulian valley aggradation which itself is locally cut into a terrace.

The bases of those terraces are cut into a dominantly sandy or clayey monoclinal Tertiary substratum. Some of those Tertiary layers contain thin discontinuous sandstone intercalations, thin layers of scattered flint pebbles and ironoxyde sandstone layers. A fossil Pliocene beach and spit pebble stretch has also been cut and reworked by the Quaternary denudation. Locally the younger incisions have reached a Paleozoic hard rock substratum (massif of Brabant). In the southern parts Cretaceous chalk with flint layers has been laid bare (northern edge of the Artois, dôme of Mélantois, synclinal valley of the Haine). In the eastern

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part middle-Pleistocene Meuse terraces with Paleozoic rock pebbles have been reworked and redeposited in the Scheldt basin.

The older terraces are covered with a blanket of coarse sediments (sands and gravel), whose thickness generally does not exceed a few meters. The sediments of these older terraces show quite distinct fluviatile primary structures. The petrographic nature of their material consists mainly of flint. This nature indicates a partly more distant origin and a partly more or less local admixture reworked from the Tertiary substratum or from the older terraces themselves.

The lowermost levels may contain datable material or at least show syngenetic primary sedimentary structures allowing a paleoclimatic interpretation, or even present a sediment-genetic succession allowing an age interpretation.

The middle and old Pleistocene terrace sediments however do not contain Quaternary fossils or any other evidence allowing a chronostratigraphic identification by classic geological means. Hence the morphostratigraphic position of any terrace level in a complete sequence and the identification of the paleoclimatic conditions of deposition remain the only way to an age assesment of those terraces. One of the basic topics of discussion concerns the glacial or interglacial age of the deposition, a glacial period here corresponding to periglacial climatic conditions. Hence syngenetic periglacial structures within those sediments are of great importance. Unfortunately, due to the coarseness of the deposit and locally also to the clayey nature of the substratum or to subsequent reworking, classic periglacial structures in those terrace sediments are either extremely rare, or hardly recognisable.

Some of the gravelly terrace sediments however show pillar channels, a type of syngenetic sedimentary macrostructure.

PILLAR CHANNEL STRUCTURE

Pillar channel structures have been observed for the first time in vertical sections in a gravel pit at Clarques near Thérouanne (Northern France) in a mainly flint pebble middle-Pleistocene terrace deposit along the Lys river valley (DE MOOR, 1978). The terrace deposit rests there upon a substratum of fine glauconiferous sands of Paleocene age (sables d'Ostricourt). Further pillar channel structures have been discovered at different other places in a similar lithological context and at various levels.

The coarse terrace deposit comprises a discontinuous lower part consisting of local grouping of pillar channel structures, and a continuous upper part with a large scale planar and shallow cross-trough stratification. Lateral terraced repetition of this sequence has been observed.

The initial pillar channel structure type consists of a more or less close juxtaposition of well individualised channels showing either wedge-like or more or less rectangular cross-sections, deeply cut into a fine-sandy substratum. They reach depths up to 4 m and are 1 to 3 m wide. The distance between chan-

nels varies between less than 1 m and more than 6 m. Often the channels are separated by thin, sometimes very thin walls of completely undisturbed substratum material. Sometimes these walls are less than 20 cm thick for a height of 2 m. Hence the banks of the channels are quite steep to vertical, sometimes even undercut, mostly rectilinear, sometimes slightly curved or steplike. These channels are filled up with subhorizontally well bedded, undisturbed deposits showing an alternation of more sandy and more gravelly layers. The gravelly fraction consists mainly of flint, but nevertheless contains a rather high amount of brittle ironoxide sandstone fragments and unconsolidated sandy or clayey pebbles of local origin. In one group the bases of these channels reach nearly the same level. Locally piping tracks occur underneath the channels. Neither the position, nor the depth of these channels are directly related to structural or to sedimentological characteristics of the substratum, although that is affected by a much older narrow fault complex and by some down faulted blocks.

The channel walls as well as their infillings have been truncated by the flat base of the upper gravelly part. This shows a distinct large-scale planar to cross--trough stratification, and consists dominantly of flint pebbles with much less material of local origin. If outcropping, it can be supperficially affected by presumably postgenetic cryoturbations. The zones with pillar channels pass laterally into larger stretches of the terrace deposit, showing sedimentary structures and lithological characteristics similar to those of the upper part.

The initial wedge-like or rectangular pillar channel type is not however the only one occurring in these groupings. Three other types are soldered channels, pocket channels and communicating channels. They represent more developed types.

Soldered channels consist of an intergrowing of initially separated channels. The lower parts of channels and infillings are still well individualised; the upper parts on the contrary have lost their individuality due to syngenetic erosion of the wall separation.

