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From planation surface to Holocene climate pulses: the landscape evolution in plateau reliefs

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Abstract
In the central portion of Brazil, there are extensive and continuous flat surface plateaus, which are presented in a staggered way, separated by embedded fluvial valleys, among which the Uberlândia-Uberaba plateau stands out in the region of Triângulo Mineiro - MG. Considering the aforementioned, geomorphological features such as veredas and summit depressions populated by murundus, commonly associated to the drainage network in tabular relief, are considered here as key environments for paleoenvironmental interpretation. To characterize and understand the formation processes of these environments and their evolution in the landscape, morphometric indexes, topographic profiles and evolutionary models of landscape were elaborated, presenting a general panorama and demonstrating the importance of geomorphological elements and landscapes from Paleogene planation surfaces to the Holocene climatic pulses.

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INTRODUCTION

Occurring in the central portion of Brazil, numerous plateau reliefs, characterized by possessing tabular surfaces delimited by steep/gradual slope ruptures on its borders, which provide them a prominent position in the landscape. Flat surfaces cause the occurrence of Paleogene, Neogene and Quaternary pediplanation over horizontal or sub-horizontal sedimentary layers associated with basaltic spills and/or concordant hardened sublayers, such as concretions and lateritic crusts.

According to Ab'Sáber (2003), flattened sedimentary uplands from the central region of Brazil, consist in extensive plateaus with elevation varying from 600 to 1100 meters approximately, naturally covered by Cerrado vegetation. This unity of relief is sectioned by fluvial valleys occupied by gallery forests, being characterized, according to the author as the "Domain of interior tropical uplands with Cerrado and gallery forests".

After discussing with various authors who presented classic definitions regarding plateaus, Martins and Salgado (2017) list some basic attributes to identify and define this unity of relief: Sufficient height to highlight it in relation to its neighboring area; minimum extension of 10 hectares; slope rupture between the levels and its surroundings; surface with a slope of ≤ 6º conditioned by layers dip; and emphasizes this type of relief is primarily modeled on sedimentary rocks, although can occur on low metamorphism meta-sedimentary rocks, volcanic sedimentary and/or mafic volcanic.

Regarding plateau genesis Martins and Salgado (2017) two preponderant factors are weighted: changes in the base level causing the drainage network vertical embedding sculpting the residual shape of the plateau and tectonic processes also being responsible to individualize uplands that posteriorly evolve into plateaus, with the edges receding and its flat surface being maintained.

The morphology of these units of relief indicate processes responsible for the surface coverings genesis and geomorphological features that occur in this central portion of the country, making possible the interpretation and formulation of the local landscape evolutionary picture.

Considering the characteristics presented above, the objective of this manuscript lies in revising and describing the main planation events that occurred in the region during the post-Cretaceous period, in order to distinguish singular processes between different topographic levels, thus leading to the current distinction of: Soil types, lithology, altimetry and surface coverings. Besides, consists as another objective, to correlate Holocene climate pulses to the establishment of geomorphological features in plateau environments. By means of these interpretations, it is aimed to comprehend part of the evolution from the elements structuring the local and regional relief/landscape.

Within this context, the study area is presented as a plateau and its surrounding area, located between the municipalities of

Uberlândia and Uberaba in the Triângulo Mineiro region, west of Minas Gerais (MG).

STUDY AREA CHARACTERIZATION AND LANDSCAPE PHYSICAL ATTRIBUTES

Lithological aspects

In order to comprehend the formation processes of planation surfaces in the Triângulo Mineiro region, it is primarily necessary to characterize the regional lithology, since each rock formation is differently affected by the generalized planation imposed by erosive cycles, depending on the rock hardness degree and the outcrop elevation level.

According to Batazelli (2003) and Barcelos (1984), the region that forms the study area possesses three abundant rock types: Sedimentary (Bauru basin and Cenozoic deposits), metamorphic (Pre-Cambrian basement – Araxá Group, Bambuí and Canastra) and magmatic (Serra Geral Formation and alkaline intrusions from Alto-Paranaíba uplift).

