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EROSION SURFACES OF CENTRAL AFRICAN INTERIOR HIGH PLATEAUS

BY

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ECA - INÉAC Soil Mission
Belgian Congo.

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VOIR SUITE PAGE 3 DE LA COUVERTURE

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ABSTRACT

In contrast to the recognition by previous workers of three peneplains, end-Tertiary, mid-Tertiary, and Jurassic-Cretaceous, in the Ituri District, Belgian Congo, one major erosion surface, the end-Tertiary (High Ituri Plateau), is recognized. The mid-Tertiary surface is identified as erosional remnants, each of only a few hectares in distribution, standing above the end-Tertiary surface. The Jurassic or Cretaceous surface of previous workers is non-existent.

Six Quaternary surfaces are identified. The upper four occur in stepped sequence normal to major drainages in watersheds cut below the end-Tertiary surface. The lower two are an alluvial terrace along and the present floodplain of the major drainages. The Low Ituri Plateau (in part the Bunia-Irumu Plain) that extends westward from the vicinity of the Albertine Rift Valley to the Congo Basin is probably a Quaternary erosion-surface complex and not end-Tertiary peneplain as previously recognized. Cutting of Quaternary surfaces is related to upwarping and faulting caused by Albertine Rift Valley tectonic disturbances.

Similar surfaces of the Tertiary and Quaternary, some previously recognized, were observed in extensive occurrence east and west of and adjacent to the Albertine-Tanganyika Rift Valley in Uganda, Ruanda-Urundi, and the Kivu District, Belgian Congo.

INTRODUCTION

During the period June 1951 to August 1952, geomorphological studies were conducted on the central African interior high plateaus adjacent to and east and west of the Albertine-Tanganyika Rift Valley. Under the auspices of E.C.A. and INÉAC ([1]) semi-detailed and detailed field studies were completed in parts of Mahagi Territory, Ituri District, Belgian Congo, and reconnaissance studies were completed in parts of the Kibali-Ituri, Kivu, and Stanleyville Districts, Belgian Congo, in Uganda, and the Ruanda-Urundi.

The region of the reconnaissance extends from approximately 3° N to 4° S latitude and approximately 25° E to 35° E longitude. (See figure 1). The area of semi-detailed and detailed field studies is in the vicinity of Nioka-Ituri, Belgian Congo (30°40' E, 2°10' N). (See figure 2).

The writer wishes to express his appreciation to Mr F. JURION, Directeur général de l'INÉAC and other officers of INÉAC who made possible the geomorphological studies.

([1]) E.C.A. was the Economic Cooperation Administration (now Mutual Security Agency), United States of America. INÉAC is the Institut National pour l'Étude Agronomique du Congo Belge.

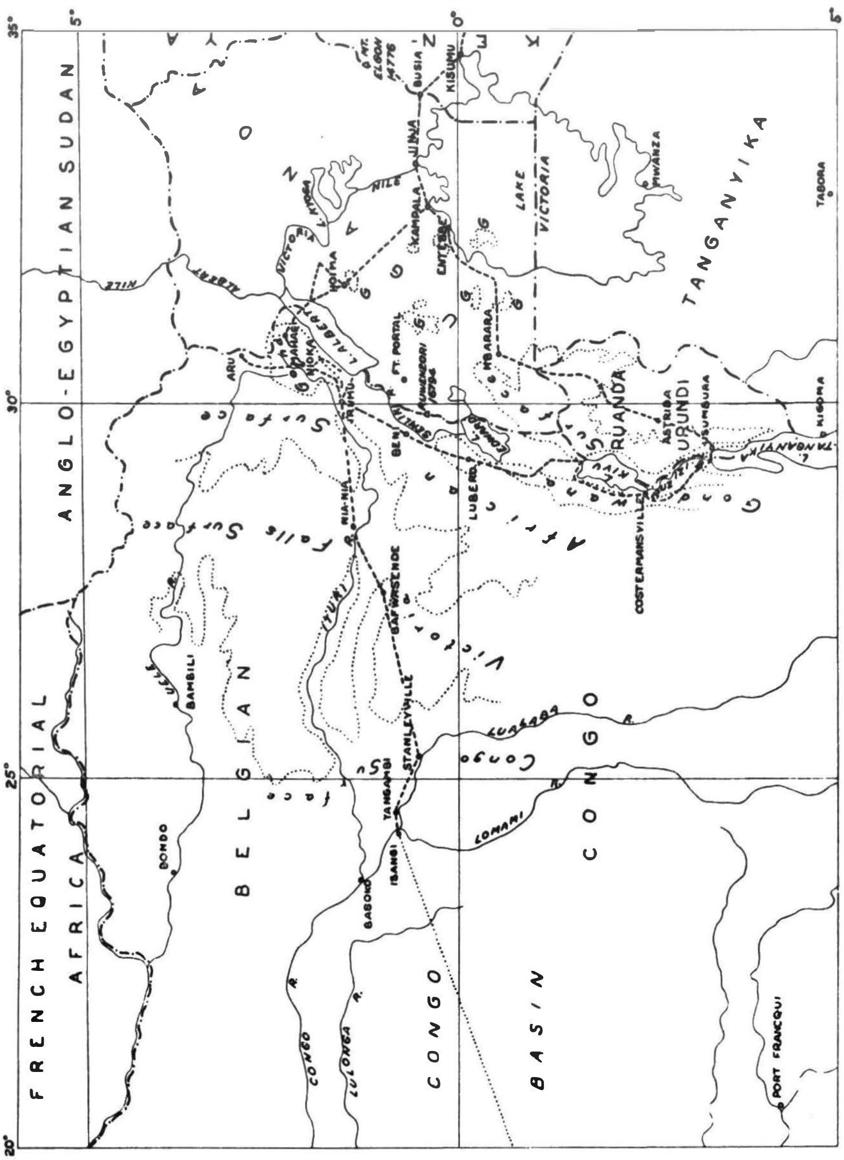

Figure 1. — Region of reconnaissance studies in Belgian Congo, Uganda, and Ruanda-Urundi. Broken lines indicate routes of reconnaissance and location of profile (A), plate I. Dotted lines indicate limits of « Congo », « Victoria Falls », « African », and « Gondwana » erosion surfaces of KING (1951) relative to present writer's reconnaissance.

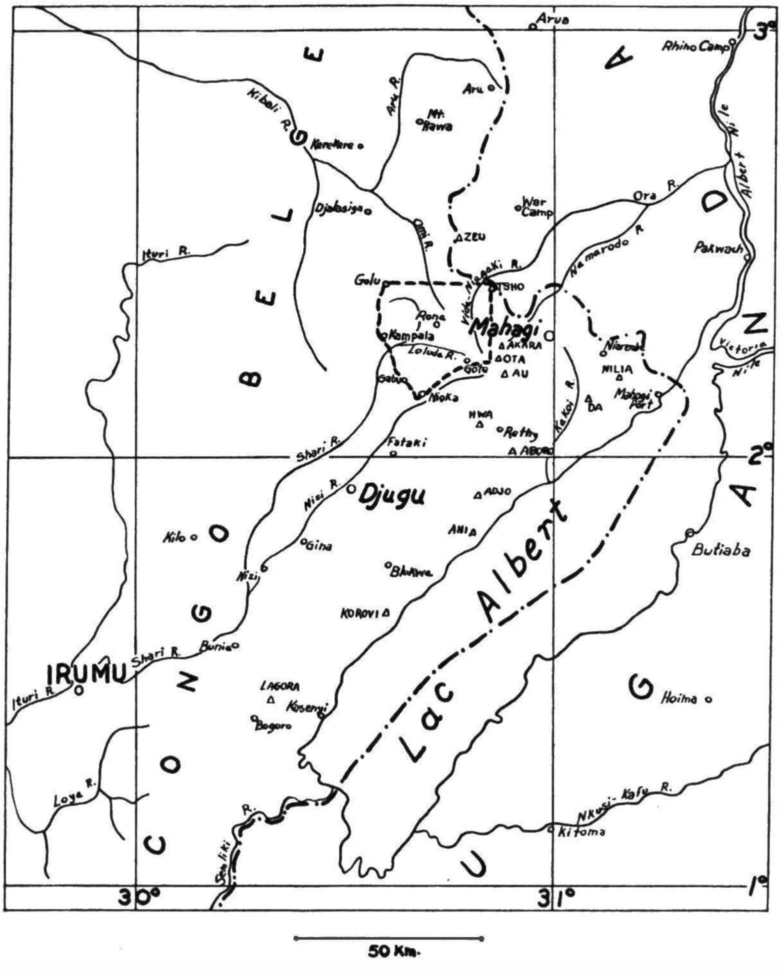

Figure 2. — Areas of reconnaissance, semi-detailed, and detailed studies, Ituri District, Belgian Congo.

PREVIOUS WORK

GEOGRAPHIC DISTRIBUTION OF MAJOR EROSION SURFACES

Although multiplicity of erosion surfaces has been recognized in central Africa, workers within the past two decades have demonstrated that most of the landforms can be referred to a relatively small number of major erosion surfaces. Some authors (e.g. DIXEY) maintain multiplicity as numerous as five whereas other writers (e.g. VEATCH) maintain a duality of surfaces. The following discussion synthesizes landscape interpretations of previous workers in the region of or regions adjoining that of the study of the present writer.

In Uganda, WAYLAND (18) identified three major surfaces, two of which are recognized today as the type « peneplains » of central Africa. Peneplain I (PI), the oldest surface, occurs extensively in Ankole District, southwestern Uganda and attains a maximum altitude of more than 6,000 feet above sea-level. Peneplain II (PII), the intermediate surface, for example occurs extensively in the Masaka and Mengo Districts, Uganda, and attains a maximum altitude of 4,300 to 4,400 feet. In the Kampala area Peneplain II forms the accordant summits of hills that stand above the general surface, Peneplain III (PIII), the youngest surface. Peneplain III, upon which Lakes Victoria and Kyoga rest, attains a maximum altitude of 3,700 to 4,000 feet above sea-level.

