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A HIGH BAUXITIC SURFACE IN THE AMAZONE TERRITORY OF VENEZUELA. MAPPING THROUGH THE RADAR-SLAR IMAGERY AND EXPLORATERY EXAMINATION

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ABSTRACT — During the geomorpho-pedological survey of the Federal Amazone Territory in Venezuela completed in 1983, considerable bauxitic areas were observed in the highlands (between 1000 and 1400 m) of the crystalline mountains at the east and north of this territory.

These areas are associated with a specific type of landform. Its characteristic pattern reaveled through the Radar-Slar imagery determined its mapping as well as its frontiers in relation with the other lower polyconvex surfaces. This old erosion surface is distributed along an extensive crescent form of 500 km long and 100 km wide which rises above the large turn of the Upper Orenoque river. It stretches over poorly tectonized and often porphyric granites including alkaline types (Surucucu granites, Paraguaza granites).

The field observations evidence a fossil landscape with remarkable uniform aspect. It consists of long interconnected glacis dug out by a rather dense river network with V-shaped narrow valleys in a herring-bone pattern. Locally, the primitive structure has been deeply incised in cuts parallel to the tectonic lineations. The soils are ferrallitic (petroferric gibbsiorthox) with bauxitic hardpan blocks in the upper layer.

The alterite is not very well known from a geological point of view. It is possible to recognize three main horizons up to 8 m deep : a mottled clayey, a soft oxic, and a gravelly horizon with bauxitic hardpan blocks. The mineral composition which is qualitatively constant defines the alteration as intergrade between allitization and fermonosiallitization with an early dehydration state of the oxides : much gibbsite, some Al-goethite, a little hematite and boehmite, very little kaolinite. Downslope in the valleys, the allitic evolution is not so pronounced probably due to the proximity of the bedrock : gibbsite, goethite, some more kaolinite and quartz, traces of weathered minerals, absence of hematite and boehmite.

Bauxites, Amazon, Venezuela, Planation surface, Allitization, Exploration mapping

Existence d'une haute surface bauxitique en Amazonie vénézuélienne. Première reconnaissance et cartogaphie à l'aide des images Radar-Slar

RÉSUMÉ — Au cours de l'inventaire géomorpho-pédologique à 1/250 000 du Territoire Fédéral Amazonas au Vénézuela, achevé en 1983, d'importantes altérations bauxitiques ont été reconnues dans les zones élevées des hauts massifs montagneux cristallins de l'Est et du Nord de ce territoire, à des altitudes variant entre 1000 et 1400 m : sierra Maigualida, sierra Parima.

Ces altérations sont associées à une forme particulière de modelé. Sa signature caractéristique sur les images Radar-Slar a permis d'en cerner l'extension ainsi que la limite avec les niveaux géomorphologiques inférieurs à relief polyconvexe. Cette vieille surface forme un arc long de 500 km , large de 100 km, dominant la grande boucle du haut Orénoque. Elle s'étend sur des granites peu tectonisés, souvent porphyriques, avec variétés alcalines (granites de Surucucu, granites de Parguaza).

Les observations de terrain révèlent l'existence d'un paysage fossile qui apparaît d'une remarquable uniformité. Il se compose de longs glacis emboîtés sur lesquels un réseau hydrographique relativement dense creuse d'étroites vallées en V dessinant un maillage en chevrons. Localement, des incisions profondes conformes aux directions tectoniques redécoupent la structure primitive. L'ensemble est couvert de sols ferrallitiques indurés (petroferric gibbsiorthox) à blocs de cuirasse bauxitique.

Le manteau d'altération est assez mal connu. Il est d'épaisseur importante : 40 à 80 m. Un sondage de 8 m a montré, de bas en haut : un horizon argileux tacheté ; un horizon oxique meuble ; un horizon gravillonnaire à blocs de cuirasse bauxitique de taille métrique. La composition minéralogique, invariable qualitativement, situe l'altération entre allitisation et fermonosiallitisation, avec un début de déshydratation des oxydes : beaucoup de gibbsite, de la goethite alumineuse, un peu d'hématite et de la boehmite, très peu de kaolinite. En bas de pente, dans les entailles, l'évolution allitique est moins poussée sans doute à cause de la proximité du front d'altération : gibbsite, goethite, davantage de kaolinite et de quartz, des traces de minéraux altérables, pas d'hématite ni de boehmite.

Bauxites, Amazonie, Venezuela, Surface d'aplanissement, Allitisation, Cartographie

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INTRODUCTION

The study of the geomorphic surface aspect of the continental plates and specifically that of old continent shields reveals planation features resulting from succeeding alteration and denudation periods which marked the physiognomy of the earth crust mainly since Mesozoic to Pleistocene age.

These planation remnants can be used to reconstruct the original landscapes and to consider the main characteristics of their soil mantle.

The high bauxitic surface of the Amazone Territory of Venezuela is a remarkable relict of such a general planation episode. It spreads along a vast surface of repetitive relief features bearing a thick lithomarge. This geomorphic entity is considered as a natural pedological body with its proper structures organized in sequences and its specific or significant frontiers.

The data concerning geomorphology and soil geography are derived from the results given by a general survey of the Amazone Territory of Venezuela at scale 1:250.000. It was conducted from 1978 to 1982 by a group* composed of ORSTOM soil scientists, engineers from the Venezuela Ministry of Environment and a CNRS geomorphologist (CEGET-Bordeaux).