Araxá Group is the only unit representing Proterozoic, found around the study area, possessing its main outcrops on the East portion of Triângulo Mineiro, however, it also occur over the canyons dug by Araguari river and Uberabinha river in low course (NISHIYAMA, 1989).

Botucatu Formation consists of sandstones located above the crystalline basement from Araxá Group and below/interspersed the volcanic rocks from Serra Geral Formation or Bauru Group, showing low occurrence of outcrops over the region. The sandstone grains are rounded and opaque, indicating eolian transport and origin, its stratification is predominantly plane-parallel changing to crossed (NISHYAMA 1989).

Starting from this stratigraphic level, the formations are exposed on their own erosive scarp from the analyzed plateau or superficially outcropping in road cuts, becoming primarily source material for surface coverings.

Serra Geral Formation consists of basaltic rocks with small sandstone lenses alternating with the spills, possesses massive aspect with containing irregular and subconchoidal fractures, forming layers with diverse thickness over the numerous cycles of spills (BARCELOS, 1984). Above this Formation, the sedimentary rocks from Bauru group are to be found, grouping up Adamantina, Uberaba and Marília Formation. The sandstones from Bauru Group present variable granulometry and composition, however, they are very friable, thus being susceptible to erosive cycle, therefore becoming the basis to the tabular relief in the region.

From Bauru Group, the uppermost member, Marília Formation, is constituted by flat surface covers and scarped edges between Grande, Paranaíba and Araguari rivers. According to Barcelos (1983), forming sierra tabular reliefs throughout its area of occurrence over the Triângulo Mineiro oriental portion. Composed by very friable conglomeratic sandstones with crossed stratification, possess significant amount of calcium carbonate in its composition. According to Batezelli (2003), the soils deriving from this rock are very friable, originating sandy soils and medium texture, favoring mechanic erosion and posteriorly gullies appearance.

