

SUMMIT LEVELS, BEDROCK CONTROL AND THE ETCHPLAIN CONCEPT IN THE BASEMENT OF SURINAME¹

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ABSTRACT

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A comparison between summit levels distinguished by various authors in the basement of Suriname, photogeological landscape units, lithological information from the new geological map and LANDSAT imagery shows that many summit levels coincide with photogeological and lithological units in the lowlands that form the main part of the basement. Steps that separate summit levels of different altitude commonly are also lithological discontinuities. Such steps might originate under humid climatic conditions as jumps in the weathering front due to differential chemical weathering of contrasting rock types. The steps are exposed at the surface during periods of semi-arid conditions under savanna vegetation by stripping of the saprolite. In this etchplain model, summit levels at different heights do not differ essentially in age but only in resistance of underlying rocks to deep weathering. Only those levels that are protected by means of duricrusts against further surface lowering, or that were exhumed as domed inselbergs survived several cycles of etching and stripping.

INTRODUCTION

Major landforms in the rainforest-covered interior of Suriname, underlain essentially by Precambrian igneous and metamorphic rocks of the Guiana Shield, have been looked upon in two different ways. (1) In terms of the concept of *cyclic denudation* (KING, 1964, ZONNEVELD, 1969). On the base of topographical maps summit levels have been recognized at different altitudes, separated from each others by scarps or 'steps'. These features have been explained by these authors by a cyclic alternation of periods with planational processes accompanied by parallel slope retreat, with periods of dissection. Planation levels usually are held to bevel different geological formations (KING, 1964; ZONNEVELD, 1969, 1982; DE BOER, 1972). (2) In terms of (photogeological) *landscapes* (O'HERNE, 1969a, b). O'HERNE (1969a) defines a landscape according to VAN DER EIJK (1957) as 'an area which as result of its specific geological origin, morphologically forms a unit,

characterized by a special rock formation and a variation in soil conditions and vegetation typical of the area'. O'HERNE adds: 'In a strongly weathered and densely forested country like Suriname, a landscape is characterized mainly by its particular vegetation. Similar landscapes usually show similar rocks or rock associations'. O'HERNE produced a geomorphological map, later renamed photogeological map, of the whole interior of Suriname, based on detailed analysis of aerial photographs. He distinguishes 54 different landscapes grouped according to the major lithological units; major escarpments, steps or other discontinuities are mapped as lithological contacts and/or tectonic lineaments. O'HERNE refrains from forwarding hypotheses as to the morphogenesis of these landscapes, because of the limited information available at that time about the geology of the basement.

Although both concepts have been used next to each other in many publications dealing with the morphology of the Surinam basement, there is a clear controversy between them as to the role played by lithological differences. In the first concept, planation surfaces bevel different lithological formations and scarps originate by parallel slope retreat; in the second concept scarps mark lithological contacts. The present paper aims to come nearer to a solution to this problem, now that knowledge of the interior has greatly increased by (1) the

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completion of a new geological map 1:500000 (GEOLOGICAL & MINING SERVICE: 1977; BOSMA ET AL., 1977, 1983; DE VLETTER in prep.); (2) the forthcoming publication of a new landform and soil map at 1:200000 of a large part of the northern half of the interior (MELITZ. in prep.); (3) the availability of LANDSAT imagery of parts of the interior.

OUTLINE OF THE GEOLOGY

In the Surinam basement three metamorphic belts have been distinguished: (1) the Falawatra Group in northwestern Suriname, consisting of charnockitic granulites mainly; (2) the Coeroeni Group in southwestern Suriname, consisting of various types of gneisses, and (3) the Marowijne Group, a typical greenstone belt consisting of low-grade metamorphic basic and intermediate volcanics and sediments (Paramaka Formation), metagreywackes, phyllites and schists (Armina Formation) and coarse volcanoclastic metasandstones and metaconglomerates (Rosebel Formation). These metamorphic belts are separated from each other by a huge granitoid complex which is associated with migmatitic gneisses in the east, and with acid metavolcanics in the western part of the country. Small intrusions of gabbroic of ultramafic rocks (De Goeje Gabbro) occurring throughout the country are included in the granitoid complex. All these rocks formed during the Trans-Amazonian Orogeny some 2000-1870 million years ago. The Trans-Amazonian rocks are unconformably overlain by unmetamorphosed sandstones and conglomerates of the Roraima Formation, equally of Precambrian age. The basement is intersected by dolerite dykes, of which the thicker ones are generally of Precambrian age (Avanavero Dolerite), and the narrower ones of Permo-Triassic age (Apatoe Dolerite).

These crystalline rocks occupy the southern 80% of the country. Towards the coast they disappear below a cover of Cenozoic sediments. Outcropping sediments in the coastal area are the bauxite-covered Paleocene-Eocene sands and clays of the Onverdacht Formation, the Pliocene fluvial sands of the Upper Coesewijne Formation, the Pleistocene coastal sediments of the Coropina Formation and the Holocene coastal sediments of the Demerara Formation. Older formations have been found in both onshore and offshore drillings. Further details can be found in BOSMA ET AL. (1977, 1983) and DE VLETTER (in prep.).

