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THE MICRORELIEF OF THE SANDCOVERED PLATEAUX NEAR KOLWEZI (SHABA, ZAIRE)

II. The microrelief of the crest dilungu

Le microrelief des plateaux sableux de la région de Kolwezi

II. Le microrelief des dilungu sommitaux

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RESUME

Les plateaux des environs de Kolwezi sont couverts, en grande partie, d'un dilungu, un mince manteau de sables fins couvert d'une végétation steppique. Le microrelief du dilungu est très développé et très varié. Dans cette partie de l'article le microrelief du dilungu couvrant le sommet des plateaux sera discuté. L'auteur postule un relief de départ d'origine éolienne et l'évolution d'un climat aride vers un climat semi-aride à steppique pour expliquer le façonnement de la partie la plus importante de ce microrelief. De nombreuses observations de terrain soutiennent cette hypothèse. La genèse de ce microrelief typique est postérieure à la mise en place de la "Série des sables ocre" (Système du Kalahari) néogène. Une partie importante des formes éoliennes originelles est antérieure aux mouvements tectoniques qui ont soulevé le Haut Shaba et accentué le graben de l'Upemba au début du Pléistocène.

ABSTRACT

Great parts of the plateaux near Kolwezi are covered by a dilungu, a thin sandy layer with a steppic vegetation. The dilungu shows an extensive and varied microrelief. In the present part of the article, the microrelief that occurs on the dilungu covering the crest surfaces of the plateaux - the crest dilungu - discussed[1]*. The author proposes the evolution of original eolian landforms under changing climatic conditions from arid to semi-arid and steppic,*

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(1) The microrelief of the over-all dilungu (the dilungu covering the plateau indifferently to his macromorphology) was discussed in Geo-Eco-Trop, 1979, 3 (1), 1-18. We also refer to this article for general physical geographical data on the Kolwezi area and for an outline of the plateau-morphotype in this region.

to explain the genesis of this microrelief. This hypothesis is supported by numerous field observations. The morphogenesis of the typical microrelief is situated after the deposition of the Neogene "Série des sables ocre" (Système du Kalahari). An important part of the original eolian landforms was modelled before the tectonical movements that lifted up Upper-Shaba and accentuated the Upemba graben during the early Pleistocene.

THE MORPHOLOGY OF THE MICRORELIEF ON THE CREST DILUNGU

Morphography (Fig. 1)

The *dilungu* shows an extensive and varied microrelief. An important part of the microrelief-units is found on the whole *dilungu*, whatever his morphographic position on the plateau may be. Other microreliefforms only occur on the crest *dilungu*. They will be discussed in the present part of the article.

The crest microrelief is composed of separate features. A big part of them are long-stretching, other have a more limited extent.

Among the long-stretching units a subdivision can be made in linear and sinuous microridges and in linear microdepressions. The linear microdepressions are very shallow (depths up to 30 cm) and narrow (maximum width of 40 m) but very long (lenghts between 1 km and 3.6 km). Although difficultly surveyable on the field, they are easily discernible on aerial photographs. They show a remarkable constant E by S - W by N direction. The linear microridges (Fig. 2) are low (maximum height of 50 cm), narrow (widths between 50 m and 100 m) and also very long (lengths between 1 km and 5 km). They are always associated with the linear microridges, running parallely or subparallely with them. In some cases ridges join and then form an Y-shaped fork with two long prongs and a short stem always pointed to the W by N. It should be noted that the linear microridgees are not always evenly spaced. The sinuous microridges are very low (average height of 20 cm), narrow (maximum width of 50 m) and long (lengths between 200 m and 1200 m). The direction of their long axis ranges between SSE-NNW and SE-NW. It is difficult to survey them on the field but they are also easily detectable on aerial photographs. Field measurements in the Kahilu test zone on the Lupasa plateau show a net asymmetrical crossform with a more gentle slope facing ENE or NE. Drainage differences at the onest of the dry season are well translated in the airphoto image by tonality differences (Fig. 3), making the