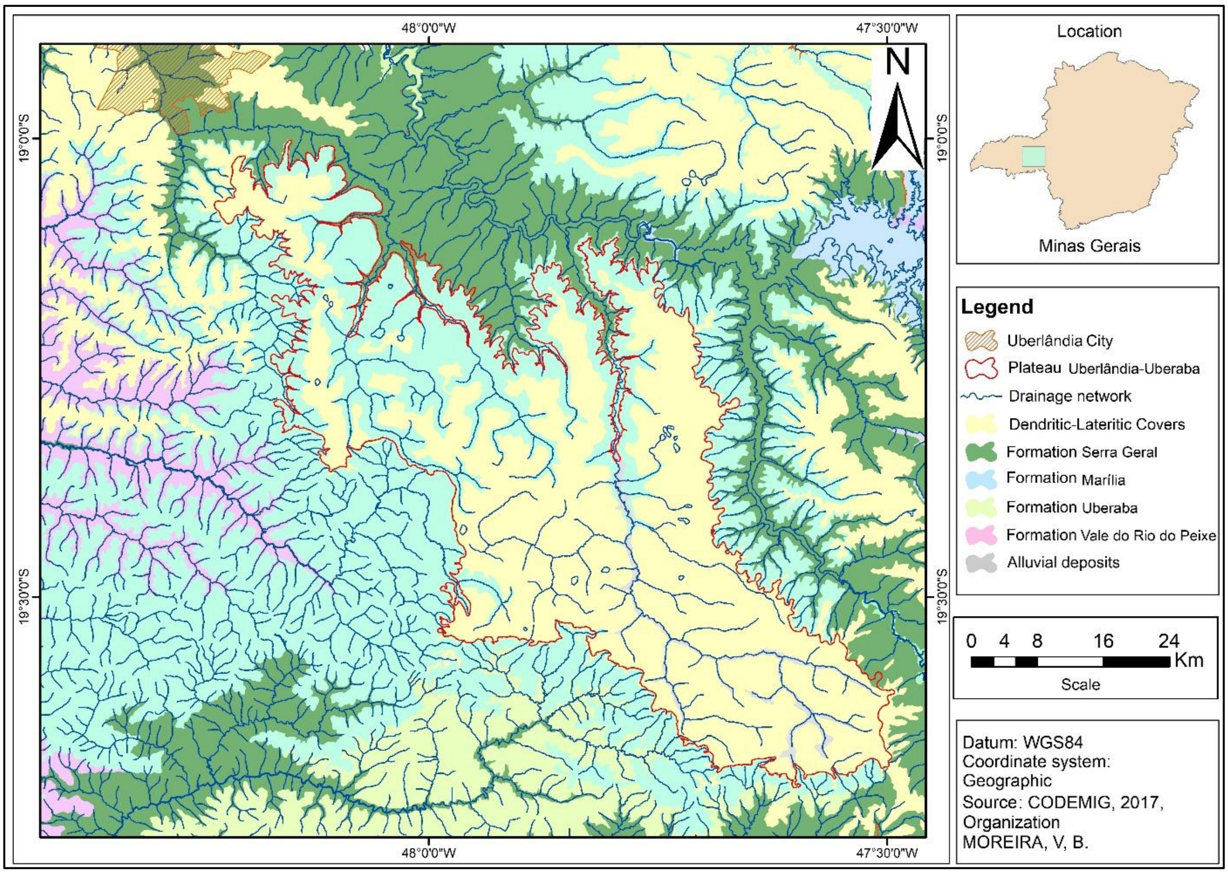
Covering the tops from part of the regional lithology, especially over Uberlâdia-Uberada plateau and surroundings, occur the Cenozoic Covers described by Barcelos (1984) or Dendritic-Lateritic Covers characterized by Mamede et al. (1983) as: Planned surfaces located in quotas superior to 800 meters, over Paleozoic and Mesozoic lithology from Paraná Sedimentary Basin. Lateritic hardpans on the basis below mottled clays and homogenous sandy-clay or clay packets about 20 meters thick.

There are important debates in the literature regarding the origin of Cenozoic cover material. One current of researchers points to sedimentation evidences and material remobilization over the Tertiary covering levels of planation as Mamede et al. (1983), Barcelos (1984), Nishiyama (1989) and Baccaro (1991) suggesting new aloestratigraphic unit. Another current defends that covers found above Triângulo Mineiro plateau are evidence of alteration in situ of underlying rocks from Marília Formation, altered by the time of exposure, as described by Lima (1996), Feltran Filho (1997) among others. In reports of RADAMBRASIL project, pedologists, geologists and geomorphologists, present distinct hypothesis on the subject, and are prolonging for many years the debate over the origin of the covering material.

The firstly systematized geological maps in small scale to all Minas Gerais estate, disregard Cenozoic covers in the region of Triângulo Mineiro, or limit them in small occurrence areas. According to Moreira (2017), that was considered a misconception, for this Cenozoic coverings cover all the lithology from Uberlândia-Uberaba plateau, becoming a relevant element to comprehend the occurrence of typical geoforms in plateau tops.

The most recent geological mapping of Triângulo Mineiro region accomplished by CODEMIG (2017) in a more adequate scale to the region, retake the discussions regarding the covering material, denominating them Dendritic-Lateritic coverings, recognizing its vast occurrence over the plateaus in Triângulo Mineiro, corroborating the line of thinking from the authors found in this manuscript. On Figure 1, the most recent geological map is presented with the Uberlândia-Uberada plateau being delimited.

Figure 1 – Uberlândia-Uberaba plateau and surroudings litoestratigraphic units.



Source: CODEMIG, 2017. Adapted by the authors.