OUTLINE OF THE MORPHOLOGY (see Fig. 1)

Mountains in central and southern Suriname (over 300 m)

The highest top of the Surinam interior is the Juliana Top (1280 m) in the Wilhelmina Mountains, in central Suriname. These mountains, just as the Eilerts de Haan, Käyser and

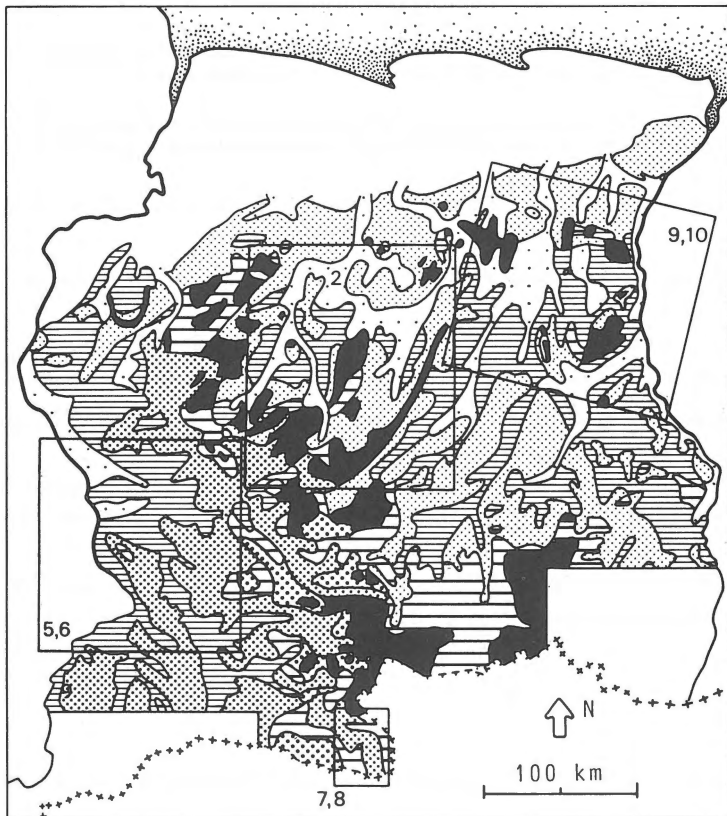
Oranje Mountains in southern Suriname consist mainly of granitoid, and to a lesser extent, acid metavolcanic rocks. They protrude abruptly from the surrounding lowlands, and show a rugged morphology with steeply incised valleys, and a drainage pattern strongly influenced by lineaments of the basement (Fig. 2). The outlines of these mountain complexes commonly seem to be related to tectonic features. Correlation between basement lithology and landforms is poor, except for the positive expression of remnants of a former Roraima sandstone cover within the Wilhelmina Mountains and larger Precambrian dolerite dykes (VERHOFSTAD, 1969, 1970). Many summits in these mountains are bare inselbergs, sometimes with corestones on top of them, at altitudes commonly between 700 and 1000 m. Outside these mountainous areas domed inselbergs occur scattered throughout the granitic lowlands in the country.





The Tafelberg (1026 m) a westward sloping plateau remnant occupies a special position, as it represents the downfaulted remnant of a once extensive cover of Roraima sandstones on top of the crystalline basement (Fig. 2). The base of the sequence of 700 m thick is situated at about 300 m, and is marked by a Precambrian paleosol developed in granites (KROONENBERG, 1978) which thence represents the oldest fossil groundsurface identified in Suriname.

Mountains in northern and eastern Suriname

The highest elevations in northern and eastern Suriname are of an entirely different character. They are all laterite- or bauxite-capped plateaus which commonly reach 500-650 m. Among the most prominent ones are the Nassau Mountains (500-550 m), Lely Mountains (600-650 m), Browns Mountain (500 m), Brokolonko Mountains (500 m) and Bakhuis Mountains (400-450 m) (see review by ALEVA, 1979). Most plateaus have developed on metamorphic rocks; those of northeastern, southeastern and northern Suriname on basic metavolcanics of the Paramaka Formation, those in the Bakhuis Mountains on charnockitic granulites; high-quality bauxite have formed especially on anorthosites in the latter area (KROOK & DE ROEVER, 1975; ALEVA, 1983). The Bemau Top (Saramacca river) and the De Goeje Mountains plateau in southeastern Suriname have been formed on ultramafic and gabbro intrusions related to the granitoid complex (De Goeje Gabbro).

Moreover there are a great number of steep elongate ridges with summits between 400-700 m, which only locally have flat plateau-like surfaces but all carry laterites on top. These ridges correspond with thick Precambrian dolerite dykes (Avanavero Dolerite). Conspicuous examples are the Van Asch van Wijck Mountains (Fig. 2), the horseshoe-shaped mountains in the Dalbana Creek area, the Emma Range, Ebba Top, and many others. Narrower dolerite dykes, both Precambrian and Permo-Triassic ones and De Goeje Gabbro intrusions also stand out above the surrounding lowlands and have laterite covers, but they do not reach altitudes higher than 150-300 m as a rule.



-  Level 6
-  Level 5
-  } Level 4a
-  }

-  Level 4b
-  Level 3
-  Mountains



Fig. 2
 LANDSAT image (band 7) of the central part of Suriname. W – Wilhelmina Mountains; T – Table Mountain; E – Emma Range; A – Van Asch van Wijck Mountains; B – Bakhuis Mountains; C – Coppename River; S – Saramacca River.

Fig. 1
 Summit levels in the Suriname lowlands, after ZONNEVELD. (1982). Numbered boxes refer to figures in the text.

The lowlands

By far the greater part of the basement of Suriname is occupied by extensive lowlands, which rise from about 60 m in the north to about 250-300 m in the extreme south of the country. The mountains described above generally protrude from them with abrupt escarpments. The lowlands do not have a perfect flat surface, but they are dissected by small creeks into 'a monotonous mosaic of equal-sized five- or six-sided hills' in the words of STAHEL & GEUSKES (1940) who first flew over the country. Incision depth is commonly in the order of magnitude of 10-50 m. Within the lowlands smaller escarpments are visible, in the order of magnitude of 20-50 m, themselves equally dissected, separating levels of slightly differing altitude. Locally thin lateritic covers occur, depending upon rock type: rare on granites and gneisses, common on Marowijne Group (especially Paramaka Formation) metamorphic rocks (see also MAAS, 1977). Corestones and low bare outcrops (ruwares) are commonly found in areas underlain by granites but are only occasionally visible from the air because of the vegetation canopy.

Weathering depths are in the order of magnitude of 10-50 m, depending upon rock type and position in the landscape. The larger rivers only locally succeeded in reaching the weathering front; where they meet fresh bedrock, extensive rapids (sulas) developed (ZONNEVELD, 1972). Drainage often shows rectangular patterns suggesting bedrock control.

