La grotte de Mbilibekon; un pseudo-karst dans la couverture lateritique du craton du Congo (Ebolowa, Cameroun).

[Mbilibekon Cave, a pseudo-karst in lateritic cover of the Congo basement (Ebolowa, Cameroon.)]

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[Apologies for the poor quality photos - they were scanned from a photocopy!]

The cavities that one finds in soft erodible formations form by mechanical absorption of particles, along fissures or joints (fluid movement of "piping" type). This note presents an original example of a pseudo-karst network hollowed out in the lateritic cover of the South Cameroon in a humid equatorial context.

INTRODUCTION

If the functioning of pseudo-karsts within non-carbonate rocks has been frequently described in formations of very varied petrographic nature, these phenomena are less well known within soft rocks. In Africa, some examples have been observed in the top Continental cover of several basins of the Gulf of Guinea, particularly in the Ivory Coast (comm. S.Pomel). Most descriptions of pseudo-karst in soft rocks (NEBOIT, 1974; ERASO, 1975; SPONHOLZ, 1989; WILLEMS *et al*., 1993) concern systems situated in regions of various climates but having in common a sparse, even absent, vegetation cover. Mbilibekon Cave, featured in the tourist guides, is the first example of pseudo-karst described in soft rock within the dense humid forest of Cameroon.

Mbilibekon Cave is situated on the South Cameroon plateau in the Ebolowa region (fig. 1). This zone, covering from 630 to 850 m altitude, is characterised by an equatorial climate of Guinean type with a rainfall