WAYLAND noted that Peneplain I differed from the other two in that «it has but local patches of lateritic ironstone upon its surface, while the lower erosion levels are characteristically blanketed by it». WAYLAND concluded that Peneplain I is probably a true peneplain formed during a long period of quiescence but that the erosion surfaces below it are etched platforms formed during periods of slow elevation ([1]).

([1]) Current interpretation of African landscape accepts PII and III as distinct erosion surfaces whereas PI as a separate and distinct surface is doubtful.

Willis (21, p. 31) in East Africa recognized only two major erosion surfaces : « A Miocene peneplain is our datum. There is a somewhat older Jurassic peneplain... but the later one alone is directly related to our study of African plateaus and rift valleys ». The surfaces of Willis probably are correlative of PII and PI of Wayland respectively. Apparently Willis did not recognize the surface PIII that Wayland considered Pliocene in age. Willis' work encompassed parts of Tanganyika, Ruanda-Urundi, Uganda, and Kenya.

Dixey (7) described three major surfaces in the vicinity of Kavirondo Gulf of Lake Victoria (Kisumu area, fig. 2). The high level peneplain was delineated at 6,200 feet or higher, the main peneplain (Miocene or Uganda) at 4,400 feet, and a Pliocene surface 500 feet below the Uganda surface ([1]). The high surface was dated as Jurassic or Cretaceous. Dixey noted that the main peneplain is represented throughout Uganda, near Kavirondo Gulf, along the east side of Lake Victoria into Tanganyika and extending into South Africa. The same author (8) identified three major surfaces in Tanganyika Territory and noted (p. 348) that many plateaus stand 2,000 - 3,000 feet above the main peneplain. In northwestern Tanganyika Territory, uplands at 7,000 feet were observed to be continuous with similar but more extensive uplands of Ruanda-Urundi. Apparently there is agreement between Willis and Dixey that in Ruanda-Urundi a Jurassic surface stands above the Miocene peneplain.

Dixey (9) identified five peneplains in the region of Mount Elgon (fig. 1) on the Uganda-Kenya frontier. Two surfaces, end- and mid-Tertiary, were recognized of major distribution. Other surfaces at 5,000, 6,200, and 10,000 feet were identifiable as remnants. Apparently in the Northern Frontier District, Kenya, it is a rarity when every flat summit is not raised to the status of a peneplain.

Shackleton (16) recognized three surfaces, Jurassic, Buganda (sub-Miocene) and end-Tertiary, in the vicinity of Kavirondo Gulf. However, the same writer (p. 378) pointed out that three surfaces identified by Dixey in the Elgon-Kitale-Kisiani-Kavirondo region are one and the same surface. Shackleton wisely stated :

([1]) The Uganda peneplain is known by various names : the mid-Tertiary peneplain, the Miocene peneplain, or the Buganda surface.

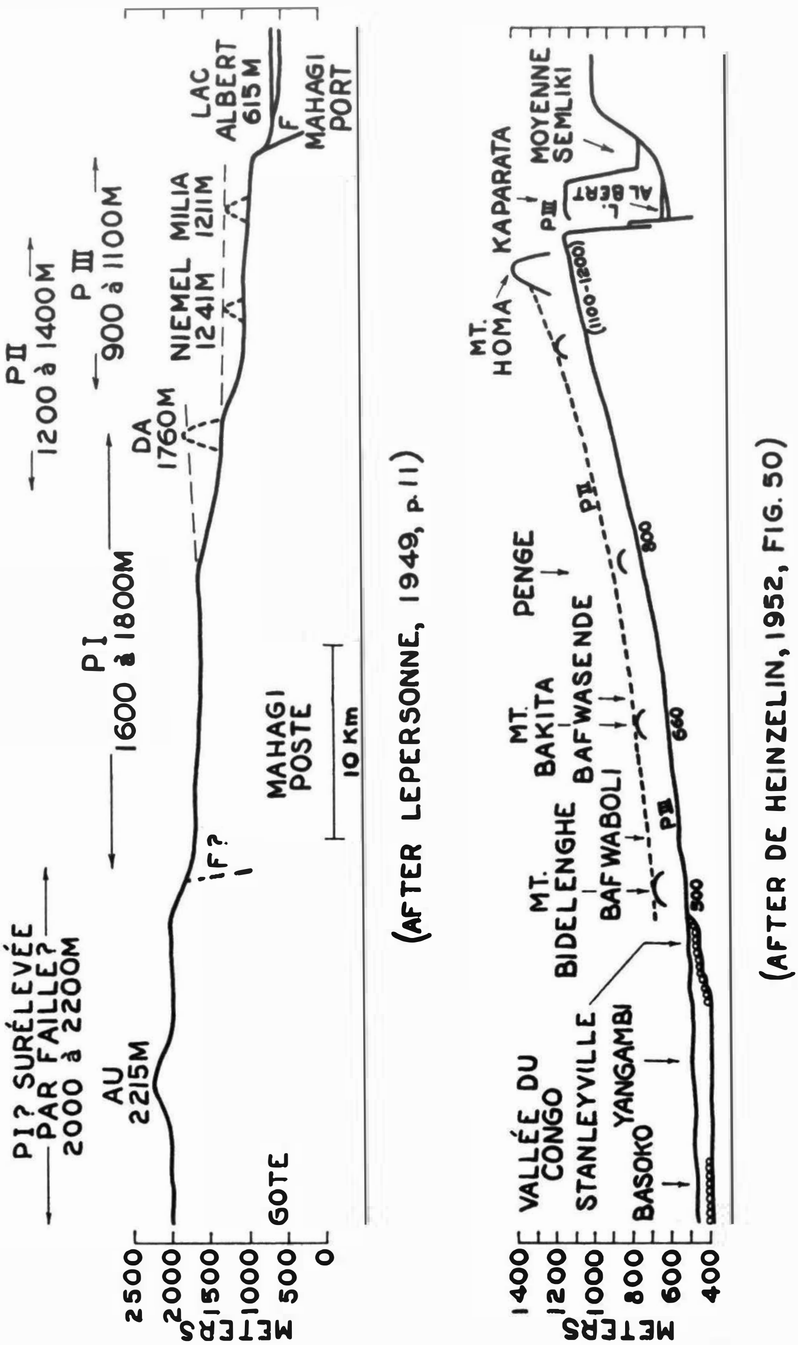

Figure 3. — Classification of erosion surfaces in the Ituri District, Belgian Congo, by LEPERSONNE (1949), and in the region Congo Basin-Ituri Plateau, by DE HEINZELIN (1952).

«...in these regions affected by the Rift Valley system of movements, the several surfaces cannot be specified or recognized by their elevation above sea-level. Either their continuity must be followed on the ground or they must be related to some datum such as the deposits of the shallow Miocene lakes... ».

KING (14) has summarized his many papers on African geomorphology. Of particular interest to the present study is the «Erosion Cycle Map of Central and South Africa». Two major surfaces are mapped throughout the region of the interior high plateaus, a «Gondwana» landscape, and a landscape of the «African» cycle of erosion. These two surfaces are apparently correlative in distribution of the mid- and end-Tertiary surfaces respectively of other investigators. Two younger surfaces, the «Victoria Falls», and the «Congo», were mapped also. Distribution of the surfaces of KING in the region of the present writer's study is shown in figure 1.

In the Belgian Congo, several geomorphological studies indicate the occurrence of the central African surfaces. VEATCH (17) observed in the Kasai-Lunda, Katanga, Kundulungu, and Kibiri regions two major erosion surfaces that were referred to the mid-Tertiary and end-Tertiary. Of particular interest is VEATCH's observation of the laterite and silicified cover of the mid-Tertiary surface and the breaching of that cover during end-Tertiary development.

LEPERSONNE (15) presented the results of his study of the region Albert-Semliki-Edward in the Ituri and Kivu Districts, Belgian Congo. In the area Gote-Mahagi Port, Mahagi Territory, three peneplains were identified that were correlated with the three surfaces of WAYLAND in Uganda. LEPERSONNE's interpretations are shown graphically in figure 3. The present writer is not in accord with the interpretation of LEPERSONNE.

DE HEINZELIN (6) recently reported on geomorphological studies in the north-oriental sector of the Congo Basin and projected his interpretations eastward to the Albert-Semliki rift region. The projection of DE HEINZELIN is shown graphically in figure 3. The present writer is not in accord with the interpretations of DE HEINZELIN along the projected traverse.

KING (12, p. 443) has pointed out the difference in concept of «actual» and «comparative» dates of development of erosion surfaces. « 'Actual dates' are those derived from the evidence of fossils found *in situ* in surface deposits genetically related to the cutting of the surfaces, and they refer to the date at which the surface was cut at the spot where the fossils were found». On the other hand, «'comparative' dates refer to the times at which cycles were terminated at the coast » [1]. « Comparative » age is based on the assumption that a long period of time is required for the development of a cycle on the continental scale, with its slow inland advances up the major drainage systems and its lateral spread by scarp retreat. The present writer points out that the assumption is valid *if the cycle of erosion is initiated or terminated at the coast.* Initiation of erosion of continental magnitude, assuming that KING's « Victoria Falls » and « Congo » cycles are of such nature, does not require necessarily initiation at the coast. This fact will be brought out in the relating of interior high plateau surfaces to the Congo Basin.