Quartz gravel terraces are locally found along the larger rivers, mainly in central and eastern Suriname (BAKKER, 1968; DE BOER, 1972; BALSEM ET AL. 1979).

SUMMIT LEVELS

At the request of the Geological and Mining Service of Suriname KING (1964) made an analysis of Surinam landforms on the base of topographical maps at scale 1:100000. In his internal report and accompanying map, KING distinguished three different summit levels, which formed the starting point for geomorphological research in Suriname. The highest level is formed by the bauxite- or laterite-capped plateaus at 500-600 m, which was termed Early Tertiary level. Below this level, scarce remnants of a Late Tertiary I surface occur at around 300-350 m, whereas the extensive lowlands of the Surinam interior were designated Late Tertiary II level. Similar summit levels were described in the neighbouring countries by McCONNELL (1966), BERRANGÉ (1975) and CHOUBERT (1957). KING (1964) assumed intermittent uplift to be responsible for the cyclic development of Surinam morphology. In his model, uplift would lead to incision, while during a subsequent period of tectonic quiescence the valley slopes formed during dissection retreated parallel to themselves, thus creating pediments at their foot (KING, 1953).

KROOK (1970, 1979) advocates a model which is much more controlled by climatic change. Periods with arid or semi-arid

climatic conditions, partly coinciding with glacials give rise to the development of savannah vegetation, as evidenced also by palynological data (WIJNSTRA & VAN DER HAMMEN, 1966). These circumstances lead to stripping of saprolite cover from the bedrock, formation of pediments by sheet wash, and transport of coarse-grained sediments by braided rivers to the sea. Humid periods, partly coinciding with interglacials, give rise to the return of the rain forest, leading to progressive deep chemical weathering and vertical dissection of planation levels, and only little supply of sediment to the coastal area. By studying correlative deposits in the coastal area and the continental shelf, KROOK (1979) established a more detailed chronology of the morphological development as related to climatic changes. The summit levels recognized in Suriname and their equivalents in neighbouring countries are listed in Table I (taken from KROOK, 1979).

Whereas KING (1964) did not subdivide the Late Tertiary II level, ZONNEVELD (1969) concluded from topographical profiles constructed perpendicular to the main rivers, that several steps can be recognized within the lowlands. In this way he came to a subdivision into 5 additional levels; his map is reproduced here as figure 1.

ZONNEVELD (1969) discusses three possible origins of the minor steps detected in the lowlands: (1) a stepped peneplain concept comparable to that of KING (1964), (2) a 'steady state' concept in which summit levels are controlled exclusively by drainage density and degree of depth erosion, and hence bear no relation to any planational processes, and (3) control by different resistance of specific rock types. He adopts a modified version of the first model (see also ZONNEVELD, 1982), in which tectonically induced knickpoints in the river longitudinal profile form the starting points for a wave of parallel slope retreat, spreading successively outwards from the river channel. This would occur under climatic conditions comparable to those of East-Africa at present. This process was largely brought to an end by Quaternary dissection caused by the spreading of rain forest vegetation. In this way a combination of tectonic and climatic factors are held to be responsible.

Detailed mapping in several areas in the lowlands (RIEZEBOS, 1979; KIPS & SNEL, 1979 and others) confirmed the presence of several steps, separating summit levels of different altitude. In these studies the steps are considered to be due essentially to parallel slope retreat, and to bear little relation to lithological contacts. Some key areas will be discussed below.

DISCUSSION OF SOME KEY AREAS

1. *Coeroeni-Lucie area*

In a sequel to his 1969 paper, ZONNEVELD (1982) shows a longitudinal and a transversal profile across the Lucie River drainage basin. These have been reproduced here as figure 3 and figure 4. Several summit levels are distinguished, which partly would be related to knickpoints in the river.

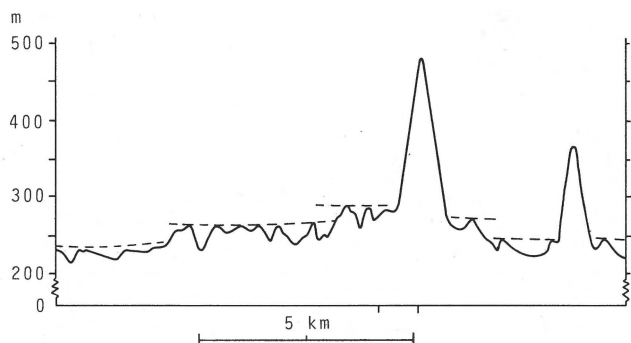


Fig. 3
Summit levels in a topographical profile across the Lucie River Basin after ZONNEVELD (1982).

On the other hand, ELSINGA (1966, 1972) made a detailed photo-geological analysis of the area between the Lucie and Coeroeni rivers, in which he distinguishes 14 different landscapes, of which the most important are the Gt and Gk landscapes in the western part, and the Gw landscapes in the eastern part of the area. Supported by limited field and petrographical data he correlates the Gw landscapes with granitoid and volcanic rocks, and the Gt and Gk landscapes with heterogeneous granitic and gneissic rocks. During detailed field and petrographic study of the area (KROONBERG, 1976) the validity of ELSINGA's contact was not only confirmed, but it was also possible to conclude on the base of the petrographic symbol maps that within the western area, occupied by the Coeroeni Group, the Gt landscape correspond to quartzofeldspathic gneisses, and the Gk landscape to sillimanite-muscovite-biotite gneisses and related rocks (see Fig. 6). Even on the LANDSAT image both landscapes are clearly individualized (Fig. 5).