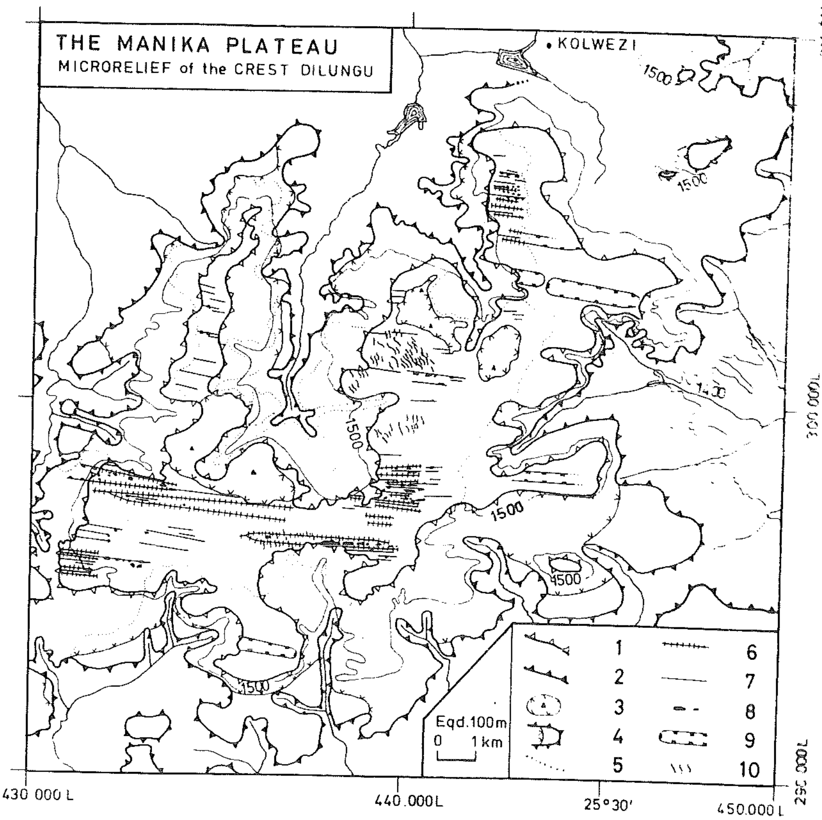

Fig. 1 : The microrelief of the crest *dilungu* on the Manika plateau (S of Kolwezi). 1 : Crest surface edge convexity; 2 : Plateau-rim convexity; 3 : Crest-hill; 4 : Marginal surface shoulder; 5 : Extension of the *dilungu*; 6 : Linear microridge; 7 : Linear microdepression; 8 : Depression-pan; 9 : Dry trough shaped valley; 10 : Sinuous microridge.

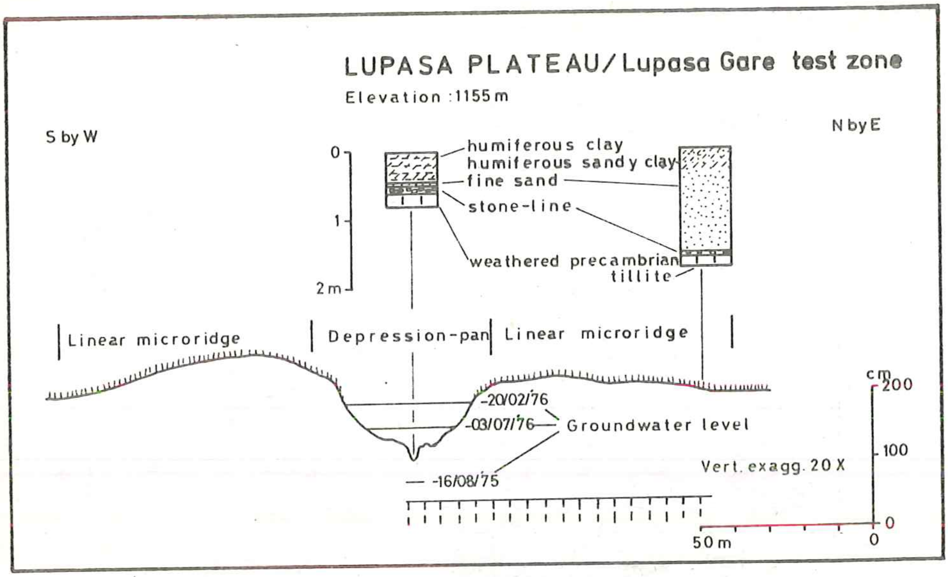

Fig. 2 : Cross-section in a set of two linear microridges and a depression-pan in the Lupasa Gare test zone on the Lupasa plateau.