I — THE AMAZONE TERRITORY OF VENEZUELA

The federal Amazone Territory (fig. 1) represents the western edge of the Guianese shield. It extends between latitudes of 1° and 6°north. The climate ranges from humid tropical to rainy equatorial southwards. The annual rainfall distribution ranges from 2200 mm to 3700 mm. The annual water balance surplus (USDA system) reaches 500 to 1960 mm.

The entirely Precambrian basement is composed of acid intermediate granitic rocks among which prevail granites, gneiss and migmatites. Two highly siliceous, sedimentary and pyroclastic formations are intercalated in granitoids and appear in the form of rather narrow but very thick synclines.

The geomorphologic aspect (KING, 1958 ; MILLOT, 1980) is outlined by a vast succession of alteration and denudation surfaces which grade from an altitude of 70 to 2000 m, adapted to large tectonic blocks or modified by the effects of faults and fractures.

Deposits features exist only in narrow alluvial channels along the main rivers : the Orenoque flowing towards the north, the Guainia or Rio Negro flowing towards the Amazon in the south and the Casiquiare which links these rivers together.

The evergreen dense forest covers almost the whole landscape except for the highly siliceous sites located in the rocky summits and in the low sandy plains. Here, typical shrub and herbaceous savannas grow. In the highlands, semi-deciduous open forests grow along with pyrophilous savannas. Apart from a few small urban centers, the Amazon Territory is inhabited only by a sparse community of itinerant farming and hunting people (COCCO, 1957). It has retained its natural integrity.

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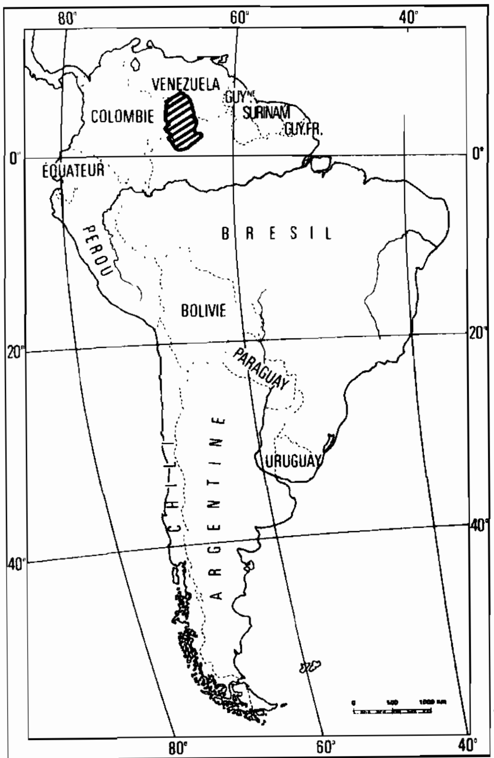
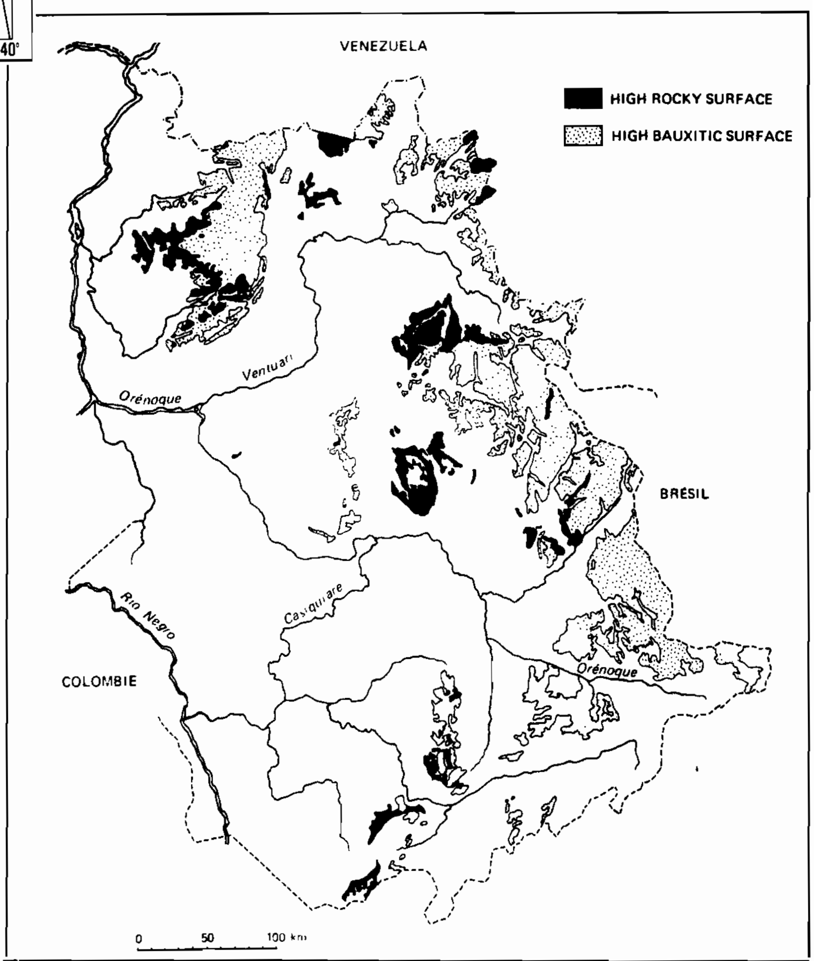


← Fig. 1 — Location of the Amazone Territory of Venezuela in South America.

Localisation du Territoire fédéral Amazonas dans l'Amérique du Sud.