These landscapes are not only distinct in drainage pattern and degree of dissection, but also in altitude. The granitoid-volcanic landscapes in the east, and north of the Lucie River, define a summit level sloping from 270 m in the east to 230 m in the west; the landscapes in sillimanite-muscovite-biotite gneisses a level from 210-170 m, and the quartzofeldspathic

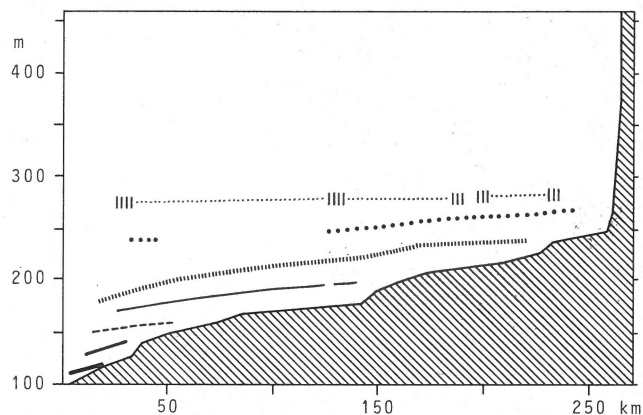


Fig. 4
Summit levels above the longitudinal profile of the Lucie River, after ZONNEVELD (1982).

gneisses a level from 190 to about 140 m. These levels can be compared directly with ZONNEVELD's summit levels in figure 3, and comparison with his small scale summit level map (Fig. 1) indicates that these levels correspond to his 4a, 5 and 6 levels, respectively, both in their altitude and in their extension on the map.

2. The Sipaliwini area

This area in the extreme south of the country is of special interest as it is the only savannah area of some extent in the interior. It consists essentially of granites and acid to intermediate metavolcanic rocks similar to those in the eastern part of the Coeroeni-Lucie area (MAAS & VAN DER LINGEN, 1975). A detailed geomorphological and soil study of the area was made by RIEZEBOS (1979). This author distinguishes three main summit levels on the basis of topographical profiles and photoanalysis. Comparison with the geological map (Figs. 7 and 8) shows that the higher level I between 360 and 320 m is essentially underlain by granitoid rocks, the intermediate level II between 320 and 290 m by the acid metavolcanics.

Table I
Summit levels in Suriname and neighbouring countries, after KROOK (1979)

Suriname	Brazil	Guyana	French Guiana	Age		
King et al. 1964	Bigarella & Andrade, 1964	King. 1967	McConnell, 1966	Berrangé, 1975	Choubert, 1957	
		Gondwana		Kanuku (900 m)		Jurassic or older
E.T.S.	Pd-3	Post Gondwana	older bevels	Oronoque (270-300 m)	1e Pénéplain (525-550 m)	Lower Tertiary
L.T.-I	Pd-2	Sul-Americana	Kopinang (630-690 m)	Kuyuwini (225-255 m)	2e Pénéplain (300-370 m)	Oligo-Miocene
		Early Velhas	Kaieteur (390-450 m)		3e Pénéplain (210-260 m)	
L.T.-II	Pd-1	Late Velhas	Rupununi (100-150 m)	Rupununi (100-165 m)	4e Pénéplain (150-170 m)	Pliocene
Quaternary	P-2	Paraguaçu	Mazaruni	Mazaruni		Quaternary
Fluvial Cycle	P-1					

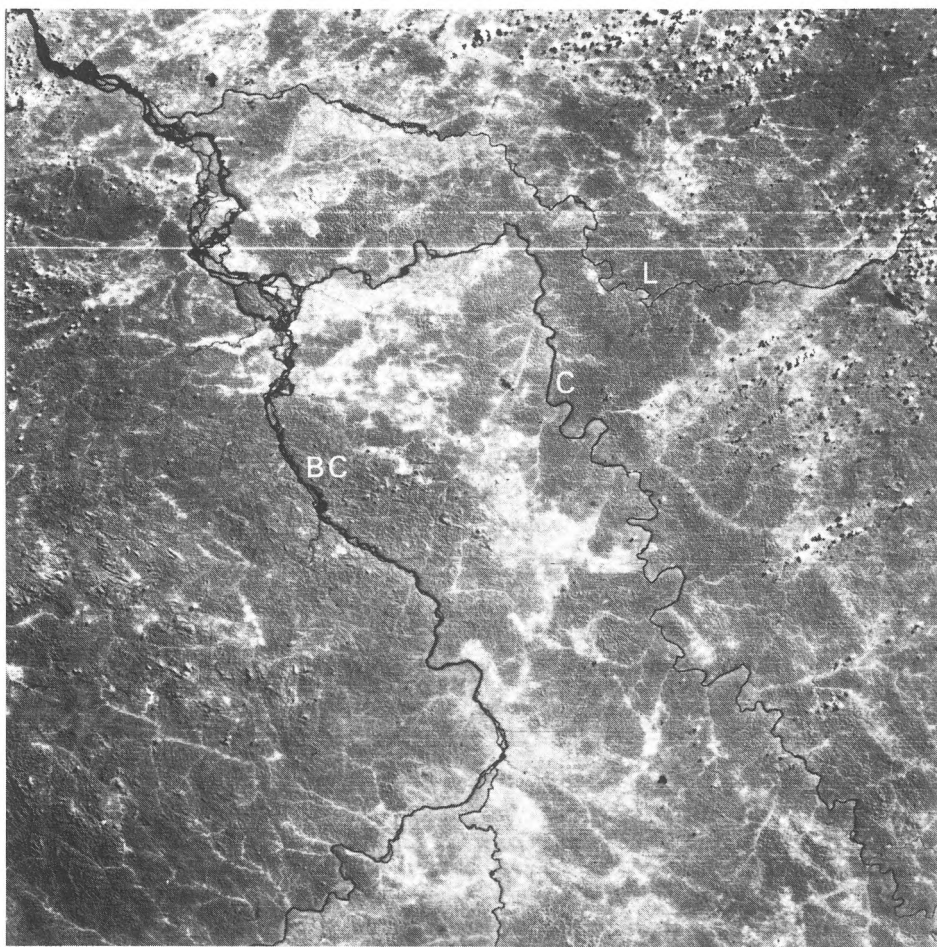


Fig. 5
 LANDSAT image (band 7) of the Coeroeni-Lucie area. C – Coeroeni River; L – Lucie River;
 BC – Boven-Corantijn River.