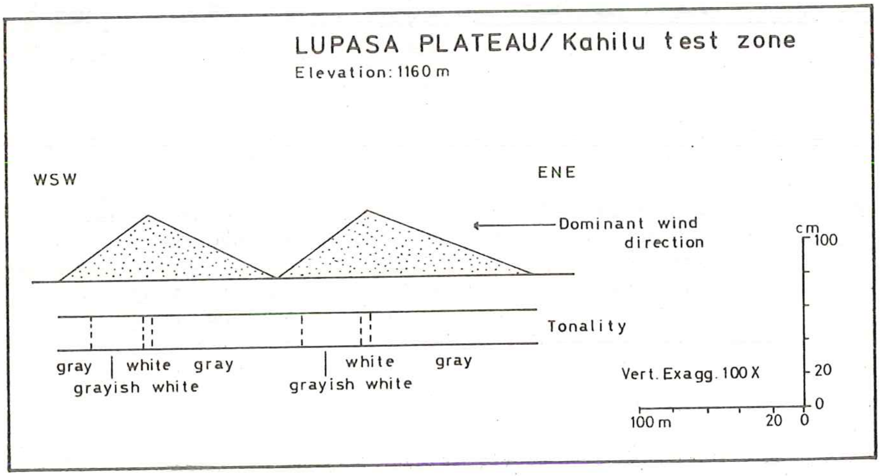

Fig. 3 : Asymmetrical cross-section of sinuous microridges translated by tonality differences on the aerial photo image, as observed in the Kahilu test zone on the Lupasa plateau.

morphographical survey more easy for the whole complex of plateaux.

In the linear microdepressions occur some pans for which we reserve the term depression-pans. These closed microforms are shallow (depths between 1 m and 3 m) and show a circular, elliptic or oval-shaped planform. Their diameter or axis varies in length from 50 m to 200 m.

Morphogenesis

The linear microdepressions, linear microridges and depression-pans figure a landform association always situated on the peripheral zones of the crest dilungu (Fig. 1). On the contrary, sinuous microridges chiefly occur on the central zone where the sandcover is slightly thicker. In some cases sinuous microridges are developped on and affect the set of linear microdepressions and microridges.

Taking account of their remarkable constant direction and their important geographical extent - identical forms were observed on the *Biano* plateau by ALEXANDRE-PYRE (1971) - eolian landforms are the most obvious origin of the linear microdepressions and microridges.

We consider the linear microridges as remnants of extensive longitudinal dunes. This intrepretation particularly leans on the studies on dune sequences made by VERSTAPPEN (1968 and 1972) showing how longitudinal dunes, many kilometers long, irreversibly can be formed out of parabolic dunes. The same author insists on the fact that the great longitudinal dune ridges are not always evenly spaced and that they often join to form a fork wich stem is always directed leeward. The depicted spatial arrangement perfectly fits with our observations in the Kolwezi area.

An eolian origin let suppose an arid climatic phase with very sparse or even lacking vegetation cover offering conditions in which the *dilungu* sands could easily be modelled and transported by the wind. Following the morphography of the ridges the dominant direction of the winds should have been E by S.

We suppose the linear microdepressions and the depression-pans are indirectly derived from the longitudinal dune landscape. The evolution of an arid phase to a semi-arid or steppic climatic phase involving some amount of precipitation could led to a shrub vegetation able to fix the eolian forms. Runn-off could concentrate in the "straats"[2], the

(2) "straat" : Afrikaans-term; they are typical for an area between the Okavango Swamps in Botswana and the Etosha Pan in Southwest Africa/ Namibia (GOUDIE, 1973, p. 117).

parallel depressions between the dunes.