Planation Surfaces

Planation surfaces can be defined by erosion or accumulation surfaces, resulting from structural or paleoclimatic processes, sculpted during different geological periods/epochs, being those short or prolonged duration events (MARQUES NETO, 2014). According to Silva (2009), the most elevated level of surfaces tends to be older than the ones found in lower levels, consequently being younger.

The shape and extension of these surfaces can be diverse, depending on tectonic activity, lithology resistance and homogeneity that has been under the process. Rocks more resistant to erosion tend to sustain these surfaces for more time and in a contiguous way (SILVA, 2009). In areas where occur tender lithologies, the surfaces tend to be fragmented, however in some places, with specific characteristics such as Uberlândia-Uberaba plateau, the surface is continuous due to the occurrence of resistant paleosurfaces (detritic-lateritic pavement) and for the low density of the drainage network, which decreases the performance from erosion processes of surface separation.

According to Salgado (2007), considering the large amount of works available related to the topic, there is no possibility to comprehend origin of a planation surface at a given location, making use of a unique theoretic model, for there are correct and incorrect points in each one of them. A broader view is made necessary to consider such hypothesis of surfaces origin to a determined region. Therefore, juxtaposing several authors and their relative chronologies referring to periods of relief planation, may be the path to achieve conclusions on the plateaus of the study area.

Authors such as De Martone (1943), King (1956), Barbosa (1959), Ab'Saber (1962), Bigarella et al. (1965) and Valadão (1998) proposed relative chronologies to several surfaces recognized within the Brazilian territory, however, the chronology between these authors differs in terms of period and structural/sculptural agents.

Silva (2009) presents a comparative chart of planation events and chronologies (Frame 1), according to the aforementioned authors, recognizing similarities and complement within their works.

Comparing every theoretic model on the topic, it is observed that "South-American" surface from King (1956) was widely discussed and recognized throughout the national territory, being cited by several authors as found in the review made by Marques Neto (2014). Regarding Triângulo Mineiro region, Baccaro (1991), relates the South American surface from King (1956) to the summit levels (flat tops that occur between 950 and 1050 meters) which have been flattened by denudational processes, posteriorly sculpted by the "Velhas" and "Paraguaçu" cycles providing staggering aspect to the local plateaus.

Due to the higher correlation presented in other studies, the model developed by King (1959), will be used as a model of reference in this research, in order to understand planation surfaces genesis.

After Bauru Group sedimentation in Triângulo Mineiro, which dates from superior Cretaceous, in the Paleongene, according to King (1956), occurred a vast period of continental proportions with dry/arid climate, and as a result produced planation surfaces and leveled several topographies throughout the Brazilian and African relief, forming extensive detritic pavements over the surface and providing tabular format to the plateaus present in the studied region, this event is known as South American Surface. Posteriorly to this event, according to King (1956), another period of erosion occurred, carving part of this surface during the Neogene, characterizing the "Velhas" cycle.

The "Velhas" cycle, would be responsible for the incision of fluvial valleys in Minas Gerais and São Paulo, carving the plateaus produced by the previous cycle, rarely reaching the generalized planation phase as the previous surface. The difference of topographic levels in the South American surface and the "Velhas" cycle is of approximately a 100 meters, possessing as main characteristic the drainage channels branching and ridges for the most recent surface. According to King (1956), this cycle is yet responsible for the origin of extensive sandy deposits of Pliocene age in the coastal region, denominated Barreiras Formation.

Frame 1 – Events and relative chronologies of planation surfaces.

Author / Period Epoch	De Martone (1943)	King (1956)	Ab'Saber (1962)	Bigarella et. al (1965)	Barbosa (1959)	Almeida (1964)	Valadão (1998)
Quaternary		Cycle Paraguaçu	Surface Jundiai	Terraces Pedimented	Surface Pleistocênica		
Plio-Plaistocene				Pd1		Several surfaces along valleys, caused by slope erosion, without lateral planing	Surface South-American II
Neogene	Surface Neogene	Cycle Velhas	Surface Neogene		Surface "Araxá"		Surface South-American I
Tertiary Middle			Surface of medium ridges	Pd2		Surface Japi	Surface South-American
Paleogene	Surface Paleogene	Cycle South-American		Pd3	Surface after Bauru		
Cretaceous Upper		Cycle after Gondwana	Surface high Field		Surface Gondwana		
Cretaceous Middle	Surface of field	Cycle Gondwana					
Jurassic							
Triassic		Surface Desert					
Permian							
Carboniferous						Surface Itaguá	
Devonian						Surface Itapeva	

Source: Silva, 2009. Adapted by the author.