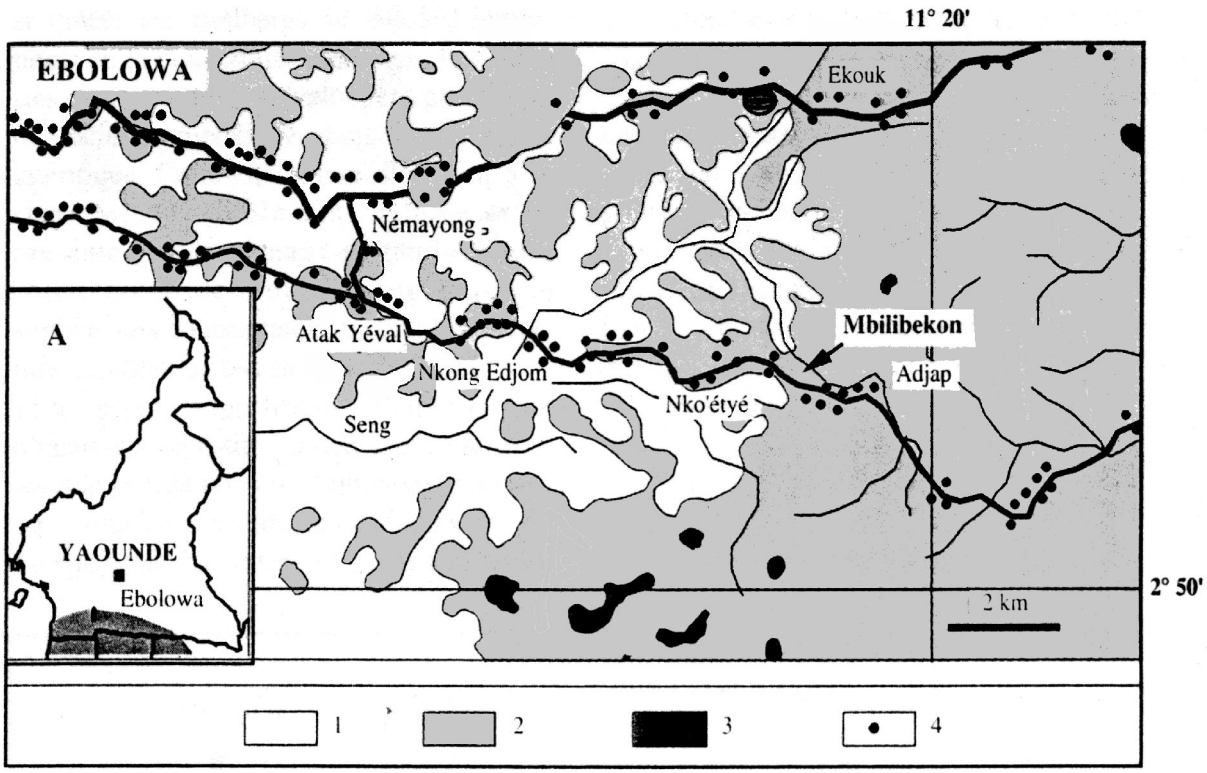

Figure 1 : Carte de localisation de la grotte de Mbilibekon. 1, altitude inférieure à 600 m. 2, altitude comprise entre 600 et 800 m. 3, altitude supérieure à 800 m. 4, constructions en dur. A : localisation du socle de Ntem (figuré en gris) dans le Sud du Cameroun.
Located map of the Mbilibekon cave. 1, altitude lower than 600 m. 2, altitude between 600 and 800 m. 4, altitude higher than 800 m. 4, permanent building. A : location of the Ntem basement in the Southern Cameroon.

of 1,500 to 2,000 mm per year and a mean temperature of 25 C. The forest vegetation, of Guinean-Congolese type, is a mixture of deciduous forest of *Sterculianaceae* and *Ulmaceae* and Atlantic evergreen forest of *Lophira alata, Saccoglottis gabonensis* and rare *Caelsalpiniacae.* The deciduous forest dominates the Atlantic evergreen forest. The rural density, relatively high (mean 10 /km^2) is revealed by substantial food crop cultivation along axis routes and the presence of numerous cocoa plantations in the depths of the forest. In this zone the forest appears as a pattern of islets of primitive forest and areas of degradation linked to human activity. Even in the most degraded areas, vegetation cover is never absent, for one of the most characteristic features of this degraded forest is takeover by tall herbaceous plants, mainly belonging to the *Marantaceae* and the *Zingiberaceae* (SANTOIR & BOPPA, 1995).

From a geomorphological point of view, the Ebolowa region constitutes a basin which presents a relief of half-oranges, frequently encountered on the South-Cameroon plateau where rounded small hills [butte] are separated by a "persille" [like cheese with green flecks through it] hydrographic network . The rocky stubstratum only outcrops exactly at the summits of the surrounding massifs, for the warm humid climate favours the development of a thick alteration bed of lateritic type. Mbilibekon Cave is situated near the track which leads from Nko etye to Adjap (fig.1), 250 m from the military post[?] of Nko etye (which is the last house in the village). The entrance to the cave is in a cocoa plantation, 50 m to the left of the track.

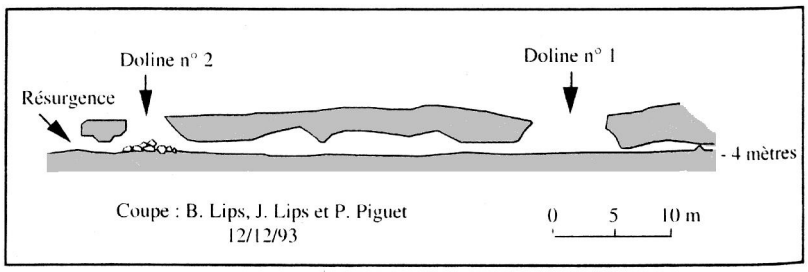

Figure 2a : Coupe schématique longitudinale de la partie aval de la grotte (d'après LIPS, 1994a et b). ***Schematic section of the down stream part of the cave (after LIPS, 1994a et b).***

I. GEOLOGICAL CONTEXT

The Ebolowa region is situated on the Ntem basement which in the Cameroon constitutes the NE termination of the Congo craton. The Ntem basement, stabilised in the Eburnean 2 Ga (1 Ga = 1 million years), is made up of magmatic and metamorphic rocks represented mainly by granodiorites, charnockites (magmatic rock typical of precambrian basements) and gneisses. Outcrops of intact unweathered rock are limited to the summits of the inselbergs because of the significant lateritic cover. The cave's passages are developed at the contact of the charnockite basement, in the lateritic cover. This last, of a thickness of about 5 m (fig. 2a), is weakly indurated and does not present any particularly resistant layers nor a ferruginous surface crust. Sections made in the cover show from bottom to top (fig. 2b):