In the case of a very thin sandcover as observed in the peripheral zones (Fig. 2) this water concentration could cause a drainage pattern running parallel to the longitudinal dunes. On the other hand, in the central zones where the sandcover was more important concentrated water soaked entirely through the permeable sands impeding streams to develop.

During this first stage of evolution, dune ridges were already partially degraded by the attack of sheetwash erosion. In the peripheral zones the supplied sediments could be evacuated by the streams. In the central zones on the contrary sheetwash led to aggradation in the straats.

In the long run higher precipitation amounts led to a slow rise of the average water table perched on the relatively impervious precambrian bedrock, involving a growing seasonal hydromorphy in the peripheral zones. Under this conditions it is highly probable that the shrub vegetation was gradually replaced by a steppe vegetation of suffrutex and geofrutex, similar to the one that occupies the Malungu nowadays(3). In this second stage of the evolution, topsoil being less protected by vegetation, sheet - and rill - erosion could become more important and accelerate the degradation of the dune ridges. Taking account of the very gentle sloping surface it is very possible that the growing sediment supply could not be sufficiently evacuated any more, envolving a filling of the drainage network in the straats. The sketched evolution generated the linear microdepressions and depression-pans that we consider as regression-pans. Several authors (DE PLOEY, 1965; FLINT and BOND, 1968; VERBOOM and BRUNT, 1970; STERCKX, 1974) consider the pans as original blowouts. Nevertheless it must be stated that their interpretation mostly relies on the sole morphographic aspects of this features.

The shrub vegetation probably lasted longer in the central zones, the average water table laying deeper in this part of the crest *dilungu*. In this zones the combination of degradation of dune ridges and aggradation of straats in the first place had a wiping effect on the microrelief

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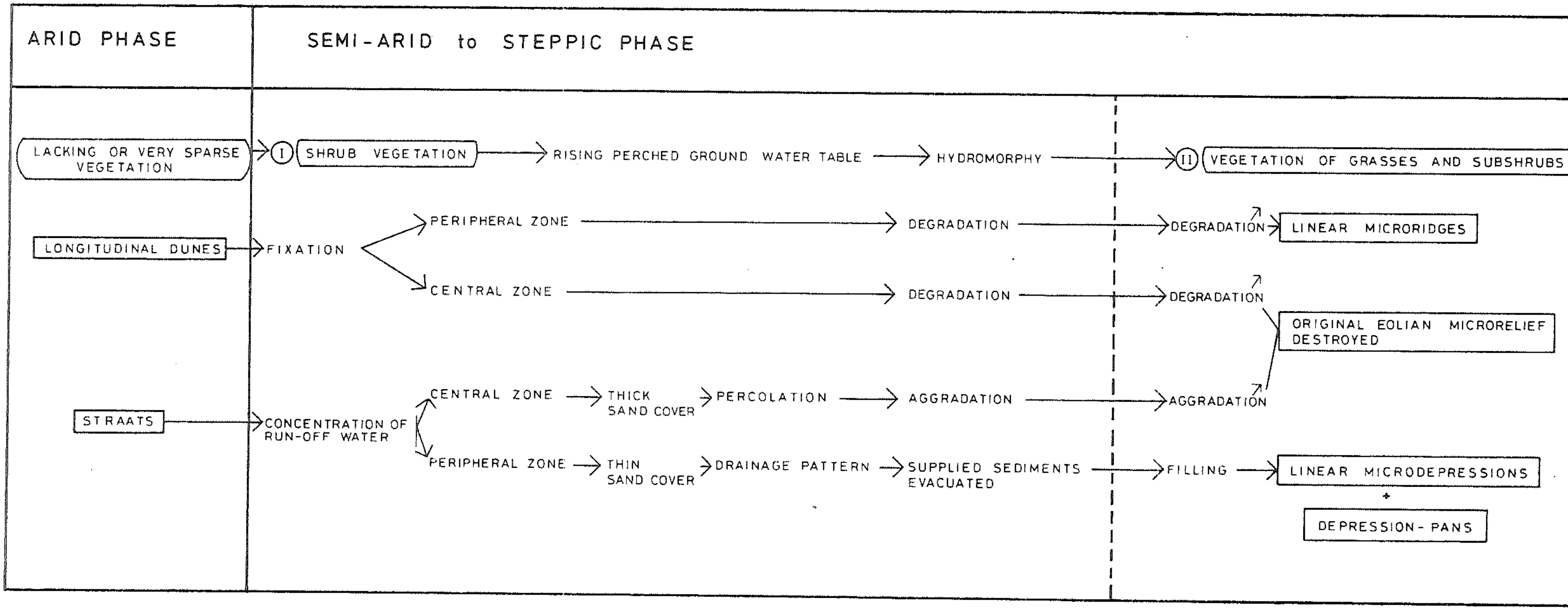
(3) Following MALAISSE (1975) the inverse process can be observed nowadays on the sandcovered plateaux : "La steppe sèche se caractérise principalement par l'abondance des géofrutex qui lui donne son aspect caractéristique ... Dès que le niveau de la nappe phréatique s'abaisse quelque peu, cette formation évolue en steppe sèche arbustive ou arborée, formation végétale differente, mais à composition floristique très voisine." (p. 20).