«Actual» ages of two major surfaces on the central African interior high plateaus seem to be fairly well established. The mid-Tertiary or Miocene surface was observed by DIXEY (9) in the Northern Frontier District, Kenya to truncate beds carrying a lower Miocene mammalian fauna. DAVIES (4), WILLIS (20), and CHANEY (3) reported that a flora from the basal Bugishu Series that rests on the mid-Tertiary surface in the Mount Elgon region is probably of Middle-Tertiary age. DAVIES suggested that sedimentation and volcanic activity of the Elgon region necessitated completion of the «Middle Peneplain», i.e., the mid-Tertiary surface, during Upper Miocene.

However, discrepancies in dating surfaces still exist. In the Kavirondo Gulf area, relationships of the Kurungu lake beds (Lower Miocene) to the main peneplain is in dispute. SHACKLETON (16) believes the beds to rest on the surface indicating an «actual» age

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(1) KING (14, p. 244) further defined « comparative » age by stating : « Determination of the initial and terminal dates of the major cycles of erosion is, however important, and here some use may be made of the coastal sedimentative record, for erosion upon the lands and sedimentation about the continental margins are but halves of the same problem ».

of the erosion surface as pre-Lower Miocene. DIXEY (7) believes that the main surface truncates the Lower Miocene beds, thus indicating an « actual » age of post-Lower Miocene ([1]).

The second major surface (PIII of WAYLAND) may be related to the mid-Tertiary surface. In the areas described above, there is general agreement that a major erosion surface is cut below that of the mid-Tertiary. The lower surface is traceable directly to the Albertine Rift Valley where it is downthrown in the Albert trough. Resting on the downthrown surface are the Kisegi-Kaiso beds faunally dated as Plio-Pleistocene in age. DAVIES and BISSETT (5) reported that the Kaiso beds, carrying a Lower Pleistocene fauna in the upper part, and Kisegi beds constitute a fill of 4,000 feet in the Albert trough near Butiaba. KING (14, p. 339) reported that the Muzizi Valley ([2]) is partly floored with Kisegi sediments of the same age as the earliest rift accumulation, suggesting that these beds accumulated before the main rifting. Thus the Plio-Pleistocene date of rifting is established more firmly. LEPERSONNE (15, pp. 51-59) in his studies of the Albert-Semliki-Edward region concluded that the equivalent of the Kisegi beds are not stratigraphically independent of the Kaiso beds and are probably Lower Pleistocene in age. LEPERSONNE also observed that these beds rest on a peneplaned surface. The peneplain is probably the end-Tertiary surface.

Thus in Uganda-eastern Belgian Congo region «actual» ages of the two major surfaces are probably Miocene and Pliocene, mid- and end-Tertiary respectively. These designations shall be utilized throughout the following discussions.

([1]) Lack of agreement by contemporary workers developed in small areal correlations of African erosion surfaces indicates somewhat presumptuous worldwide correlations by KING (13) of African surfaces with those of other continents.

([2]) The Muzizi River drains into the southern end of Lake Albert from the southeast in Uganda, and is emplaced on the end-Tertiary surface above the Albert trough.

TERTIARY EROSION SURFACES OF THE ITURI, BELGIAN CONGO

One major erosion surface occurs extensively in the Ituri District, Belgian Congo. This surface has been correlated with the end-Tertiary surface of the Lake Kyoga area, Uganda by : 1° direct tracing, and 2° relating lithologies of surfaces to the type area of the Miocene and Pliocene surfaces in the vicinity of Kampala, Uganda.

On plate I, profile A relates the surfaces of the type area of Uganda and the Ituri. At Kampala, Uganda two erosion surfaces are identified. The upper surface, mid-Tertiary, is represented by the accordance of summits standing approximately at 4,300 feet. Transgressing all rocks types on this surface is a well-indurated laterite in some places several tens of feet thick.

Cut below the upper surface and apparently sloping southward to Lake Victoria and northward to Lake Kyoga is the most extensive erosion surface of Uganda, the end-Tertiary surface. Distributed abundantly on the younger surface is detritus derived from the breaching of the laterite crust of the higher mid-Tertiary surface. In some areas, the detritus (detrital laterite = murram) occurs as a gravel on the younger surface. In other places the detritus is recemented to a fairly well-indurated rock (murram conglomerate).

In the type area of Uganda are thus two distinct erosion surfaces : 1° the older of mid-Tertiary age occurring as remnants of a formerly extensive surface and characterized by a well-indurated laterite, 2° the younger of end-Tertiary age occurring as an extensive plain from Lake Victoria to Lake Kyoga and characterized by a mantle of detrital laterite or recemented detrital laterite. These relationships are shown in plate I, profile A and in plate III, A and B.

The relationships, erosion surface-laterite and erosion surface-detrital laterite, appear to have wide geographical significance in central Africa. Du Preez (10) described in Nigeria a higher-lying or peneplain laterite and a lower-lying or pediplain detrital laterite. Andrew (1) in the Equatoria Province, Anglo-Egyptian Sudan described two peneplains. The upper peneplain is characterized by an ironstone sheet capping small hills that stand 5 to 25 meters above the present day plateau surface. The upper surface has been regarded as the mid-Tertiary peneplain. The lower peneplain, present plateau surface, is characterized by concretionary ferruginous pellets. It was previously noted that VEATCH described similar occurrences in southern and southwestern Belgian Congo.

The end-Tertiary surface in Uganda extends westward to the top of the Lake Albert escarpment at Butiaba. Westward across Lake Albert and above Mahagi Port, Belgian Congo, an extensive erosion surface (Ishwa Plain) extends westward to the foot of the Niarembe escarpment. Above the escarpment from Niarembe westward through Mahagi to the foot of Nzi escarpment, a similar extensive surface occurs along the interfluve divides. Two additional segments of a similar surface extend westward : 1° from the top of Nzi scarp to the top of the Talla scarp and 2° from the foot of the Talla scarp southwesterly through Gote to Nioka. An accordant surface is traceable northwesterly from Gote through Rona to Golu. These surfaces are shown in profile on plate I, profiles B, C, D. Profile C is the segment Talla-Nioka of profile B. Profile D is the traverse described above from Gote through Rona to Golu.

It is necessary to compare profile B, plate I along the traverse Nioka-Gote-Mahagi-Mahagi Port with the profile of LEPERSONNE (15), figure 3. The present writer considers the extensive erosion surface throughout this traverse, illustrated in plate I, as one and the same surface. LEPERSONNE (pp. 11-12), on the other hand, considers the step-like occurrence of surfaces to represent three peneplains, PI-II-III. Apparently the threefold interpretation is based on the accordance of summits that fall into elevation ranges of 1,600-1,800 meters, 1,200-1,400 meters, and 900-1,100 meters. The threefold classification is suggested further by the occurrence of erosion remnants (Da, Niemel, Milia) on lower segments of the sequence that are accordant with elevation of the adjacent higher segment. The present writer points out, however, that LEPERSONNE suggests the uplift of surface PI to the range of 2,000-2,200 meters along a possible fault that coincides with the scarp of Nzi (plate I, profile 3).

In order to determine whether the traverse constitutes one surface or three surfaces, it is necessary to examine the lithology, stratigraphy, and structure. From Nioka to Gote the surface bevels granite with a flow structure oriented west or north. At Gote the surface cuts across a diorite-gabbro dike. From Gote to the Talla scarp the surface transgresses mica and quartzitic schists that range in dip from 42 to 88 degrees. Accordance of summits that are mantled by well-rounded quartz and detrital laterite gravel and that truncate steeply dipping rock types of variable degrees of erodibility attest that the surface is a true erosion surface.

The Talla scarp trends N20°E and transects the regional strike of rock structure at an angle of approximately 35 degrees. West of the Talla scarp mica schist exposed on the surface summits outcrops at 1,816 meters, and underlying granite on an adjacent slope outcrops at 1,765 meters. At the crest of the scarp at Talla, quartzitic schist overlies granite at an elevation of 1,879 meters. Faulting is thus proven by 1° occurrence of the scarp, 2° transection of the regional strike by the scarp, and 3° stratigraphic upthrow and downthrow of similar lithology, i.e., metamorphic complex over granite, east and west of Talla scarp respectively.

In the Talla-Nzi segment mica, quartzitic, and amphibolitic schists overlie granite at elevations of 1,820 to 1,903 meters. East of the Nzi scarp in the vicinity of Mahagi, mica schist overlies granite at 1,670 meters. The Nzi scarp trends northeasterly and transects the northwesterly regional strike. Thus the Nzi escarpment is a fault scarp similar to the Talla scarp.

The axis of the Au-Ota-Akara mountains is located along the plane of traverse at approximately kilometer 36. The range is composed of durable, resistant quartzite dipping 55°W and is a hogback on the general erosion surface. There is no reason to conclude that the summits of this range at 2,200 meters elevation represent an older erosion surface. The range represents a more resistant rock type that has not been lowered to the accordance of the general plain of the Talla-Nzi upland.

Similar geological evidences show that the Niarembe scarp is primarily structural and not erosional. Schists overlie granite at 1,300 to 1,350 meters in the vicinity of Niarembe. East of the scarp similar steeply dipping schists outcrop above granite at 1,050 to 1,120 meters. The Niarembe scarp is noted on aerial photographs to parallel the Lake Albert scarp, both of which cut across the regional strike. Thus throughout the traverse from Nioka to Mahagi Port, the step-like arrangement of the plains is a result of faulting of one surface and not the occurrence of three surfaces as interpreted by LEPERSONNE. Block faulting and warping of the surface are shown in plate I.

Erosional remnants, few in number, stand above the general surface along the traverse. At kilometer 78, Mt. Bieti stands at 1,435 meters, approximately 75 meters above the general erosion surface. At kilometer 93, Mt. Nilia stands at 1,211 meters, approximately 250 meters above the general erosion surface of the Ishwa Plain. Remnants such as these may represent an older erosion surface. The landscape of Mt. Nilia and the Ishwa plain is shown in plate IV, A.