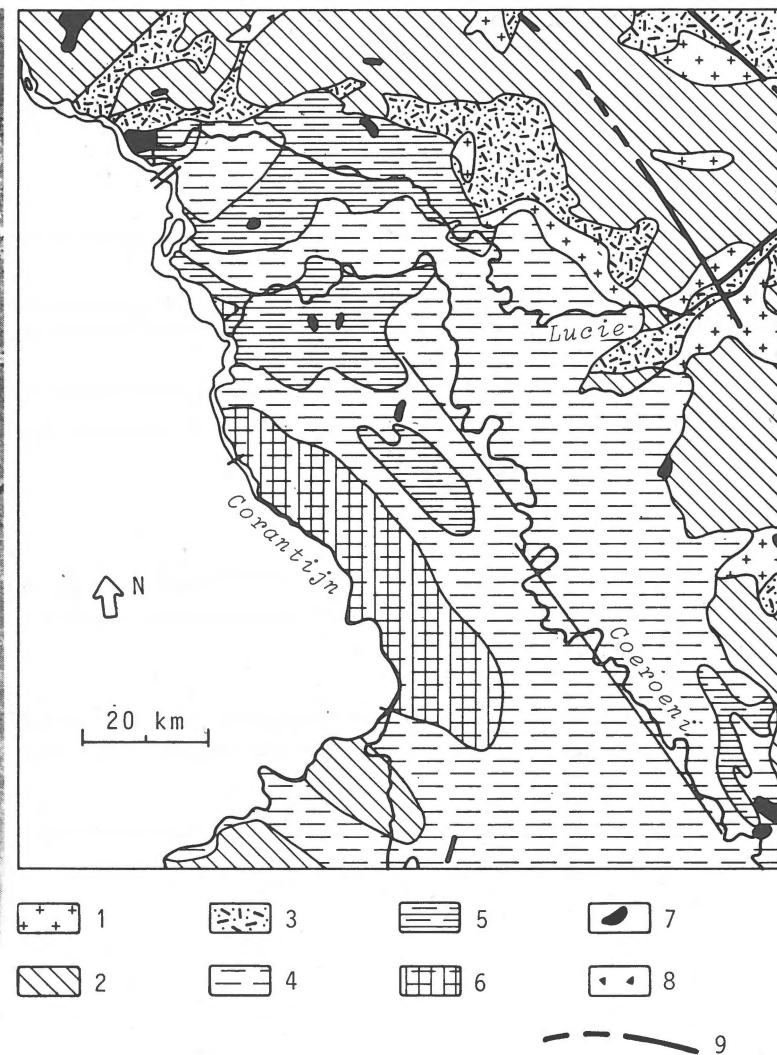


Fig. 6
 Geological map of the Coeroeni-Lucie area, same area as figure 5. After
 KROONENBERG (1976), BOSMA ET AL. (1983) and BERRANGÉ (1977) (southwestern
 part). 1 – Biotite granites; 2 – Fine grained granites and leucogranites; 3 – Acid
 to intermediate metavolcanic rocks; 4 – 5 – 6: Coeroeni Group; 4 – Sillimanite-
 muscovite-biotite gneisses mainly; 5 – Quartzofeldspathic gneisses; 6 – Garnet-
 cordierite-sillimanite-biotite gneisses; 7 – De Goeje Gabbro; 8 – Avanavero
 Dolerite; 9 – Käyser Dolerite.

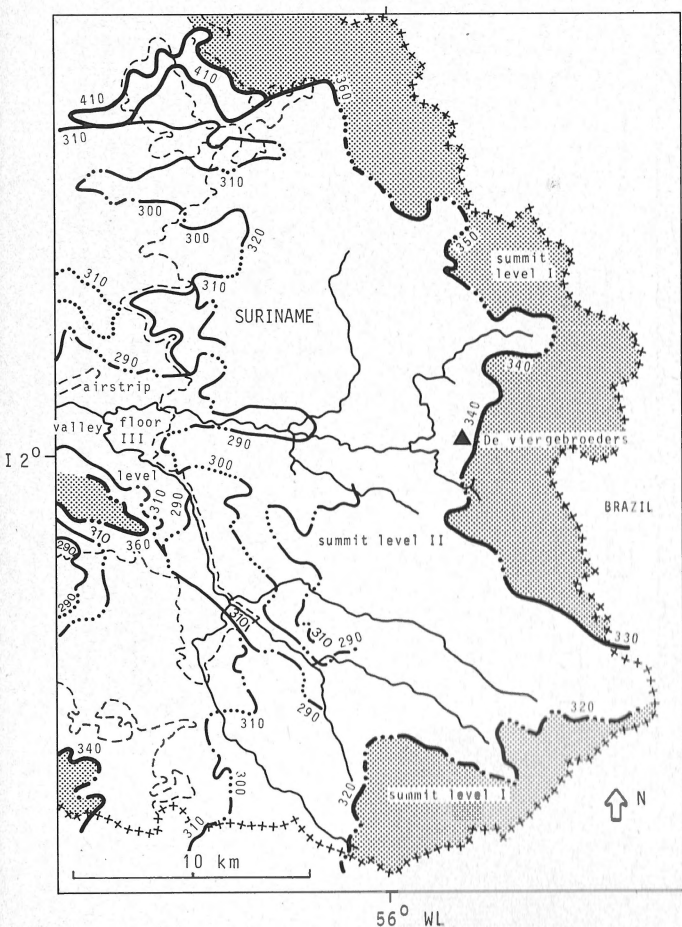


Fig. 7
Summit levels and steps in the Sipaliwini area, after RIEZEBOS. (1979). Heavy lines: steps between levels I and II, thin lines: steps between levels II and III. Broken lines indicate weakly developed steps.

Level III corresponds with the actual valley floors. This broad coincidence between summit levels and underlying lithology cannot be ignored in any explanation regarding their origin, the more so as a very similar relationship between granitic and acid metavolcanic morphology has been found in the rain-forest covered Zuidrivier area (MAIJER, 1969).