Fig. 2 — The high bauxitic surface spreads into a single block in the eastern and northern part of the Territory above the large bend of the Orenoque river. It separates the Amazone basin in the south from the Llanos lowlands in the north. It is limited upstream by the tabular reliefs of the high rocky surface.

La haute surface bauxitique forme un grand panneau au Nord et à l'Est du Territoire Amazonas, dominant la boucle du haut Orénoque. Elle sépare le bassin de l'Amazone au Sud, de la dépression des Llanos au Nord. Elle est limitée en amont par les témoins de la haute surface rocheuse.



II — THE HIGH BAUXITIC SURFACE

1. A vast landscape up to 900 m altitude with scarped edges

The old surface still spreads into a single block in the eastern and northern part of the Territory (fig. 2). It forms an extensive crescent 500 km long and 100 km wide above the large bend of the upper Orenoque river and separates the Amazon basin in the south from the Llanos lowlands in the north. A few planation remnants are distributed along the western edge of the crystalline mountain ranges.

According to the altitude, it is limited upstream by the outliers of the high rocky surface which are either quartzitic (Roraima) reliefs or granitic ones (granites and granophyres) with table forms (DUBROEUCQ, 1986), and downstream by the upper polyconvex surface which displays its vast rolling landscapes with high and steep hills.

The high bauxitic surface is clearly limited by edges which separate it from the lower polyconvex surfaces. These edges correspond to the fracture trends of the basement. They are steep scarps with relief of 350 to 600 m whose upper part displays rocky flanks and whose lower part shows a weathered pediment (Pl. I, 1). These alterated materials suggest rock falls due to scarp retreat. In other cases, the edges are composed of stepped blocks with general slope gradient from 1 to 1.3 % dissected by a parallel valley pattern with thick alterations on slopes and crests and resulting from tilting and faulting observed on the edge of the graben.

2. A specific landform

The mean altitude ranges from 1000 to 1400 m and the general slope gradient of the crest lines varies from 0.1 to 0.5 %. The junction between the bauxitic surface and the rocky surface was observed locally (Upper Rio Ocamo) in long hardened lateritic slopes. Elsewhere, the relief (Pl. I, 2) is composed of clusters of hills of 80 to 120 m high with steep sides (20 to 50 %). They show an asymmetric section of polyhedric form composed of two or three successive linear units.

The different topographic sections which have been observed show that each side of the hills is composed of a regular succession of two linear units cut by erosion scarps. The slope gradient of these linear units amounts respectively to about 10 % and 20 % (fig. 3). A theoretical landscape without any erosion cut can be observed by drawing out the lower linear units of the hill and connecting it to that of the next hill in the topographic sections. This landscape represents theoretically the primitive landform. It is composed of successive dihedral crests (Pl. I, 3) with mean slopes of 10 % connected by long concavo-linear glacis with gradients of 20 % upslope, of 5 % midslope and of 2 % downslope. The whole section is 600 to 900 m long. The existence of bauxitic fragments of a few kilometers long displaying an inverted relief (altitudes 1075 m, 1200 m and 1475 m) confirms this interpretation. They appear as hardened basins with concave relief and curvilinear river networks, clearly evidenced through the Radar-Slar imagery (Pl. I, 6).

3. A dense river network

The river network is dense with a drainage line every 500 m on an average. It cuts the surface into small V-shaped valleys along natural diaclases and fractures. It displays a typical herring-bone pattern composed of parallel linear axes connecting the main drainage line with a angular pattern (Pl. I, 5).

4. A thick lithomarge

The lithomarge covers the whole surface except for a few elongated rocky summits of about some 100 m higher than the general landscape and for the boulders reaching a few meters and appearing in the valley bottoms. The bed rock appears in the valleys over larger surfaces as the bauxitic sueface displays highly scarped and eroded features (fig. 6). The strongly eroded type of the bauxitic surface occurs on the edge of the mountain range and close to the frontier with the lower polyconvex landforms.