Throughout the traverse from Nioka to the top of the scarp above Mahagi Port detrital-laterite gravels mantle the accordant summits. It will be recalled that eastward across Lake Albert above Butiaba in Uganda a similar surface extends to Lake Kyoga also mantled by detrital-laterite gravel.

Further evidence as to the identification of the surface Nioka-Mahagi Port is gained along the traverse Nioka-Gote-Rona-Golu. The general erosion surface is traceable to the top of the scarp at Rona. West of the scarp, the same surface is downthrown along the divide of the Shari and Omi Rivers. Evidences that prove faulting along the Rona scarp and that the surfaces east and west of the scarp are correlative are : 1° Rona scarp trending N22°E and transecting the regional strike of northwesterly trend, 2° stratigraphic upthrow east of the scarp where mica schists overlies granite at 1,721 meters whereas west of the scarp mica schist overlies granite at 1,676 meters, 3° horizontal offset of the Loluda River south of and aligned with the Rona scarp, and 4° zones of sericitization, chloritization, and talcitization in granite along the strike of the scarp in the Nioka area. Lineation of the Rona fault is well displayed on aerial photograph mosaics of the area. Mt. Rona may represent a remnant of an older erosion surface standing above the general plain.

West of the Rona scarp the hills Munzi and Alu (plate I, D) stand 20 to 25 meters above the general erosion surface. Both of these hills are capped by a well-indurated laterite crust (plate IV, B). The general surface below Munzi and Alu has detrital laterite abundantly distributed upon it. Munzi and Alu represent erosional remnants of an older erosion surface.

Thus in the Ituri area, the relationship erosion surface-laterite and erosion surface-detrital laterite exists. Similar occurrences were observed in Uganda and as previously noted have been described by

DU PREEZ, ANDREW, and VEATCH. Thus the conclusion may be reached that the remnantal laterite surface of Munzi and Alu is the mid-Tertiary erosion surface, and the lower very extensive erosion surface mantled with detrital laterite, derived from the breaching of the mid-Tertiary surface, is the end-Tertiary erosion surface. Additional evidence to strenghten the correlations was noted previously : that direct tracing of the end-Tertiary surface in Uganda to Lake Albert and the end-Tertiary surface in the Ituri to Lake Albert brought these surfaces in juxtaposition both geographically and sequentially. Thus, the surfaces that LEPERSONNE identified as three peneplains are one and the same surface, the warped and faulted end-Tertiary erosion surface.

The writer traced the end-Tertiary surface northward from Golu through Djalasiga and Kerekere to Mt. Hawa and Aru (fig. 2). Mt. Hawa stands approximately 60 meters above the adjacent Plain d'Aru. Mt. Hawa has a thick well-indurated laterite cap. Detritus, blocks and gravel, from the crust are distributed abundantly on the slopes of Mt. Hawa and on the adjacent Plain d'Aru. Thus again is the relationship high erosion surface-laterite crust, lower erosion surface-detrital laterite. Mt. Hawa is a remnant of the mid-Tertiary erosion surface; the Plain d'Aru is the extensive end-Tertiary surface. The erosion surfaces are cut on the granitic, metamorphic, and basic rocks of the «Complexe de Base» (11). See also CAHEN and LEPERSONNE (2). It is suggested that a point of departure for geomorphological studies of the «cuirasse latéritique» of the Uele District, Belgian Congo may well be the region of the Plain d'Aru.

Additional tracing of the end-Tertiary surface was conducted in the region Fataki-Rethy-Djugu-Blukwa-Korovi. From Nioka at an elevation of approximately 1,735 meters, the end-Tertiary surface rises to an elevation of approximately 1,830 meters in the vicinity of Rethy. Southward to Blukwa the same surface gradually rises to an elevation of 1,920 meters. Flat-summited Mt. Hwa stands at 2,196 meters, approximately 75 meters above the adjacent end-Tertiary surface. Hwa probably represents a remnant of the mid-Tertiary surface. Mt. Aboro in this same area rises to 2,435 meters and is probably a reflection of rift valley tectonics.

Mt. Korovi south of Blukwa stands at an elevation of 2,170 meters, approximately 200 meters above the adjacent end-Tertiary surface. The top of Korovi is expressed by a very subdued rolling topography. On all sides of the mountain a steep slope descends to the end-Tertiary surface. Korovi, similar to Aboro, is delineated on its eastern side by the Lake Albert fault and escarpment. The summit of Korovi is probably remnantal of the mid-Tertiary surface. The excessive stand of Korovi above the end-Tertiary surface suggests post-Tertiary uplift of the mass along the Lake Albert fault.

Other remnants of the mid-Tertiary surface may be represented by Mts. Adjo and Ani that are in similar relationship to the end-Tertiary surface as the landscape units described above. Throughout these traverses the erosion surface truncates the granite and metamorphic rocks of the «Complexe de Base».

Southwesterly from Nioka at 1,735 meters, the end-Tertiary erosion surface is traceable through the Djugu forest and in the savanna via Fataki. Elevations of the surface decrease gradually to approximately 1,685 meters at Djugu. Throughout the traverse detrital laterite is abundantly distributed on the end-Tertiary surface. In this area, granite of the «Complexe de Base» is truncated to accordant summits by the surface.

Southwesterly from Djugu the end-Tertiary surface decreases in altitude to approximately 1,650 meters at Gina to 1,550 near Nizi. A few kilometers south of Djugu the surface transgresses rocks of the «Groupe du Kibali». In the vicinity of Nizi, a younger erosion surface debouches from the margin of the plateau cut by the end-Tertiary surface. The younger surface stands approximately 150-200 meters below the end-Tertiary surface. Thus the southwesterly margin of the end-Tertiary surface is located in the vicinity of Nizi. Physiographically the end-Tertiary surface to the northeast may be designated as the High Ituri Plateau whereas the lower Bunia-Irumu surface to the southwest may be identified as the Low Ituri Plateau.

In the Ituri District, Belgian Congo there is only one major erosion surface that ranks equivalently to the «peneplain» status of other investigators. This erosion surface is the end-Tertiary, and is extensively distributed along the interfluve divides of the High Ituri Plateau. There is no extensive distribution of the mid-Tertiary surface. On the contrary, occurrence of the mid-Tertiary surface is restricted to summits of isolated remnants of less than a few hectares in distribution. An erosion surface equivalent of the PI of Wayland or the Jurassic or Cretaceous surface of other investigators does not exist in the Ituri.

It is necessary to clarify the literature pertaining to the Ituri. The threefold peneplain classification of LEPERSONNE (15) in the region Djugu-Nioka-Mahagi-Mahagi Port is rejected. The three surfaces of LEPERSONNE PI, II, III, are one and the same surface, the end-Tertiary PIII.

KING's (14) mapping of the «Gondwana» surface in the Ituri west of Lake Albert must be rejected. The «Gondwana» surface of KING is correlative in geographic distribution to the mid-Tertiary surface of other writers. If KING's terminology is to be applied in the Ituri, then the «African» surface must replace the «Gondwana» landscape mapping. The «African» surface of KING is generally correlative geographically to the end-Tertiary surface of other writers.

DIXEY's (8) discussion of the region west of Lake Albert is no longer valid. He stated (p. 353) that the Miocene peneplain is well represented throughout the northern Rift Zone and is present in the Belgian Congo west of the western rift, and noted (p. 355) a broad upland area at 6,500 to 7,000 feet and a lower surface at 5,000 feet which surrounds the upper surface to the west, north, and south. The lower surface (p. 361) represents the margin of the Congo Miocene peneplain, and (p. 362) «it would be reasonable to regard these highlands also as essentially of residual character; in which case, there would appear to be little need for postulated thrusts and local upfolding». Apparently the residuals were thought to be remnants of the Jurassic surface.

DIXEY's (p. 351) interpretations of the Ituri, Belgian Congo were based on the premises : 1° one side of the rift valley is higher than the other (e.g., Albert and Tanganyika); 2° in any one rift the principal surface of reference, the Miocene peneplain, lies essentially at the same level on either side; 3° «...it is demonstratable that the difference in the elevations of the plateaux on either side is due, not to variations in the level of the Miocene peneplain, but to variation in the elevation of the uplands and plateau remnants residual upon this peneplain»; and 4° tilts are illusory, in that slopes observed are due, not to tilting but to the topographic effect of remnants of earlier cycles rising out of the Miocene peneplain in the vicinity of the rifts.

An examination of these premises is necessary to determine their validity. Number 1 is valid. (See plate I, A). Number 2 is not valid. The principal surface in the Ituri is the end-Tertiary surface. The principal surface in Uganda east of Lake Albert is the end-Tertiary surface. The *Miocene* surface stands as isolated remnants above the end-Tertiary surface in both of these regions. Both the end-Tertiary surface and the Miocene-surface remnants are 500 to 600 meters lower on the Uganda shoulder of the Lake Albert Rift than on the western Congo shoulder. Number 3 is invalid. The differences in elevation east and west of Lake Albert are *absolute* differences in elevation on the end-Tertiary surface and are not related in any way to the Miocene peneplain or any residuals upon that surface. Number 4 is invalid. Elevations on the end-Tertiary surface from west to east from the Congo Basin at Yangambi, 435 meters (6, fig. 49) to the Ituri at Awe, 1,903 meters, across the Albert Rift into Uganda above Butiaba at 1,110 meters, indicate intensive warping and tilting of the surface. Faulting and warping of the datum-surface were previously demonstrated (plate I, A). Thus, the high stand of the shoulders of the Albertine rift is definitely a reflection of tectonic disturbances and not an illusory effect of residuals on an erosion surface as DIXEY stated : «My contention is that the high relief hitherto ascribed to tilting in the vicinity of the main rifts is due to other causes, and that true tilting where observable is slight».