3. Northeastern Suriname

Although only limited fieldwork has been done in the northeast after the completion of O'HERNE'S (1969a, b) photogeological map, a reexamination of all rock samples and thin sections and their plotting on the map (BOSMA ET AL. 1977, 1983) reveals a good coincidence between lithology, the landscapes distinguished by O'HERNE, and the pattern of summit levels of figure 1. Even at a cursory inspection of the LANDSAT image of the area, the structural control of the morphology is clearly seen (Fig. 9, 10). Among the most prominent units to be noted are the bauxite plateaus and the rugged Brokolonko landscapes

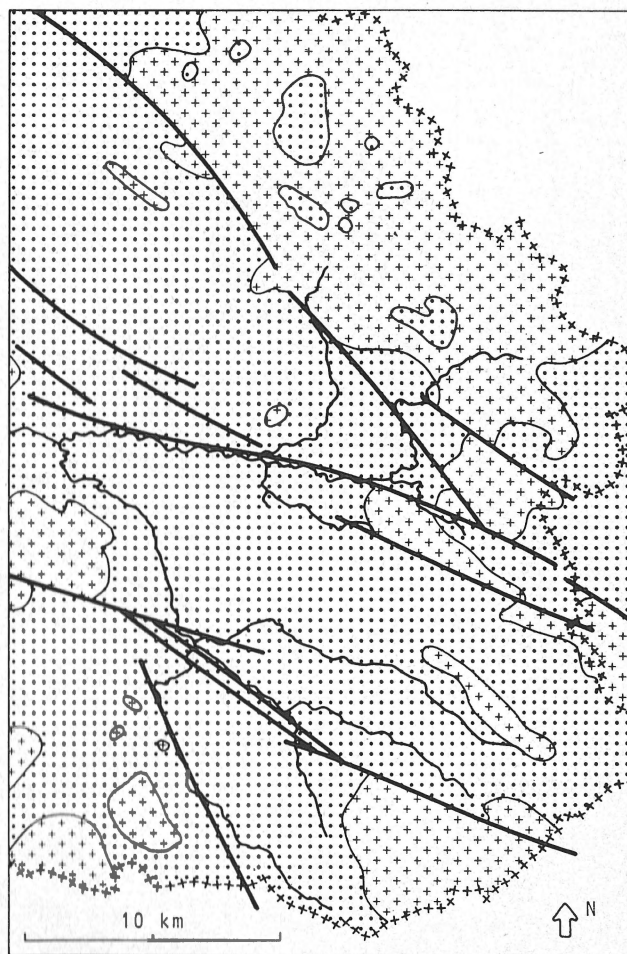


Fig. 8
Geological map of the Sipaliwini area, simplified after MAAS & VAN DER LINGEN (1975). Crosses: granitoid rocks; dots: acid to intermediate metavolcanic rocks.

underlain by Paramaka basic metavolcanics. The strongly dissected summit level at 100 m above sea level of the Tempati landscape is underlain by Armina Formation metagreywackes and phyllites, and the dark-toned subdued Sabanpasi landscapes with occasional ridges of more resistant rocks are underlain by Rosebel Formation coarse clastic rocks. The wide oval basins at 50-60 m above sea level visible in the LANDSAT image correspond with diapiric intrusions of tonalite. The escarpment of these lowlands against the higher reliefs of the metamorphic rocks delicately follows the lithological contacts. Slightly higher-grade metamorphic amphibolites of the Paramaka Formation along the contacts with the tonalites southeast of the storage lake form several prominent ridges which stand out conspicuously in the morphology. The large storage lake visible in the LANDSAT image also occupies such a tonalite basin; the dam has been constructed in the gap where the Suriname River breaches the step at the contact of the Paramaka metavolcanics with the tonalites.