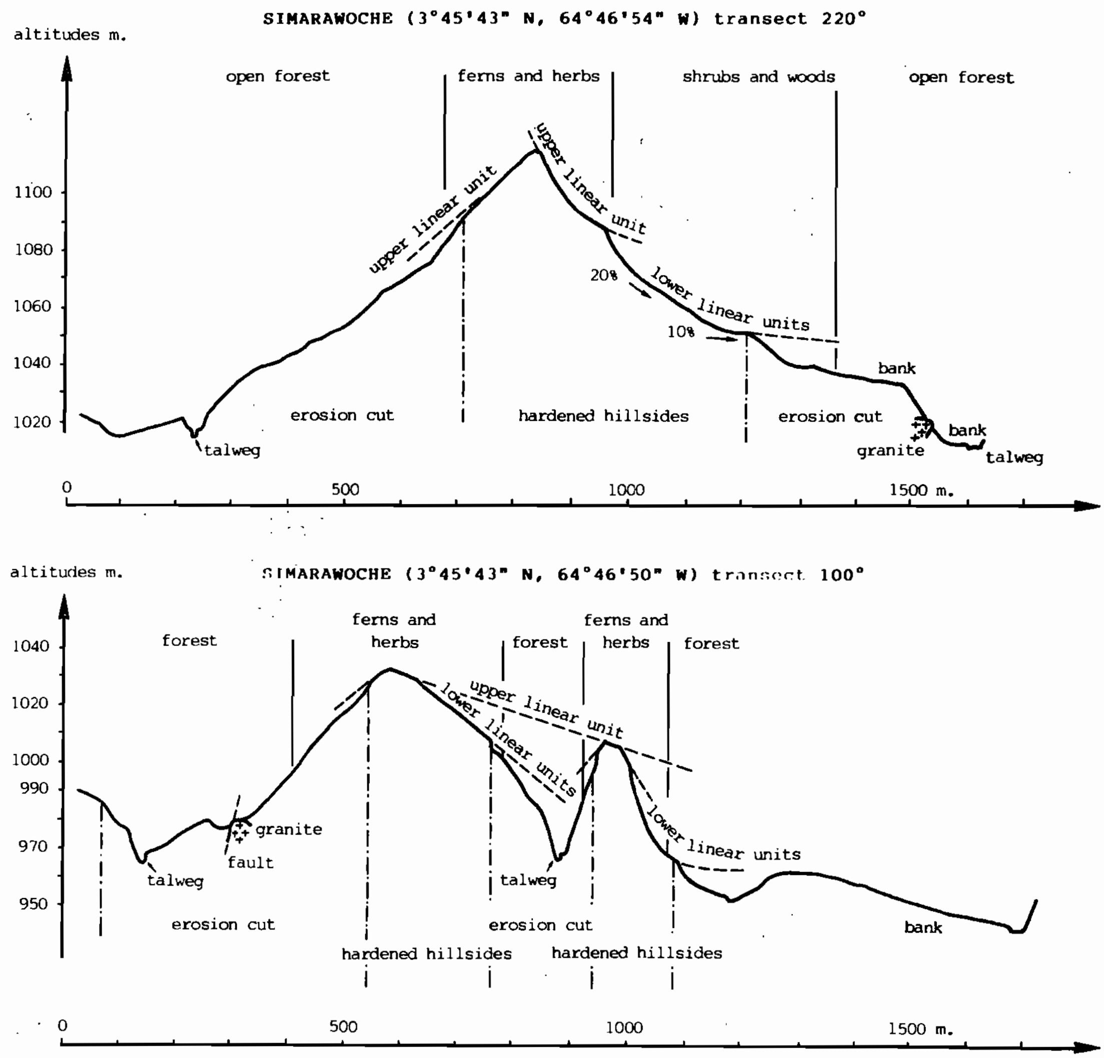


Fig. 3 — The various topographic sections of the elementary relief units show that each side of the hill is composed of a regular succession of two linear units cut by erosion scarps.
The lower linear units present a concavo-linear section with aspect of glacis.
Les différentes coupes topographiques des unités de relief montrent que chaque versant de colline est composé d'une succession constante de deux segments topographiques coupés par des entailles.
Le segment inférieur présente une section concavo-linéaire à aspect de glacis.

An 8 m deep drill hole shows from bottom to top : a clayey mottled saprolite ; up to 5 m, a red oxic horizon very friable with micro-aggregates (soft powdery oxides) ; up to 3 m, a massive bauxitic hardpan of intermediate hardness dismantled into blocks in its upper part ; from 0.5 to 0.3 m, a yellow gravelly oxic horizon with very fine granular structure ; and on the surface, an umbric crumbled horizon rich in organic matter (fig. 5).

5. The mineralogical composition of the bauxitic mantle

The mineralogical composition is qualitatively constant in most of the mantle : much gibbsite and quartz, few iron oxides (Al-goethite and rare hematite), a little boehmite and kaolinite. Downslope in the erosional scarps, near the weathering front (topographically at 60 m below the hardpan surface) an increase of kaolinite, a non-substituted goethite, no more boehmite and traces of weatherable minerals (micas) are observed.

The soft soil texture is mainly clayey with about 45 % total quartz. But the mineralogical clay content is less than 6 % of the total soil and the fine particle size lower than 2 μm is essentially composed of Al-oxides.