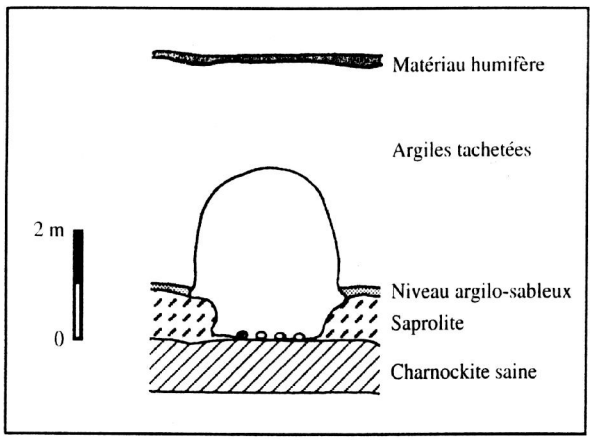

Figure 2b : Coupe géologique transversale de la partie aval de la grotte. ***Schematic geological section of the down stream part of the cave.***

(1) a saprolitic layer, about 1 m thick, made up of yellowish clay which is soft ["meuble"], very porous and weakly indurated, where the structure of the charnockite substratum is partly conserved; one finds here decimetric blocks of quartz originating from broken veins;

(2) a decimetric sandy-clay bed which corresponds to the former alteration sand;

(3) a bed about 3 m thick of clay mottled and spotted by grains of quartz and iron oxy-hydrates in small pisolites or in compact granules;

(4) a humiferous bed on the top.

At the level of the resurgence one sees, on an outcrop of several square metres, intact charnockite substratum. A fracture with an orientation N 160E to N 180 E affects the charnockite, whose internal structure is stressed by a magmatic lineation of N050 E. These fractures are not seen in the formation of the cover.

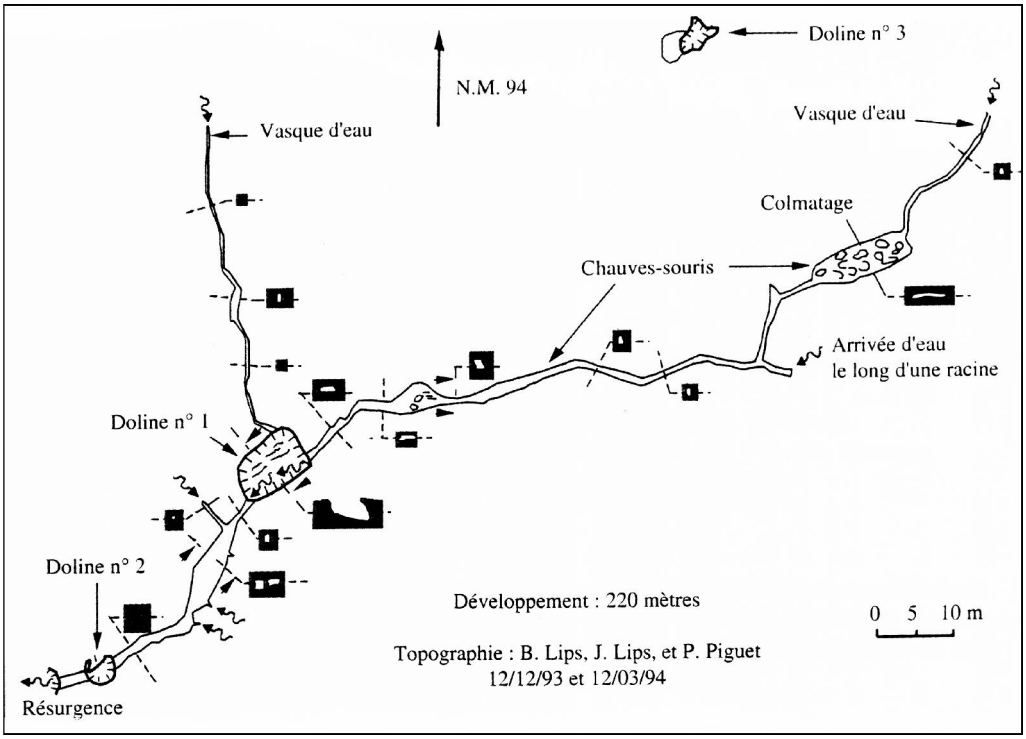

Figure 3 : Relevé topographique de la grotte (d'après LIPS, 1994 a et b).
Map of Mbilibekon cave (after LIPS, 1994a et b).