Tab. I : Scheme of the evolution of the original longitudinal dune landscape.

then followed by a general degradation. There also this evolution finally ended in hydromorphic conditions forcing the shrubs to be replaced by a steppe vegetation constituted of less protecting plants.

In the scope of this hypothesis on the evolution of the most important part of the microrelief on the crest *dilungu*, schematically represented in table I, only the peripheral zones show remains of the original longitudinal dunes and straats under the form of linear microridges, linear microdepressions and depression-pans. On the central zones the original eolian landforms were completely destroyed.

Several field observations indicate the existence of an obliterated drainage pattern on the origin of the linear microdepressions. Where the crest surface edge convexity cuts a linear microdepression frequently water seep zones can be observed, often forming the source of small trickling intermittent streams on the marginal surface. Possibly the straats drainage pattern here and there cutted into the weathered precambrian bedrock so that this former thalwegs now serve as collecting channels for the perched ground water. The occurence of linear dry trough shaped valleys (Fig. 1) parallel to the linear microrelief, on the parts of the crest surface no longer covered by a *dilungu*, could confirm this view. Though the drainage network is very sparse on the sand-covered crest surfaces, it shows a remarkable preferential E by S - W by N direction emphasizing the axes of the crest dilungu microrelief.

With respect to their morphographic characteristics and distribution an eolian origin also can be postulated for the sinuous microridges. From their rather scattered distribution with regard to the linear long-stretching microforms, one can suppose they are not obligatory formed under arid conditions but that they are merely seasonal forms issued form a climatic phase with long and accentuated dry seasons. The asymmetric cross-section as observed on the field and on aerial photographs and the sinuous wavy crest lines fit in with the morphography of transverse dunes stretching approximately perpendicular to a dominant ENE wind direction.

The origin of transverse dunes has usually been associated with low or decreasing wind speed. However, the crucial factor in the formation of transverse dunes, according to VERSTAPPEN (1972), is rather the decrease in wind velocity. They can be formed from parabolic dunes and from barchans alike. If either of these two dune types starts to move at a slower rate, the upwind dunes can catch up with the ones further downwind and thus form transverse ridges. In the case of the crest *dilungu* decreasing dune speed van results from a growth in size of the dunes approaching the more important source of sand in the central zones. Since the speed of the dunes is inversely proportional to their size, the upwind dunes under such conditions will more readily catch up with the ones further on the central zones which increased in size when reaching the sand source area. Eventually also shrub vegetation on the central zones under drier climatic conditions, could be responsible for the decrease of the dune velocity.