Supporting evidence that strengthens the supposition of tectonic disturbance of the shoulders of the western rift is the diversion and reversal of drainage in western Uganda. Streams that formerly flowed through western Uganda to confluence with the Congo have been severed by upwarping of the sides of the Western Rift and backtilted in part toward Lake Victoria (14, pp. 195-196). Several of these streams, e.g., the Nakusi-Kafu, are emplaced on the end-Tertiary surface.

Two significant facts concerning geomorphological studies of the central African erosion surfaces are : 1° the surfaces cannot be specified or recognized by their elevations above sea-level. The continuity of the surfaces must be traced out upon the ground utilizing all the geological tools, e.g., petrology, structure, etc., necessary to properly evaluate the geomorphology. 2° In the regions affected by the Rift Valley tectonics, the intimate relationship of tectonics and geomorphology must be thoroughly studied and evaluated. It is not understandable to the present writer how proper recognition of surfaces can be made when : « Complications introduced by the East African Rift Valleys and other agencies have for the most part been ignored» (14).

POST-TERTIARY EROSION SURFACES OF THE ITURI, BELGIAN CONGO

In Mahagi Territory multiple flat-summited erosion surfaces are cut below the end-Tertiary erosion surface. These post-Tertiary surfaces are limited geographically to watersheds below and on both sides of the continental Congo-Nile divide. The surfaces occur in drainage basins of the Loluda and Upper Shari Rivers that drain to the Ituri and Congo Rivers, in the drainage basin of the Omi River that drains to the Kibali and Congo Rivers, in the drainage basin of the Vida-Niagaki River that drains to the Ora and Nile Rivers. In the vicinity of Mahagi, similar post-Tertiary surfaces were observed along the upper reaches of the Namaroda River that drains to the Nile and along the Kakoi River that drains to Lake Albert near Ndaro, Belgian Congo. Observed distribution of these surfaces indicates that they are of regional significance as landscape units. (See figure 2).

Topographic relationships of the post-Tertiary erosion surfaces in the Loluda River watershed are shown in plate II. Profile A is a traverse from Nioka across the composite watershed of the Aoda, Korda, Loluda and Dadwoda Rivers to Rona and northeastward to a point near the Uganda frontier. Profile B traverses the Shari River watershed from a point midway between Kampala and Golu, crosses normal to the Rona fault, and trends southeasterly to a point midway between Nioka and Gote. Profiles C and D are located within the Loluda River watershed.

All surfaces within the Loluda River area are cut in granite that megascopically appears to be of similar composition and structure. Thus, the various landscapes are not correlative of varying degrees of erodibility of bedrock type or of varying bedrock types. The longitudinal profile of the Loluda River trends N55°W and transects the regional strike at an angle of approximately 40 degrees. The major base level control of watershed erosion-surface development is independent of structure.

Six surfaces are cut below the end-Tertiary surface and are identified in the profiles of plate II. Q-0 is the present floodplain. Q-1 is an alluvial terrace generally distributed along the major drainages although a correlative cut surface occurs on the flanks of the watershed. Surfaces Q-2, Q-3, Q-4, Q-5 are preserved as remnantal flat summits along the tributary interfluves in the Loluda watershed.

The remnantal, flat-summited erosion surfaces characteristically are elongate normal to the Loluda River or major tributaries of the Loluda River. Each surface is set off from the adjacent older-higher surface and the adjacent lower-younger surface by a well-developed break in slope. In many places the slope between adjacent erosion surfaces, i.e., long axis juxtaposition, may stand at 45 to 60 degrees. Along the short axis, the flat summits may drop off in convexo-concave slopes to a younger level of the sequence, in most cases to Q-0, which is incised throughout the watershed.

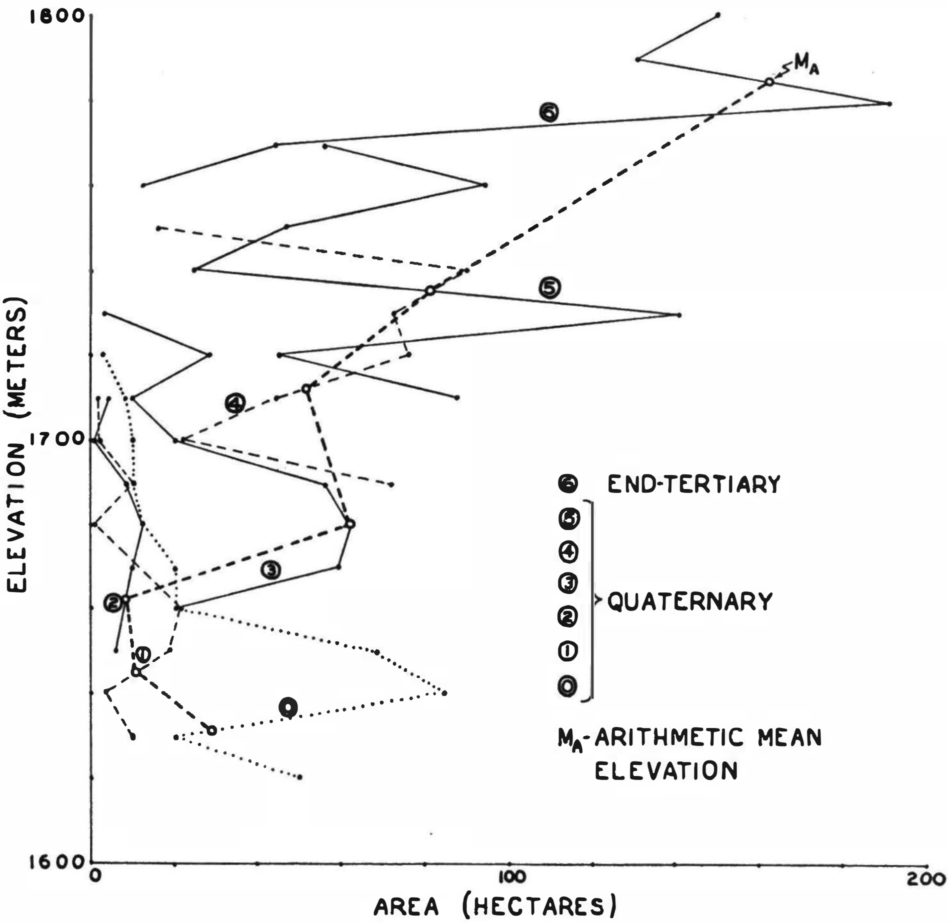

Figure 4. — Area-altitude distribution curves of the end-Tertiary and Quaternary erosion surfaces in the Loluda watershed, Ituri District, Belgian Congo. Overlap of elevation ranges of adjacent erosion surfaces of the sequence emphasizes the impossibility of correlating surfaces solely on the basis of elevation above sea-level.

The post-Tertiary surfaces stand one above the other in the sequence from youngest, Q-0, to oldest, Q-5. Their distribution is graphically shown in area-altitude distribution curves (fig. 4). The distribution curves demonstrate several geomorphological facts. 1° The curves expose the fallacy of attempting to correlate erosion surfaces on the basis of elevation. It will be noted that ranges of elevations of adjacent erosion surfaces overlap. For example, Q-4 ranges from 1,690 to 1,750 meters and overlaps the basal range in elevation of Q-5, 1,710 to 1,770 meters. The surfaces can be recognized only by tracing their continuity on the landscape. 2° Distribution of one curve relative to the group, emphasized by a statistical measure — the arithmetic mean elevation, shows that progressively older surfaces stand at progressively higher elevations. The ages of the erosion surfaces increase up-watershed or toward the periphery of the watershed.

All flat-summited surfaces of the sequence cut in granite are mantled by surficial sediments that grade downward to a basal gravel. Particles within the gravel range in degree of rounding from angular to rounded. In contrast to the detrital laterite increment of the basal-gravel composition of the end-Tertiary surface, detrital laterite does not occur in the basal gravel on the post-Tertiary surfaces. Apparently all detrital laterite has been swept from the watershed during the development of the post-Tertiary surfaces. As a result the basal gravel is more in harmony, in the composition sense, to the bedrock of the watershed, and is dominantly quartzose.

It is necessary to examine whether these surfaces represent multicyclic development or are the result of one cycle of cutting. Non-correlation of surface stands and 1° degree of erodibility of bedrock type, 2° varying bedrock types (granite throughout the watershed), and 3° bedrock structure suggests remnants of surfaces cut at former stands of local base level. A lack of parallelism between interfluve surfaces in profile to adjacent stream longitudinal profiles (fig. 5) of one cycle, Q-0, suggests that the stepped interfluve surfaces represent multicycles. If the interfluve profiles were cut in the same type of rock during one cycle, it is reasonable to assume that the interfluve profile should bear parallelism to the present stream longitudinal profile *cut in the same type of rock during one cycle.*

Further evidence of multicyclic development is found in the occurrence of nickpoints in the upper reaches of the Loluda River