II. DESCRIPTION OF THE CAVE

As well as the point of the resurgence which forms the natural entrance to the cave, it has two secondary entrances that are more recent, in the form of dolines originating from the collapse of the passage roof (fig. 3). According to the villagers, the collapse of doline No.2 happened some years ago, following the uprooting of a tree in a storm. The entire cave has a small stream running through it. The flow is around some tens of litres per second in December (some days after fairly heavy rains) and nearly insignificant in March.

With regard to doline No.1, the cave presents three distinct parts: the downstream reach, the principal upstream reach, and a small passage corresponding to a secondary upstream reach (fig.3). The downstream part extends to 40 m. Entering via the doline, one reaches a chamber whose ceiling is held up by a residual pillar (photo 1). The passage, from 1 to 2 m wide and from 1.5 to 2 m high, leads to doline No.2 (photo 2), and then to the resurgence. Traversing it doesn't present any difficulties. This section is the only one visited by the rare tourists.

The upstream part seems never to have been explored. Indeed an atmosphere of mystery and legend attaches to Mbilibekon Cave or "Hole of the Phantoms", and the villagers advise against this visit. In fact, right from the entrance (photo 3), the reduced ceiling height, the muddy soil and the presence of the underground river make progress difficult (photo 4). A substantial colony of bats of the *Rhinolophus* genus, composed of several thousand individuals, occupy the cave in December. An elevated content of carbonic gas makes the atmosphere oppressive. In the month of March, the bat colony is reduced to a few hundred

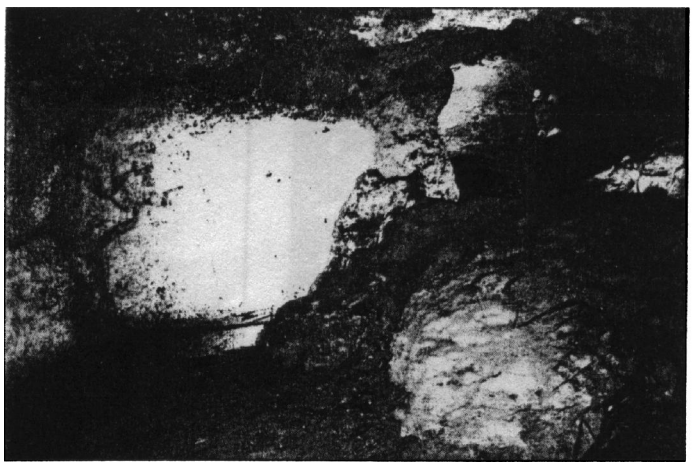

Photo 1 : Pilier résiduel de la partie aval de la grotte vu depuis l'aval.
Earth pillar in the down stream part of the cave, down stream view.

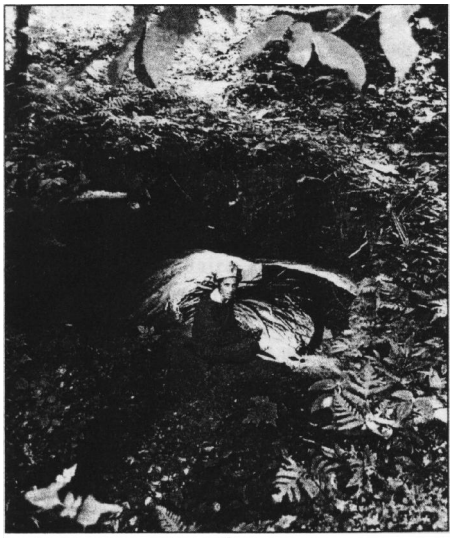

Photo 2 : Doline n°2 vue depuis l'amont.
Upstream view of the sinkhole n°2.

Photo 3 : Entrée du réseau amont. ***Entrance of the upstream network.***

individuals and the air is much more breathable. This seasonal presence of carbonic gas is perhaps linked to the presence of the bats; however, the level of CO_2 and its seasonal variations has yet to be measured.

Seventy-five metres from the entrance, an inviting secondary passage, 4 m long, ends in water coming in along a root that pierces the roof. Ten metres further on, one arrives in a shallow arched chamber 5 to 6 m wide and 40 cm high. Low progress continues for 30 m, then one finds a circular passage a metre in diameter occupied by a shallow basin of muddy water. The cavity ends in a narrow passage with only 20 cm space between the water and the ceiling. The secondary upstream section begins in the north wall of doline No.1 as a small tube 40 cm in diameter. An enlargement 30 m from the entrance permits one to stand up temporarily. After 10 m of low passage one reaches a basin of water. There again, a nearly drowned passage doesn't allow further progress. The passage goes on, rectilinear, for at least 10 m. The discovery of a collapse (doline No.3) 40 m north of the passage (fig.3) and the presence of numerous griffons [!] shows that the system is more extensive than the only known passages.