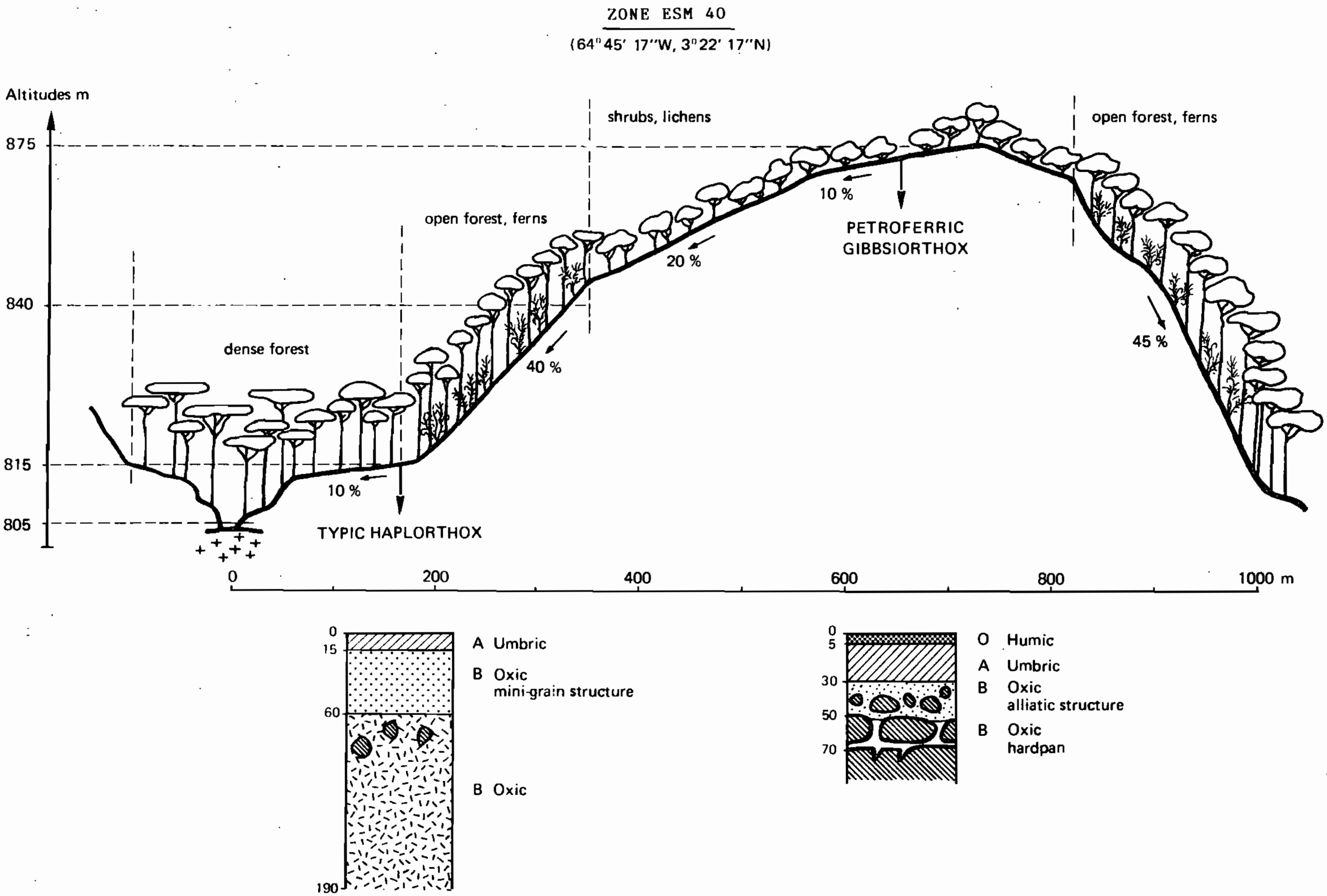


Fig. 4 — The reliefs present a soil distribution in two pedological sequences : the upper sequence corresponds to the hardened hillsides related to the old surface relicts ; the lower soil sequence corresponds to the V-shaped valleys originated during a late erosional episode.

Les reliefs offrent une répartition des sols selon deux séquences pédologiques : la séquence amont correspond aux versants indurés qui sont les témoins de la vieille surface, la séquence aval correspond aux vallées en V creusées lors d'un cycle d'érosion ultérieur.

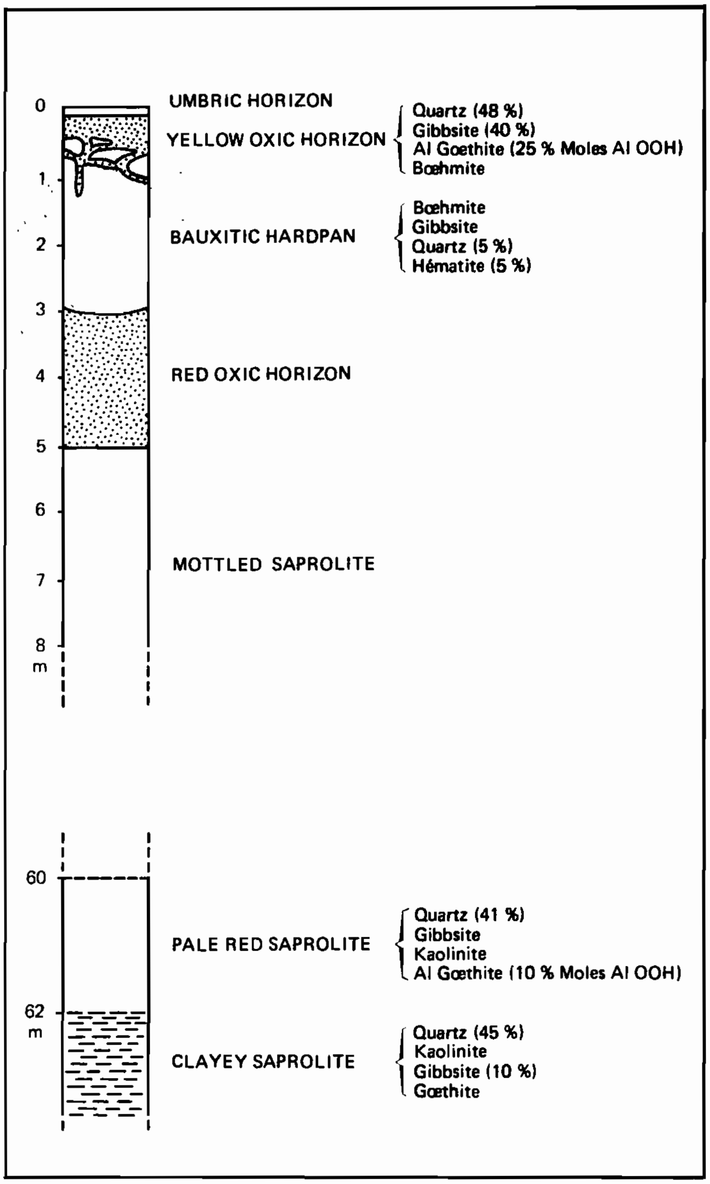


Fig. 5 — The soil profiles of the ESM 40 zone give some data about the mineralogical composition of the weathering mantle : gibbsite predominates associated with Al-goethite and boethmite, kaolinite is important near the weathering front, the hardpan shows small quantities of hematite and a loss of quartz in relation to the soft material.