At several places on the crest surface we observed grouped blocks of silcrete distinctly in association with the linear microdepressions. On the contrary, silcrete blocks observed on the marginal surface always have a scattered distribution pattern. GOUDIE (1973) states that relationship between silcrete and climate is a difficult one to assess but that there are various reasons for believing that the climatic limits of silcrete are similar to those of calcrete which is formed in a semi-arid or arid environment. It is possible that silcrete was formed in the straats by water concentration in the depressions. In this scope the observed silcrete would be posterior to the one of the "Série des grès polymorphes" of the lower Kalahari. Different ages for the "grès polymorphes" on the Biano plateau are also postulated by ALEXANDRE-PYRE (1971).

Morphochronology

It is obvious that the modelling of the *dilungu* microrelief is posterior to the deposition of the neogene "Série des sables ocre" from which the sandcover derives.

By the fact that in some places sinuous microridges are developped upon the linear microridges and linear microdepressions, one can conclude that the initial transverse dunes are younger than the former.

The unique microrelief of the crest *dilungu*, derived from eolian landforms, indicates that the marginal plateau surface is shaped to the detriment of part of the crest surface and that this development is posterior to the youngest original microreliefforms, namely the transverse dunes.

In some cases, e.g. on the Ilunga plateau (Fig. 4), the set of linear microreliefforms hits the basal concavity of the escarpment zones that deals the Kolwezi area up in a complex of plateaux. This escarpment zones result from tectonical radial faulting movements that mainly worked

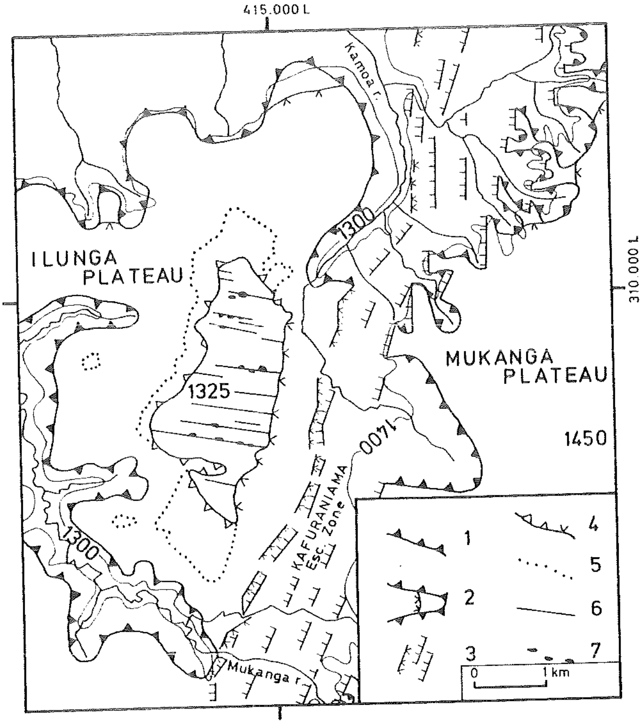


Fig. 4 : Simplified morphographic map of the Ilunga plateau. The linear microridges hit the basal concavity of the Kafuraniama escarpment zone. 1 : Plateaurim convexity; 2 : Marginal surface shoulder; 3 : Escarpment zone; 4 : Crest surface edge convexity and basal concavity; 5 : Extension of the *dilungu*; 6 : Linear microridge; 7 : Depression-pan.

during the early Pleistocene accentuating the Upemba graben and uplifting Upper-Shaba. With respect to these morphographic observations we conclude that the formation of the original longitudinal dunes must be situated before the escarpment formation. If not, the very regular longitudinal aspect would be perturbed at the proximity of the escarpments, the more so as the derived dominant wind direction was approximately perpendicular to the escarpment lines.

The formation of the marginal surfaces detrimental to the crest surfaces is the result of a general lowering of the baselevels due to the mentioned tectonical movements. During this phase of desequilibrium the thick saprolithic weathering cover, developped in the precambrian bedrock on the fini-Tertiary peneplain (CAHEN, 1954), was easily eroded shaping the typical macromorphology of the plateaux in the Kolwezi region (DE DAPPER, 1979).

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