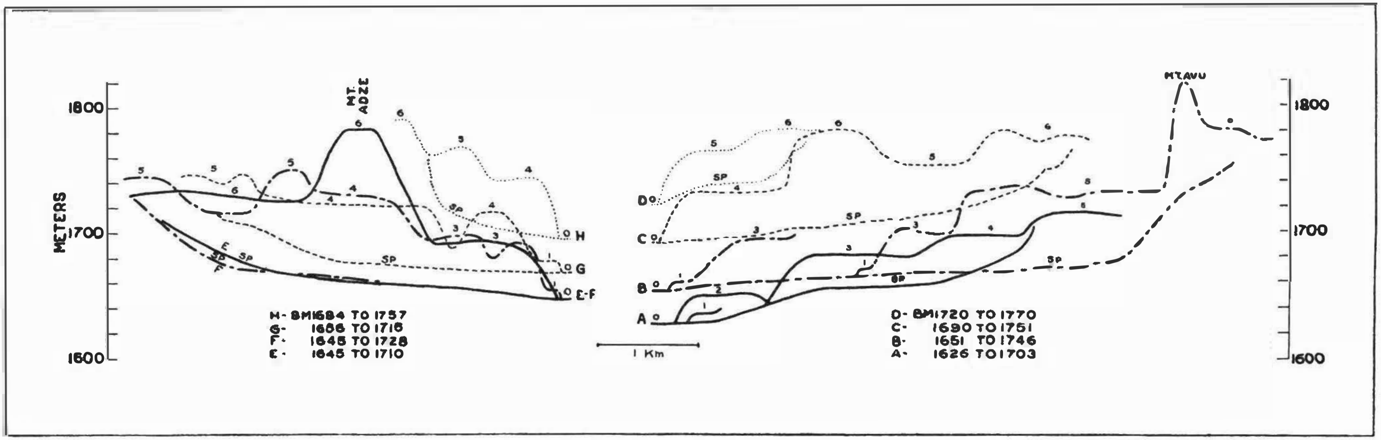

Figure 5. — Comparison of interfluve summit profiles and their adjacent stream longitudinal profiles. All streams are major tributaries of the Loluda River. Lack of parallelism is shown between the stepped interfluve profiles and their adjacent stream profiles, cut in homogeneous bedrock during one cycle. Multicyclic development of the stepped interfluve surfaces is indicated. Symbols are : SP - stream profile, 1-2- etc., refer to erosion surfaces (c.f., plate II).

and its tributaries. Nickpoints are in general occurrence throughout the watershed. In some upper reaches as many as two or three old stream gradients exist (fig. 6). The older stream gradients are traceable headward up the transverse flanks of higher erosion surfaces of the post-Tertiary sequence. The older gradients represent valleys cut below the older surfaces. Progressively downstream is a longitudinal valley-in-valley relationship.

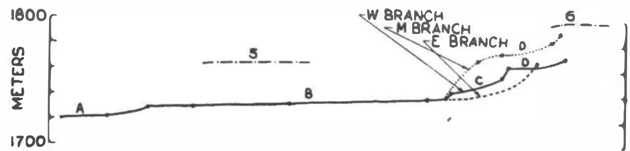

Figure 6. — Composite longitudinal stream profile of tributary of the Loluda River. A series of nickpoints is shown in the upper reaches of the stream channel. Multicyclic erosional development is indicated (see text).

In the Loluda watershed cut off spurs, with alluvial fills in the cut-offs now standing above the level of Q-0, indicate multicyclic landscape formation. Thus, all of the evidences show that the remnantal flat-summited surfaces of stepped distribution along the interfluves of the Loluda watershed are the result of multicyclic erosion, and are identifiable as a sequence of erosion surfaces.

Possible causes of the cutting of the post-Tertiary surfaces are tectonic disturbances and/or pluvial climatic regimes. ZEUNER (22, pp. 249-259) has summarized the evidences pertaining to pluvial episodes in the general region of Africa. None of these evidences was found in the Ituri District of the Belgian Congo. Thus the cutting of the surfaces is probably a reflection of the Albertine Rift Valley tectonics.

Primary evidences of tectonic causation are : 1° correlation of the Rona, Talla, Nzi, Niarembe, Lake Albert faults and scarps (pl. V, A) as probably contemporary, 2° occurrence of correlative post-Tertiary surfaces across the major faults, and on opposite sides of upthrown blocks of the rift valley fault system, 3° occurrence of a sequence of nickpoints in the stream profiles within the watersheds, and 4° occurrence of hanging side valley above main tributaries in the watersheds.

The parallelism and similar transection of regional strike of the Rona, Talla, Nzi, Niarembe, and Lake Albert faults has been described. Displacement of the datum, the end-Tertiary surface, by these faults of the Albertine Rift Valley system is demonstrated in plate I, A. Geographic relationships and displacement of the datum indicate that disturbance was correlative throughout the region Nioka to Lake Albert, a distance of 105 kilometers. Post-Tertiary erosion was initiated by relative vertical displacements of blocks between faults of the rift valley system. The occurrence of the post-Tertiary surfaces cut below the end-Tertiary surface on the upthrown blocks supports this interpretation. The surfaces of the Loluda watershed, for example, are cut across the Rona fault ([1]). The occurrence of correlative erosion surfaces on opposite sides of an upthrown block, for example, those of Vida watershed and of the Namaroda watershed west and east of the Talla-Nzi upthrown block respectively, further substantiates the interpration of causation.

Recurrence of movement along the faults of the rift valley system, cause of the cutting of younger erosion surfaces of the post-Tertiary sequence, is suggested by the occurrence of a sequence of nickpoints in the stream profiles and of hanging side valleys above main tributaries in the watersheds. These evidences suggest that stream adjustment to tectonic movement is probably a lowering of local base level at the major faults. On the upthrown blocks, nickpoints retreat upstream such that incomplete obliteration of previous stream gradients results in development of composite stream profiles, i.e., the sequence of gradients upstream. Interfluve planation contemporaneous with retreat of nickpoints has resulted in the broadly stepped landscape of the watershed as well as the longitudinal profiles of the streams.

If the hypothesis of tectonic disturbance-erosion surface cutting is acceptable, then the number of episodes of tectonic disturbance may be recorded by the number of erosion surfaces. In the sequence Q-0 to Q-5, the sequence Q-2-3-4-5 represents the episodes of major post-Tertiary surface development. Four episodes are recorded. Q-1 is dominantly an alluvial terrace three to five meters above the flood plain, Q-0 of the major drainages. Lepersonne (15, p. 77), however, has identified only three phases of disturbance in the rift valley, pre-Kaiso, post-Kaiso and pre-Semliki, and post-Semliki.

([1]) As a result, younger surfaces of the sequences of post-Tertiary surfaces are brought in elevation accordance with the end-Tertiary surface. See plate II, B. Q-3 of Loluda sequence is accordant in elevation to PIII of Shari River watershed. Confusion of identification of erosion surfaces is possible if the structural relationships are not known.

It is not possible to date precisely the post-Tertiary erosion surfaces. They may be placed in the large unit of classification of Quaternary by relating their occurrence below the end-Tertiary surface. The sequence may represent the whole of the Quaternary or only a part of it. However, it seems reasonable to correlate broadly the disturbances identified by LEPERSONNE in the Albertine Rift Valley with the entire sequence of major surfaces of the Loluda watershed (1). Thus the sequence of erosion surfaces is believed to represent the whole of the Quaternary.

Surfaces similar to the Quaternary surfaces of the Loluda River watershed were observed in Uganda, Ruanda-Urundi, and the Kivu District of the Belgian Congo. Thus the surfaces are regionally significant on the central African interior high plateaus. Surfaces were observed below the end-Tertiary peneplain in the Mengo and Masaka Districts, Uganda. WAYLAND (19, pp. 69-76) reported four terraces along the Kagera River (2) below the end-Tertiary peneplain in Uganda. In the watershed of the Akanyara River and tributary watershed north of Astrida in the Ruanda, erosion surfaces similar to those of the Loluda River watershed are cut below the end-Tertiary surface (3) (pl. V, B). More detailed field research in these areas should bear out these observations.

(1) The Albertine Rift is only 80 to 100 kilometers east of the Loluda watershed. It is reasonable to assume that disturbances traceable from Lake Albert southward to Lake Edward and probably occurring throughout the Albertine-Tanganyika Rift System would be effective in the Loluda area. The structure-datum, end-Tertiary surface, is pertinent.

(2) The Upper Kagera River is the frontier between Tanganyika and the Ruanda-Urundi.

(3) The end-Tertiary is the dominant erosion surface on the interfluve divides in the Ruanda-Urundi. Erosional remnants of probably the Miocene surface stand above the end-Tertiary surface. KING's mapping of the « Gondwana » surface is doubtful. The Jurassic surface of WILLIS and DIXEY apparently is non-existent.

RELATIONS OF THE EROSION SURFACES OF THE ITURI PLATEAUS AND THE CONGO BASIN

In the north-oriental sector of the Congo Basin DE HEINZELIN (6, p. 109) described an erosion surface that truncates the Yangambi series and the Lodja beds. The surface of planation is believed to be an element of the end-Tertiary peneplain. At Yangambi the surface stands at approximately 425 meters above sea-level.

DE HEINZELIN projected the end-Tertiary surface eastward from the vicinity of Stanleyville at approximately 500 meters above sea-level to the shoulder of the Albert Rift Valley at approximately 1,135 meters. The projection is shown in figure 3.

As stated previously, the present writer traced the end-Tertiary erosion surface southward from Nioka at 1,735 meters elevation to Djugu at 1,680 meters through Gina at 1,650 meters to the vicinity of Nizi at 1,550 meters. The High Ituri Plateau in this area drops off sharply 150 to 200 meters in elevation to the Bunia-Irumu plain or the Low Ituri Plateau. The scarp between the low and high plateaus is not known to be related to faulting, but in all probability is an erosional development.

Evidences that suggest an erosion scarp rather than a tectonic scarp are : 1° the occurrence of many erosional remnants on the low plateau surface that reach elevations accordant with the high plateau surface. The erosion outliers are geographically distributed on the Bunia-Irumu plain to the south and west of the Nizi escarpment. 2° Erosion surfaces accordant to the Bunia-Irumu plain extend up the Nizi and Shari Rivers where they are cut below the end-Tertiary surface Nizi-Gina-Djugu-Nioka. These lower level surfaces probably are traceable and correlative of the surfaces described in the Loluda River watershed. 3° No detrital laterite was observed on the Bunia-Irumu plain. However, detrital laterite mantles the end-Tertiary surface from Nioka to Nizi above the escarpment. It was previously noted that detrital laterite does not occur on the Quaternary surfaces of the Loluda watershed. 4° Faults have not been mapped in the vicinity of the escarpment at Nizi (15, pl. I).