Les profils de sol de la zone ESM 40 fournissent des données concernant la minéralogie du manteau d'altération : la gibbsite prédomine associée à la goethite-Al et à la boehmite, la kaolinite est en quantités importantes à proximité du front d'altération, la cuirasse montre de faibles teneurs en hématite et une perte relative en quartz par rapport au matériau meuble.

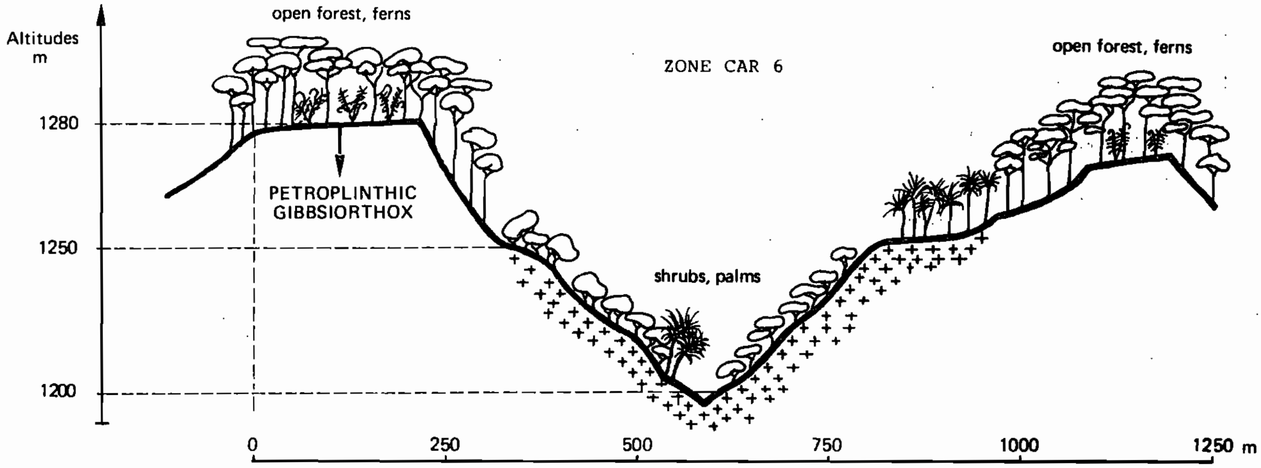
In the soil profiles of the ESM 40 zone (fig. 4) the mineralogical composition of the surface layer and the bottom layer of the bauxitic mantle is as follows.

In the oxic horizon above the hardpan :

quartz = 48 %
gibbsite (including 5 to 10 % boehmite) = 40 %
Al-goethite (rate 25 % moles AlOOH) = 5.2 %
kaolinite = 5.3 %
TiO_2 = 0.77 %
hematite = traces

In the hardpan fragments :

gibbsite (including 15 to 20 % boehmite) = 80 %
quartz = 10 %
hematite = 5 %
Al-goethite = 3 %
kaolinite = 2 %



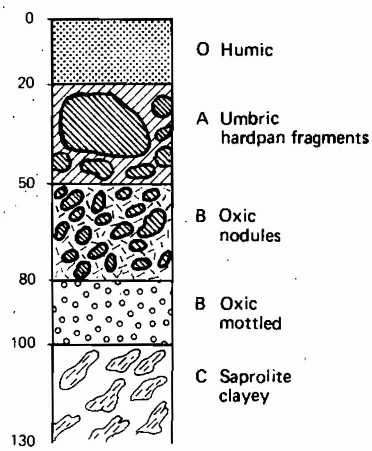


Fig. 6 — In the more tectonized zones, the erosion cuts are entirely scarped in the bedrock and the bauxitic mantle is limited to remnants covering the summits.

Dans les régions les plus fracturées, les entailles d'érosion sont entièrement creusées dans la roche et le manteau bauxitique très érodé se limite à des témoins couvrant les sommets.

At the bottom of the bauxitic mantle in the pale rose saprolite :

quartz = 41.15 %
gibbsite (including 5 % boehmite) = 20 %
kaolinite = 33 %
Al-goethite (rate 10 % moles AlOOH) = 5 %
TiO_2 = 0.54 %
hematite = traces

Near the weathering front, in the clayey saprolite :

quartz = 45 %
kaolinite = 40 %
gibbsite = 10 %
goethite (non substituted) = 3 %
TiO_2 = 0.2 %
hematite and micas = traces

The main mineralogical characteristic of the old bauxitic mantle is the predominance of gibbsite in the whole material except in the bottom layer of the saprolite, and a loss of quartz in the hardpan in relation to the soft material. The iron oxides are essentially aluminous goethite. Hematite only appears in the hardpan with approximately 5 % of total soil content.

The bauxitic hardpan fragments (Pl. I, 4) show no superficial cortex and no internal oxidic cutanes. They are composed of three different materials distinguished from field observation :

1. fine white nodules = pure gibbsite,

2. a pale red dense hardened matrix = gibbsite (85 %), hematite (5 %), very fine quartz (10 %)
3. a soft yellow material = gibbsite (50 %), kaolinite (5 %), quartz (40 %), Al-goethite (5 %).

The microscope observation confirms the close resemblance between the soft yellow material and an oxic horizon (micro-aggregated plasma, corroded quartz grains) (MULLER, 1977), and shows evident aspects of quartz dissolution (crossed dissolution cracks and quartz fragmentation) occurring both in the soft yellow material and in the pale red hardened matrix.