This cave shelters a very diverse troglophilic fauna. In addition to the colony of bats in the upstream section, one sees numerous arachnids, including some acarians [ticks & mites] and some beautiful specimens of phrynes [?], some insects (orthopterons, coleopterons, cockroaches), myriapods, and a fish [silure = possibly a catfish?]) near the upstream extremity, as well as some crabs and other crustaceans. This list is certainly not exhaustive. As a result of the rarity of caves in the Cameroon there have not been, to our knowledge, any studies undertaken of the cavernicular fauna. Mbilibekon Cave thus constitutes an original biotype which will form the object of more detailed studies; and it ought to be determined whether it shelters a truly troglobitic fauna or whether the various species observed are merely a sample of the standard nocturnal fauna of the forest.

Photo 4 : Galerie amont au niveau de la colonie de Rhinolophes. ***Upstream gallery near the Rhinolophus living place.***

III. SPELEOGENESIS

The passage presents a section in equilibrium as a more or less regular ogive (fig.3). The increase in the mean depth ["taille" = cutting] of the conduit from the principal upstream part to the resurgence, and the relative constancy of the ratio of height to width (about 1 to 3) can be interpreted as meaning a purely mechanical process of formation. Homogeneous material is eroded, at the base of the passage walls, by water circulation in periods of flood. The increase in flow of the subterranean river, from upstream to downstream, as a result of the presence of numerous griffons [? = gargoyles?], explains the growth in passage section. The speed of formation of this type of pseudo-karst, which depends on the degree of cohesion of the rock and

on the subterranean flow, can be very rapid. Formation of pseudo-karsts, in a few years, in rocks of little cohesion (sandy clays) has been described, for example, in the Ebre basin in Spain (MAIRE & PERNETTE, 1986): it is a matter of a classic “piping” process, that is to say mechanical removal of particles.

From a hydrological point of view, rain water thus infiltrates across the lateritic bed until it reaches the subjacent basement, at which level it circulates. This infiltration is made possible by the internal porosity of the lateritic bed and by the penetration of water along roots that pierce the roof. Water circulation at the base of the lateritic bed is favoured by the presence of a sandy bed.

Biological phenomena, which play a major role in the formation of pseudo-karsts by breakdown of poorly soluble rocks, such as the sandstones of Niger (SPONHOLZ, 1989) or the ferruginous quartzites of North Gabon (MARES-CAUX, 1973), probably play only a minor role here because mechanical erosion seems to be the principal phenomenon responsible for the formation of the underground network. The very recent degradation of the forest environment should not be seen as a cause as the forest has, on the contrary, a protective role in sheltering the system from superficial gullying phenomena which would lead to its destruction. In fact other pseudo-karsts are known in the altered cover of South and West Cameroon, along the new axis roads, but these pseudo-karsts, linked to the total disappearance of plant cover and the formation of badlands, are rapidly eroded in the rainy season by the excavation of small canyons with temporary flow. Initial photogeological studies show that the orientation of the pseudo-karst network is controlled by the network of fractures in the basement, as is often the case in crystalline country where faults in the basement drain phreatic water from the alteration layer.

CONCLUSION

Mbilibekon Cave is the most significant subterranean system known in the Cameroon to this date if one excepts Gaskin Cave, a lava tube on the slopes of Mount Cameroon. The present climate of South Cameroon is of humid tropical type, but study of alteration profiles in this region show that this has not always been the case (BILONG *et al.*, 1982; ENO BELINGA & KABEYENE, 1982). Recent studies carried out on the forest domain of Central Africa (ELENGA *et al.*, 1992; MALEY, 1991, V1992; SCHWARTZ, 1992) lead to similar conclusions and reveal evidence of a climatic deterioration towards 2,500 years BP. A generic link having to be established between forest cover and pseudo-karst, it was probably after this dryer epoch that the pseudo-karst was established, with the return of rains and the re-establishment of the forest. Formation of pseudo-karst in soft rock being a rapid phenomenon, Mbilibekon Cave is probably younger than 2,500 BP.

BIBLIOGRAPHY

[see original]