The evidence suggests that the Bunia-Irumu plain that stands below the end-Tertiary surface at Nizi is an erosion surface. Detailed work probably will show that the low plateau is a sequence of surfaces rather than one surface, and are correlative of the Quaternary surfaces cut below the end-Tertiary surface on the high plateau.

The Bunia-Irumu surface truncates with accordant summits various rock types. From Nizi to the vicinity of 19 kilometers east of Irumu, granite of the «Complexe de Base» is planed. From kilometer 19 to kilometer 2 west of Irumu, shales of the « Séries de la Lukuga» are truncated. Westward to the vicinity of Adusa, granites of the basement complex and metamorphic rocks of the «Groupe du Kibali» are transgressed. Westward to Stanleyville, the shales, sandstones, limestones, and dolomites of the «Groupe de la Lindi» are truncated. Throughout the traverse across the variable rock types accordance of summits is maintained on the erosion surface.

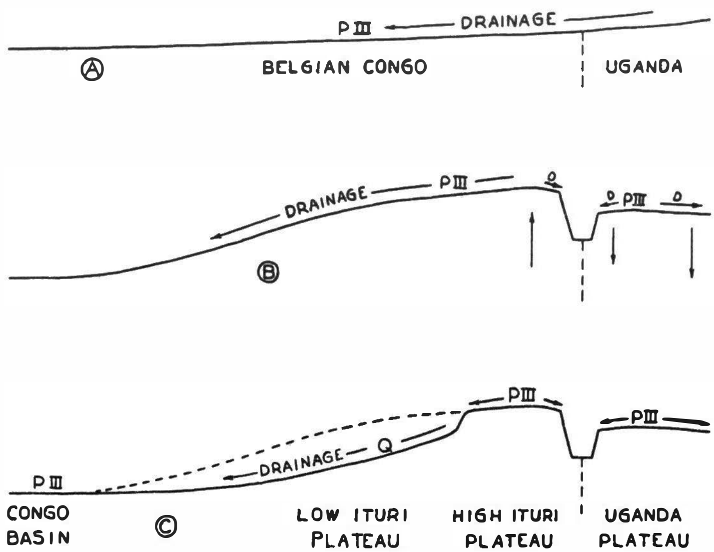

Figure 7. — Diagrammatic explanation of the cutting of the Quaternary erosion-surface complex, the Low Ituri Plateau (Bunia-Irumu Plain). (A) End-Tertiary erosion surface with integrated drainage of the Ituri, Belgian Congo, and Uganda to the Congo Basin. (B) Plio-Pleistocene warping and Albertine rifting of the end-Tertiary surface; diversion of drainage of upper reaches of Tertiary streams to Nile drainage in Ituri and Uganda; reversal of drainage of streams in Ituri to Lake Albert, in Uganda to Lake Victoria. (C) Cutting of Quaternary erosion-surface complex of Low Ituri Plateau below end-Tertiary surface, present High Ituri Plateau, but graded to the end-Tertiary surface of the Congo Basin.

Note : recurrence of Quaternary tectonics of Rift Valley incorporated as one diagrammatic presentation.

It is necessary to provide a mechanism for the geographical coexistence of erosion surfaces of different ages along the traverse from the High Ituri Plateau to the Congo Basin. The distribution of surfaces is shown graphically on plate I, A. In the north-oriental sector of the Congo Basin, segment Isangi to Stanleyville, DE HEINZELIN (6) has shown that the end-Tertiary surface is buried under the Quaternary sediments of Congo Basin, the «sables de recouvrement». At 425 meters elevation at Yangambi the end-Tertiary surface is buried under Quaternary sediments. On the High Ituri Plateau, the end-Tertiary surface at Nizi stands at an elevation of 1,550 meters. Between these areas a Quaternary surface occurs and is definitely limited on the northeast by the Nizi escarpment, but the western limit is not known with certainty.

Warping of the end-Tertiary surface provides a mechanism for development of the Quaternary surface intermediate geographically between end members of the end-Tertiary surface.

In figure 7 the mechanism of the cutting of the Quaternary erosion surfaces of the Low Ituri Plateau is pictured diagrammatically. (A) Drainage on the end-Tertiary surface was integrated throughout western Uganda, eastern Belgian Congo, and the Congo Basin (14, pp. 196-197). Ancestors of present Nkusi-Kafu, Kabonga, and Kagera Rivers of western Uganda drained westward on the end-Tertiary surface across the present locale of the Albert-Semliki-Edward Rift Valley to the ancestral Congo River. Elevations on the end-Tertiary surface are a matter of conjecture. (B) Plio-Pleistocene warping of the end-Tertiary surface ensued and culminated in rifting. The end-Tertiary surface in Uganda was downthrown relative to the Ituri surface which in turn upwarped relative to the end-Tertiary surface of the Congo Basin. Drainage diversions ensued. The upper ancestral streams of Uganda were diverted from Congo to Nile drainage. Streams of the Ituri on the western shoulder of the Albert Rift were diverted to the Nile. Reversals of drainage occurred such that eastern reaches of streams of Uganda now flow easterly to Lakes Kyoga and Victoria. Reversals of Ituri streams were inherent in their diversion. (C) Upwarping of the end-Tertiary surface to the east of the present Congo Basin caused downcutting below the end-Tertiary surface, *but graded to the end-Tertiary surface of the present Congo Basin.* The resultant landscape of the present was obtained with preserval of the end-Tertiary surface under the Quaternary sediments of the Congo

Basin and as a remnantal plateau of the High Ituri. Between these two regions, the end-Tertiary surface was destroyed and the Quaternary erosion surfaces planed.

King (12, 14, p. 191) applied the same mechanism to show how, under pedimentation and the generation of scarps, local uplift may produce apparently two cyclic surfaces in a single cycle of pedimentation graded to a single base-level. King, however, did not consider that this mechanism is applicable to erosion surface development of continental scope. King maintains the premise that continental cycles are initiated and terminated at the coast.

The present writer points out that Quaternary surfaces such as the Low Ituri Plateau probably are delineable throughout the central plateaus adjacent to the Rift Valley and are of continental significance. Initiation and termination of the cutting of the surfaces was not at the coast, but on the contrary, in the interior of the continent. It will be noted that there is essential agreement between the distribution of the Quaternary surfaces, Low Ituri Plateau, of the present writer and the «Victoria Falls» surface of King (fig. 1), which King considers post-«African» in age. As noted previously, the «African» surface of King is equivalent in geographic distribution to the end-Tertiary surface of other writers.