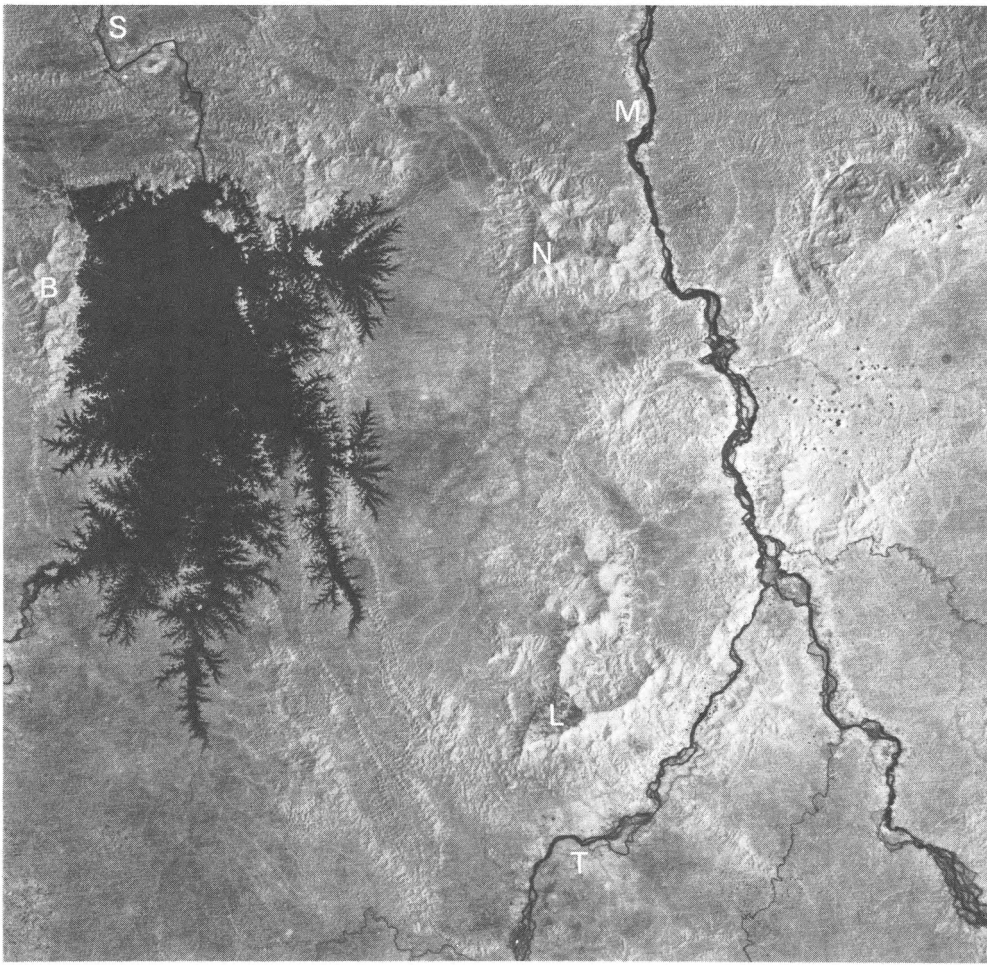


Fig. 9
 LANDSAT image of northeastern Suriname (band 7). M – Marowijne River; T – Tapanahony River; S – Suriname River; B – Browns Mountain; N – Nassau Mountains; L – Lely Mountains.

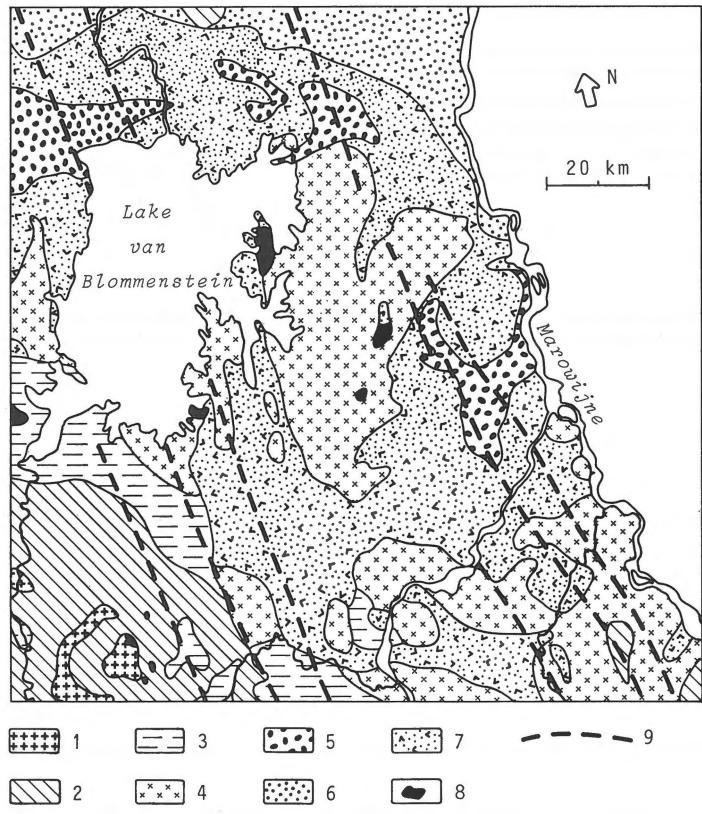


Fig. 10
 Geological map of northeastern Suriname, after BOSMA ET AL. (1983). 1 – Pyroxene granites; 2 – Biotite granites; 3 – Migmatitic gneisses; 4 – Tonalites; 5 – Rosebel Formation; 6 – Armina Formation; 7 – Paramaka Formation; 8 – De Goeje Gabbro; 9 – Apatoe Dolerite.

4. *Saramacca-Suriname area*

On behalf of the completion of the landform and soil map of the Surinam interior between the 4th and 5th parallel (MELITZ, in prep.), detailed geomorphological and soil studies of several areas between the Saramacca and Suriname rivers were made by a joint team of the Soil Survey Institute at Paramaribo and the Free University of Amsterdam (BOOTSMAN & DERCKSEN, 1977; RHEBERGEN & BALSEM, 1979; KIPS & SNEL, 1979; DE FRETES & VAN DER GAAUW, 1982). The results of the three first mapping campaigns have been compiled on a landform and soil map scale 1:200000 (BALSEM ET AL., 1979). These authors distinguished mountains up to 700 m, bornhardts of 100-300 m, planation surfaces at 100, 50 and 30 and river terraces at 15 and 5 m above the river level. Their data show that there is a good correspondence between the landform units distinguished in the higher levels, O'HERNE'S (1969a, b) photogeological landscape units, and the lithological units derived from the new geological map. The mountains correspond with Avanavero Dolerite dykes and Paramaka basic metavolcanics. Within the 100 m level, landscapes in fine-grained biotite granites, Paramaka amphibolites and narrow dolerite dykes could be mapped separately. The 30 and 50 m levels cannot be easily related to lithological differences. These levels are underlain in the north by tonalites similar to those of northeastern Suriname, passing through a migmatitic zone into more homogeneous biotite granites in the south. No unanimity exists among the various authors (BOOTSMAN & DERCKSEN, 1977; RHEBERGEN & BALSEM, 1979; KIPS & SNEL, 1979) about the validity of those levels as they distinguish respectively one, none and two levels between 15 and 50 m above the river level. Apparently the irregularity of summit altitudes makes a distinction of summit levels difficult in this area.

The river terraces are the only landform units that closely follow the present drainage pattern in the Saramacca-Suriname area.

DEEP CHEMICAL WEATHERING

The discussion of the key areas has shown that lithological control plays a much more important role in the occurrence of the summit levels and the steps in the lowlands than hitherto assumed. As most lithological boundaries in Suriname are steep to subvertical, the morphogenetic processes that led to their expression must have acted preponderantly in a vertical sense as well. The most powerful means of vertical differentiation between rock types in tropical lowlands is deep chemical weathering.