6. Soil sequence with low lateral variation

Pedological segments (CHATELIN, 1978) are closely superimposed on the topographic section of the hill with its talweg. Two soil sequences are generally observed on the side of the relief. They are separated by a hardened step and limited down-slope by two banks. The first soil sequence corresponds to the two upper topographic linear units of the hill section. It shows only petroferric gibbsiorthox, namely a highly unsaturated ferrallitic soil with bauxitic hardpan. The second soil sequence corresponds to the V-shaped valley which generally displays steep slopes (fig. 4). Upstream, it shows a rather similar soil type but more gravelly than hardened : petroplinthic gibbsiorthox. Downstream, it shows a plinthic paleudult (claypoor and mottled ferrallitic soil). The upper bank shows a typic or tropeptic haplorthox (modal or rejuvenated ferrallitic soil), and the lower bank shows a yellow tropeptic haplorthox (rejuvenated ferrallitic soil). No recent alluvions appear.

7. A characteristic predominant soil

The petroferric gibbsiorthox covers 70 % of the surface without any significant variations at the scale of the landscape unit under study :

- *O humic horizon* : under forest or ferns, not found under savanna, 5 to 35 cm thick, blackish, fibrous at the top, small-size aggregates at the bottom, moder horizon aspect ;
- *Al umbric horizon* : 10 to 35 cm thick, dark reddish, 5 to 10 YR 2-3/2-3, clay sandy, fine grained and friable structure, frequent charcoal (savannas), no evidence of runoff ;
- *B oxic gravelly horizon* : 25 to 40 cm thick, red 2.5 to 5 YR 3-4/6-8, clayey, finely polyhedric or micro-aggregated structure, irregular nodules originating from the underlying hardpan ;
- *B hardened oxic horizon* : hardpan, 0.5 to 1 m thick, massive 7.5 YR 5/8, with red (10 R 5/8) or yellow volumes and whitish nodules (gibbsite), intermediate hardness, porous, likely to outcrop in separate blocks of size about one meter, existence of a bleached cortex (gibbsite) of size about one centimeter on the exposed blocks ;
- *B oxic horizon* : about one meter thick, red (5 YR 5/8), clayey with flakes of gibbsite, fine polyhedric structure, transition into mottled saprolite at the bottom. Except for induration, this horizon is similar to the hardpan.

8. A stable soil mantle

Unlike most lateritic weathering profiles subjected to geochemical transformation and pedogenetic evolution (TARDY and NAHON, 1985), the high bauxitic surface gives an example of a stable soil mantle under humid climate in elevated topographic position. On the one hand, there is no evidence of the mineral transformation of the allitic material, no cortex on the gravels, no ferrans in the pore walls of the hardpan, no voids or tubules with similar orientation ; on the other hand, there is no evidence of any barrier in the internal soil drainage and of any predominant lateral water circulation, both agents of erosion of the soil mantle (BLANCANEAUX, 1985) : no clay-poor and bleached A horizons, no compact B horizons, no runoff, no fallen trees in the forest areas. Nevertheless, the plinthic paleudult soils found downstream in the second pedological unit show argillans and traces of eluviation in the A horizons.

Moreover, evidence of a slow destruction by linear erosion and slide of soft material is given in different aspects : denudation of hardened soil surfaces, banquettes like soil slip mounds, detachment notches on the steepest slopes, bare rock exposed at the foot of the hills.

9. Various landforms related to the degree of erosion

The above mentioned description can be applied to two thirds of the surface and corresponds to blocks covered with continuous allitic material. In the more tectonized zones (Parguaza mountain), a river network flows in the faults and fractures, leading to an accentuated fragmentation of the bauxitic surface (fig. 6). Therefore, the effects of erosion are more intense and the bauxitic mantle is limited to remnants covering the summits. The erosional cuts are entirely scarped in the granitic rock devoid of its soil mantle. They form an orthogonal pattern due to the tectonic trends. They are about 100 to 150 m deep.

Along small grabens, some tilted blocks are carved by a « comb-shaped » pattern of rectilinear and parallel valleys which open on the lower polyconvex surfaces. The crests are bare rocks upstream and hardened laterite downstream of the blocks. These valleys display a peculiar banded pattern which gives evidence of an intense scarp retreat erosion system developed into flat and non fractured granitic blocks. For example, one can mention a « comb-shaped » pattern of valleys 200 m deep, 20 km long and 1.5 km apart.

Finally, in the case of more alkaline rock (Surucucu, granites, granomonzonites) found along the Brasilian border to the east (RADAMBRAZIL, 1976), the hills are higher (about 250 m) and steep. The upper pedological unit of hardened soils is spatially limited and the cut shows tropeptic haplorthox (rejuvenated ferrallitic soils) together with boulders in process of weathering.