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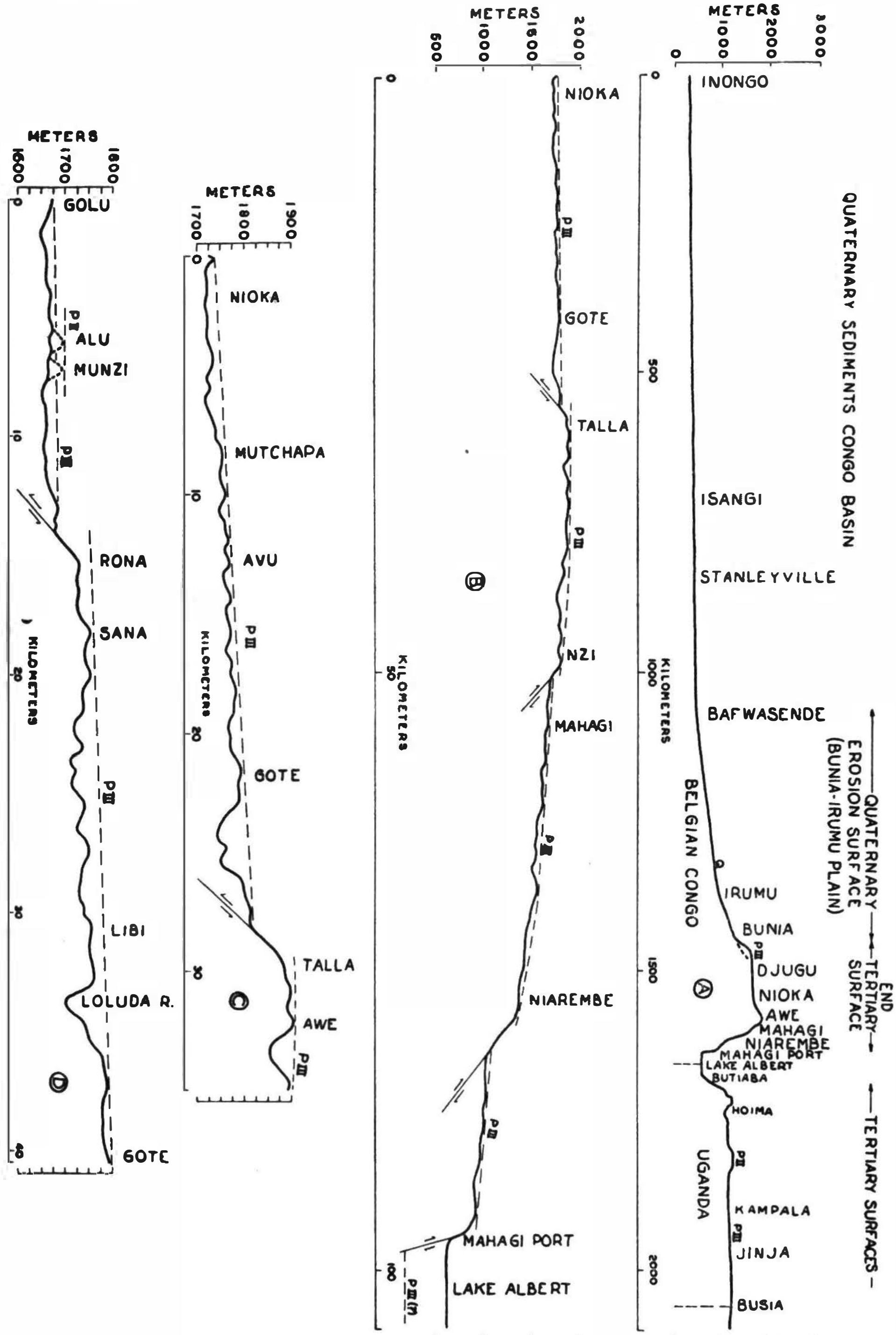
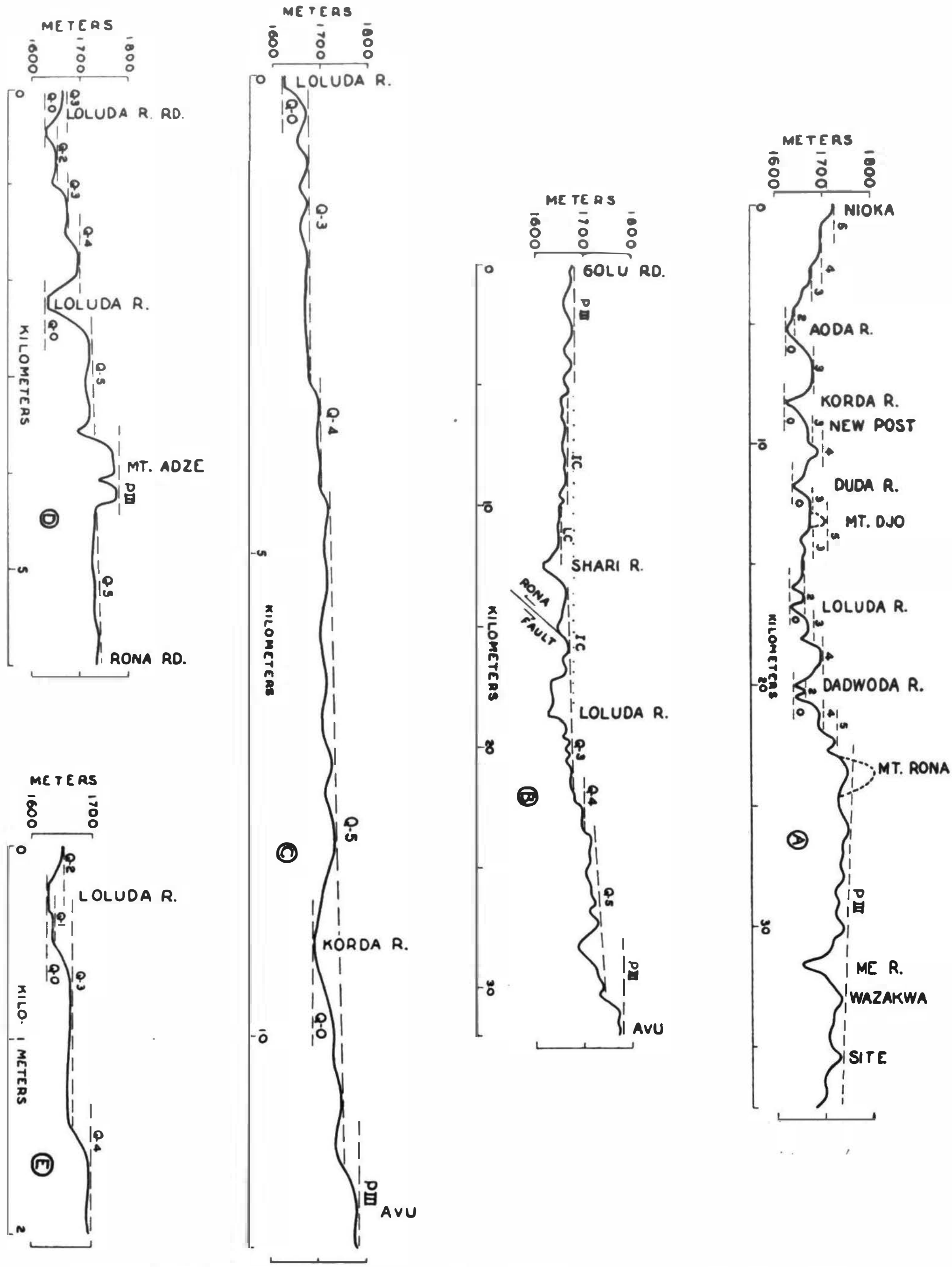
PLATE I.



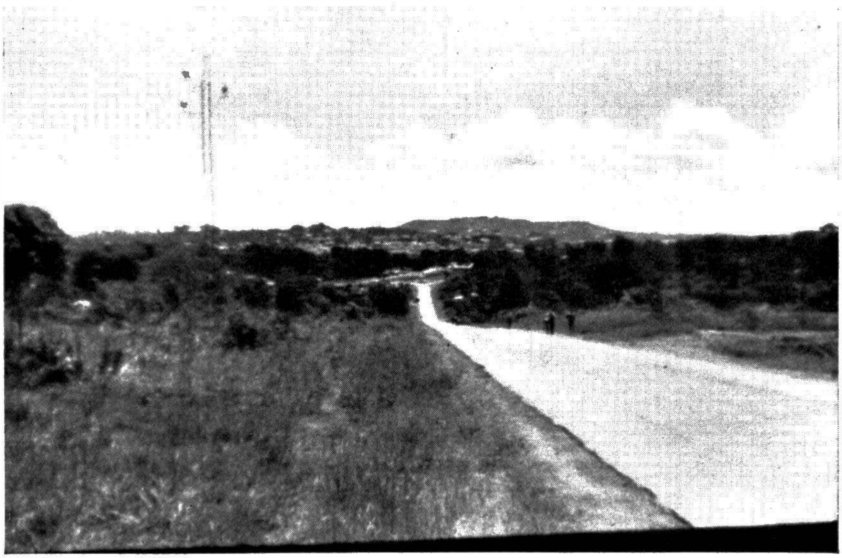
Profiles of end-Tertiary erosion surface. (A) Congo Basin across Ituri Plateau, Lake Albert Rift Valley, and Uganda Plateau. (B) Nioka-Gote-Mahagi-Mahagi Port, Ituri, Belgian Congo. (C) Nioka-Gote-Talla-Awe Forest, Ituri, Belgian Congo. (D) Golu-Rona-Gote, Ituri, Belgian Congo.

PLATE II.

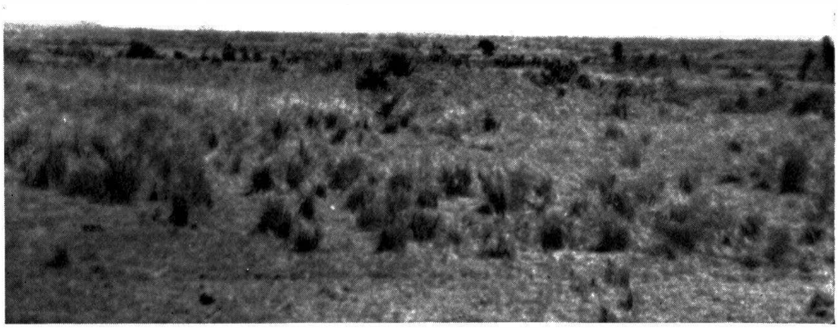


Profiles of Quaternary erosion surfaces, Nioka-Ituri area, Belgian Congo.
(A) Nioka-Mt. Djo-Rona-Zeu road. (B) Golu road-Shari River-Avu.
(C) Loluda River-Avu. (D) Loluda River road-Mt. Adze-Rona road.
(E) Loluda River-vicinity of Loluda River road.

PLATE III.



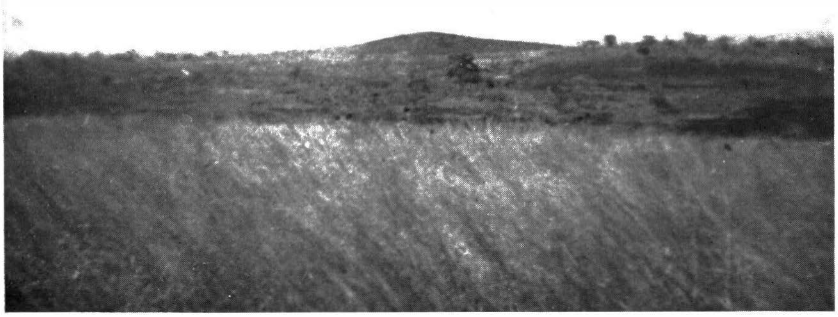
(A) Mid- and end-Tertiary erosion surfaces, Kampala, Uganda. Looking northward from summit on end-Tertiary erosion surface on Entebbe road. Mid-Tertiary surface marked by elongate hill standing above Kampala. Part of city of Kampala is built on the end-Tertiary surface.



(B) End-Tertiary erosion surface near Busia, eastern Uganda. Inselbergs visible on skyline in distance.

PLATE IV.

(A) End-Tertiary erosion surface (Ishwa Plain), Ituri, Belgian Congo. Looking eastward from Niarembe fault scarp. Mt. Nilia, residual on end-Tertiary surface in right background. Skyline marks top of Lake Albert fault scarp (pl. I, D).



(B) Alu, laterite-capped remnant of mid-Tertiary erosion surface, standing above end-Tertiary surface, Shari-Omi divide, between Golu and Rona, Ituri, Belgian Congo. Looking northwestward from Munzi.

PLATE V.

Lake Albert fault scarp, Mahagi Port, Ituri, Belgian Congo. End-Tertiary erosion surface extends westward from top of scarp to foot of Niarembe escarpment (c.f., pls. I, D and IV, A). Pleistocene lake plain, Kaiso beds, in foreground.

(B) Quaternary erosion surfaces, Akanyara watershed, north of Astrida, Ruanda, standing below end-Tertiary erosion surface marked by accordant upland summits.

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