Saprolite depths are known for different rock types mainly as a result of diamond drilling for mineral exploration. A compilation of data until 1965 by O'HERNE (1966) shows that saprolite thicknesses in granitoid rocks rarely exceed 15-20 m. Seismic survey and diamond drilling along the Bakhuis railroad reveals an average depth of 10 m (BRGM, 1972; KROONEN-

BERG, 1975). On deviating rock types such as cordierite diorites and pyroxene granites greater depths up to 45 m have been reached (KROONENBERG, 1977). Gneisses show saprolite depths of 20-40 m, basic-ultrabasic De Goeje-type rocks 15-35 m, metabasalts (greenstones) 10-35 m, phyllites, meta-greywackes and quartz-sericite schists commonly reach 40-70 m depth (O'HERNE, 1966). However, these data have to be considered with caution in geomorphological analysis, as often the position of the drill holes in the landscape has not been taken into account, and many holes were drilled through laterite or bauxite caps. A qualitative confirmation of great weathering depths in Coeroeni-Group gneisses and Marowijne Group low-grade metamorphic rocks is the fact that even in vigorously dissected areas rock outcrops are much scarcer than in areas underlain by other rock types. A similar observation was made in the Coppename area by KROOK (pers. comm.).

Extreme saprolite depths of over 200 m have been reached in the Muri Mountains alkaline complex, in the southwest of the country, on top of a presumed carbonatite body (BARRON, 1981). Nevertheless, the area is a prominent hilltop because of a protective laterite cover.

The fact that ruwares, tors and domed inselbergs are essentially restricted to areas underlain by granitoid rocks, suggests that the weathering front in these rocks is much more irregular than in other rock types, probably because joint spacing is a more important control in determining weathering depth than the weatherability of the rock itself.

ORIGIN OF THE STEPS AND SUMMIT LEVELS

The worldwide Late Cenozoic climatic changes led in the Amazonian area to an alternation of humid periods, during which tropical rainforest could prosper, and semi-arid periods in which savanna vegetation prevailed and rainforest was restricted to a number of refugia. This appears from palynological evidence (WIJSTRA & VAN DER HAMMEN, 1966; VAN DER HAMMEN, 1974), phytogeographical and zoogeographical studies (HOOGMOED, 1979; PRANCE, 1978), and sedimentological and morphological data (e.g. BAKKER, 1968, 1970; KROOK, 1970, 1979).

Assuming that indeed differential chemical weathering during humid climatic conditions can give rise to subsurface steps in the weathering front at lithological boundaries, stripping of the saprolite covers under semi-arid climatic conditions would lead to the exposure of such steps. Minor irregularities in the weathering front may subsist as pockets of saprolite between exhumed outcrops. Major irregularities such as to be expected in terrains underlain by granites will give rise to irregular topography which is not easily accommodated within a single summit level. This may be the reason why summit levels seem much better expressed in metamorphic terrains such as the Coeroeni-Lucie area and northeastern Suriname, than in granitic terrains such as the Saramacca-

Suriname area.

At the return of the rainforest in a following humid period, renewed deep chemical weathering would lead to enlargement of the height differences at the steps. In such a way a repetition of humid and arid climatic conditions would give rise to the development of several summit levels which do not differ essentially in age but only in resistance of the underlying rocks to deep weathering. In this way downwearing by differential deep chemical weathering would be more important than parallel slope retreat (cf. Fig. 11). The model can be adequately described as alternate etching and stripping, and therefore the lowlands of the Surinam interior might be compared with an etchplain in the sense of THOMAS (1974) and earlier authors. However, whether this hypothesis should be regarded as an alternative or merely as complementary to existing theories about planation processes in Suriname remains to be investigated.

The mountains that protrude above the lowlands have been excluded from lowering by deep weathering and stripping in two ways (Fig. 11). The laterite and bauxite caps of the Early Tertiary level of northern Suriname protect the underlying rocks against stripping since their formation in the Eocene-Oligocene. Degradation of the high plateaus takes place by

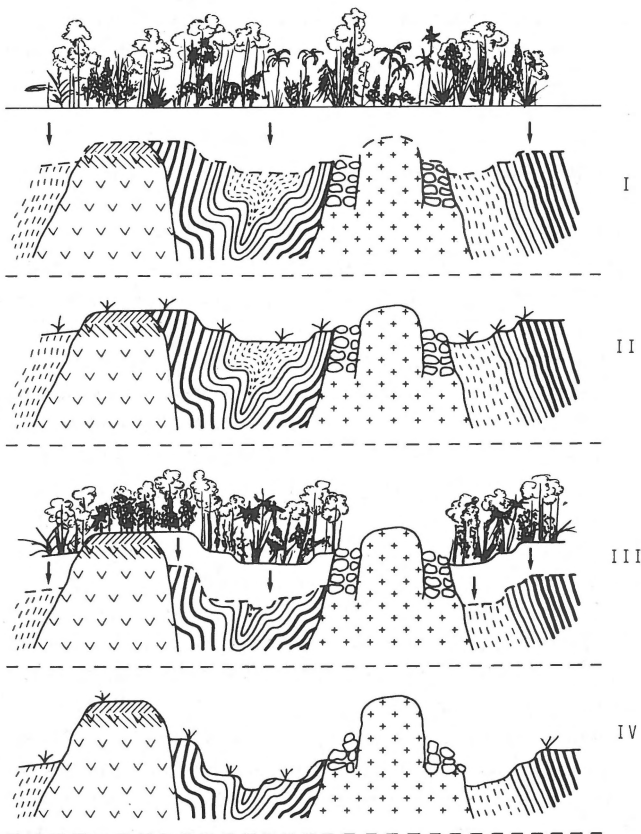


Fig. 11
Schematic model of the development of summit levels by differential etching and stripping.

dissection, undercutting and parallel slope retreat. The pediments that form at their foot essentially form the Late Tertiary I level, and often are lateritized or bauxitized themselves. Laterite caps developed at lower altitudes on a variety of basic rock types are equally excluded from further surface lowering. In the second place, bare domed inselbergs are no longer attacked by deep chemical weathering, and are progressively exhumed during each cycle of etching and stripping in their surroundings. In this model, as outlined by THOMAS (1974) and others, both laterite plateaus and granitic inselbergs come to stand out above the etch plain.

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