10. Physiographic comparisons with other similar surfaces

Some information about landform, topographic measurements and soil profiles has been documented from the old planation surfaces in the Gondwana continents by various authors (GRANDIN, 1976 ; MELFI *et al.*, 1981 ; MELFI and CARVALHO, 1983 ; MARTIN, 1970 ; BOURGEAT and PETIT, 1969 ; BOURGEAT, 1972). In the Guaiana shield, the high bauxitic surface of Venezuela displays by geographic continuity the same relative situation as the pre-Tertiary « old surface » of Guaiana (McCONNELL, 1962), although various bauxite deposits may occur in other planation levels in this part of the Gondwana continent (ALEVA, 1981). In Madagascar, the « level 1 » supposed to be of terminal Cretaceous age (BOURGEAT, 1972), shows similar physiographic characteristics : prominent altitudes, ferrallitic soils, flat hardened surfaces along extended slopes, deep river network (50 m) in a herring-bone pattern. But its landform differs by the aspect of the relief in plateaus with slope gradients lower than 12 % and not in polyhedric reliefs. The same holds true for the Adamaoua plateau in Cameroon (1200 - 1300 m) supposed to be of late Cretaceous age and therefore post-Gondwanian (MARTIN, 1970) and showing softer and more deeply allitic ferrallitic soils. Nevertheless, near its scarped edges, are found upon hills (150 m high) reworked and hardened soils more similar to the Venezuelian bauxitic ones. Therefore, the high bauxitic surface of the Amazon Territory would be part of that pre-Tertiary geomorphic entity (GAVAUD et al., 1986) with more pronounced effects of alternating linear erosion and hardening, except in some preserved areas where the original landform appears typically with flats interfluves and curvilinear river pattern.

CONCLUSION

An exploratory soil mapping based mainly on the morphological data of the landfom analysed through the Radar-Slar imagery and then measured in the field (POUYLLAU, 1982) and on the soil data obtained by the soil sequences characteristic of the various topographic units of the landscape, results in the reconstruction of a large regional entity (land-region) called high bauxitic surface.

It corresponds to one of the steps in the general grading of the landscapes described in the Amazon Territory of Venezuela (GAVAUD et al., 1986) and observed on most old continents (KING, 1976), and due to a common history of the continental crust and climates since the Mesozoic age (BECKMAN, 1985).

Under the present conditions, the high bauxitic surface supposed to be of terminal Cretaceous age shows specific landform and soil mantle. This mantle follows its proper evolutive process and presents its proper mineralogical composition which is not found in other older or younger planation surfaces.

It is inherited from a long weathering and erosional episode with specific humid climatic conditions leading to gibbsite neoformation and stability.

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Planche I

1 — The old surface is limited by steep edges which show slides of weathered material due to scarp retreat (center right in the photo).
La vieille surface est limitée par des escarpements qui évoluent sous l'effet des éboulements de l'altérite dus à l'érosion régressive (centre droit de la photo).

2 — The bauxitic surface relief is composed of clusters of hills 80 to 120 m high, with hardened sides covered with shrubs and ferns.
Le relief de la surface bauxitique se compose de groupes de collines de 80 à 120 m de hauteur, dont les versants indurés sont couverts d'une végétation de fougères et d'arbustes.

3 — Some preserved zones of the bauxitic surface display the original aspect of the relief : successive dihedral crests connected by long concavo-glacis.
Quelques zones préservées de la surface bauxitique montrent l'aspect primitif du relief : des successions de crêtes en forme de dièdre reliées par de longs glacis concavo-linéaires.

4 — The bauxitic hardpan fragments show no superficial cortex and no internal oxidic cutanes. They display a pale rose dense hardened matrix with white gibbsitic nodules and a soft yellow material filling the voids and the channels.
Les fragments de cuirasse bauxitique ne présentent ni cortex superficiel ni revêtements d'oxydes liés aux vides internes. Ils montrent une matrice indurée rose pâle contenant des nodules gibbsitiques blancs, et un matériau oxique jaune friable emplissant les pores et les cavités.

5 — In the eroded landform-type of the bauxitic surface, the typ al herring-bone river network is clearly visible on the Radar-Slar imagery.
Le réseau de drainage caractéristique en arête de poisson est nettement visible sur les images Radar-Slar d'un type de surface bauxitique à relief érodé.

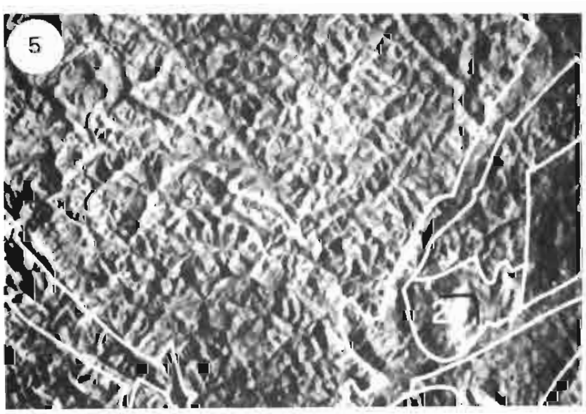
6 — In the preserved landforms of the bauxitic surface, the flat glacis and the curved dendritic river network are clearly visible on the Radar-Slar imagery.
Le réseau de drainage curvi-linéaire et les glacis aplanis sont nettement visibles sur les images Radar-Slar des types de surface bauxitique à modelé conservé.


1


2


3


4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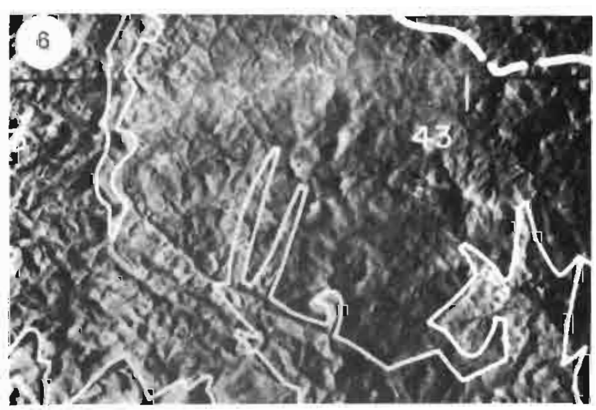
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