Pocket channels are rectangular channels whose lower part has been widened by the internal sliding of a muddy-like mass, provoking undercutting. This is proved by the structure of the lower part of the infilling which contrasts with the undisturbed upper part, the wall-parallel orientation of the pebbles in the lower part and the presence of a slide ring in the substratum skin surrounding the lower part. The structure shows that the internal sliding occurred after the infilling.

Communication channels are adjacent, mainly rectangular channels separated by quite thin walls which have been perforated over little height and at a rather constant depth. The upper and the lower parts of the perforated sandy wall however stand separately as downhanging and uprising columns showing no internal structural disturbance. This proves distinctly that the perforation occurred after the infilling.

The upper part of the infilling shows hardly any disturbance; the lower part on the contrary shows a distinct perturbation of the gravelly infilling and secondary mixing with small lobes of sand originating from the perforated wall, and sometimes even with flowed parts of the wall itself. The walls show no evidence of internal sliding within the channels. Very striking, however, is the fact that at the height of the perforation the infilling comprises a rather thin intermediate layer. It consists of well-bedded pebbles and coarse sand with a subhorizontal lamination, passing through the perforation and continuing within different adjacent channels. Its formation is more recent than the infilling and perforation, and presumably due to a local reorganisation of the infilling by water flowing under high pressure at the perforation level. Generally the lower part of the intermediate layer or a thin adjacent zone of the lower part of the infilling shows a more fine-sandy or even sandy-clayey texture suggesting a secondary enrichment of washed out fines.

GENETIC INTERPRETATION

The genetic interpretation presents macrostructural as well as microstructural aspects which in fact are interrelated. This interpretation is of course an *a posteriori* one of fossil structures observed merely in vertical profiles.

Pillar channels are syngenetic sturctures in a fluvioperiglacial deposit. They have been formed under periglacial conditions due to the lateral shifting of a braided river branch over a deeply frozen, slightly higher part of a large valley bottom. Due to this shifting, erosive microterraces cut into the substratum, hardly emerging above the level of the braiding river channel and occupied by a network of frost wedges and ice wedges, are inundated. The initial wedge-like channels and the terraced position of the grouping witness to that situation.

This inundation is related to a period of upbuilding by the braiding channels pushing the river flow sideways over the microterraces where it showed initially a lower solid discharge. Upbuilding and inundation are related to an increase in the local lateral channel inflow by solifluxion but also to an increase in the river discharge. Al together both suggest a slight seasonal or short-run climatic amelioration.

The inundation occured at the same time as a superficial thawing of the microterrace and itself provoked an increase of that thawing. The thermal conductivity of the ice being higher than that of the surrounding substratum but especially because of the voids created by their melting, the ice wedge patterns drained the water. They have been emptied, widened and deepened by hydrodynamic and thermo-erosive action of the river run off which already became quite aggressive due to the former deposition of most its solid discharge. Meanwhile separating walls still stood frozen.

After this erosive stage the channels have been filled up by river deposits. In the beginning, however, these contained a large amount of local material ori-

ginating from the walls and from the frozen sandy substratum outside the channel injected by congelifluxion and by superficial snow meltwater run off.

The first infillings contained also lot of ice blocks deposited after some rafting or still unreworked ice wedge remnants. Later on the deposition became of a more remote origin.

The melting of the buried ice blocks in the lower part of the channel infilling and the thawing of the walls within the deposit itself, provoked a decompaction and a liquefaction in the lower part of the infilling and led to an internal perturbation of this lower part, to internal sliding with the formation of pocked channels as well as to the perforation of the walls. The formation of the intermediate layer within the communicating channels occurred when water, confined between the rising permafrost table and the down moving frost front, moved under high pressure within the sediment, causing a local reorganisation of the sediment and a washout and redeposition of the fines.

CONCLUSION

The occurrence of pillar channel structures within a gravelly terrace deposit can be considered as a proof of deposition in a fluvio-periglacial paleoenvironment. It would, however, be interesting to get evidence of the present day active mechanism and features.

References

CZUDEK, T., DEMEK, J., 1970 — Thermokarst in Siberia and its influence on the development of lowland relief. *Quatern. Research*, 1: p. 103—120.

DE MOOR, G., 1978 — Structures périglaciaires syngénétiques dans quelques terrasses fluviatiles du Nord de la France et en Belgique. *Bull. Soc. Belge Géol.*, 87: p. 55—65.

PISSART, A., 1975 — Glace de ségrégation, soulèvement du sol et phénomènes thermokartiques dans les régions à perigélisol. *Bull. Soc. Géogr. Liège*, 11; p. 89—96.

TAVERNIER, R., DE MOOR, G., 1974 — L'évolution du Bassin de l'Escaut. *In*: L'évolution Quaternaire des bassins fluviaux de la Mer du Nord Méridionale". (éd. P. MACAR). Liège, Soc. Géol. Belg., Centenaire: p. 159—231.