In accordance with King (1956), in relation to denudational events post Cretaceous, Ab'Saber (1972) points that past the end of Group Bauru sedimentation, there was a drier/semi-arid period, enabling planation processes to occur easily, remobilizing materials, demoting the plateau tops and producing lateritic hardpan basis, nowadays being surfaces corresponding to the summit levels. During part of the Tertiary the climate became wetter establishing the current drainage system which carved the plateaus.

In the Quaternary, the last cycle described by King (1956), denominated "Paraguaçú", would be responsible for deepening the already established river channels that in our interpretation, exhumed Neo-Proterozoic rocks found in the river valleys from Uberabinha and Araguari rivers, nearby Uberlândia-Uberaba plateau.

Planation Surfaces and associated soil types

Among the publications dedicated to identifying the correlations between planation surfaces and associated soil types in the central plateau, there is concordance concerning the factors of the soil formation in these conditions. Motta et al. (2002) and Barbosa et al. (2009) describe three planation surfaces in plateaus close to Distrito Federal, Brazil, concluding that the soil origin material over the three surfaces are entirely different, possessing distinct chemical and mineralogical characteristics.

Through comparative research performed in the three regions from central plateau, Marques et al. (2004), utilizes Th (thorium) / Zr (zirconium) concentration rates to verify that clay soils in the South American erosion surface has common origin from the sediments of Brazil central plateau rocks that has been transported to the East to cover the underlying sandstone. The authors conclude that some of the South American surface soils are amongst the most ancient of Earth and are under alteration since the Tertiary.

The presence of hardened ferruginous layers described with several nomenclatures, is often cited as fundamental for plateau maintenance, for they can delay erosive processes of marginal recoil and difficult water infiltration over the top of the plateau. According to Motta et al. (2002) the ferruginous layers are fundamental as soil origin materials, altering the chemical composition of erosive surfaces when reworked.

According to Oliveira et al. (2017), the oxisols are the type of soil with the highest occurrence in Cerrado biome, and consequently, in the central Brazil plateau region, being their typologies variable according to the geomorphic surface analyzed.

Ramos et al. (2006), identified three levels with different types of soil corresponding to different origin material nearby Uberlândia-MG city, the data presented by the authors coincide with all the characteristics observed in Uberlândia-Uberaba plateau and its surroundings, presenting the main soil types in the study area, corroborated by the soil survey from FEAM et al. (2010) and researches accomplished by Marques et al. (2004). Therefore, in Uberlândia-Uberaba plateau prevail the Red and Red-Yellow Oxisols, clayey or very clayey. Gleysols are also common in wide valleys plains and in depressions, where there is a higher humidity concentration.

Geomorphological features developed over planation surfaces and the role of Holocene climatic oscillations

When proposing the four greater units from Triângulo Mineiro, Baccaro (1991) describes the geomorphological units found in: Intensely Dissected Relief Area; Medium Dissected Relief Area; Residual Relief Area and summit areas with flat, wide and large tops, corresponding to Uberlândia-Uberaba plateau. Every unit possess intrinsic geomorphological features and are distinguished, according to the author, by their correspondent planation surfaces.

Relevant geomorphological features of the landscape are cited by Baccaro (1991) as fluvial valleys dissection, drainage density, relief ruptures, among other characteristics that are altered according to the geomorphological feature analyzed. Among the described features the Veredas and concave depressions on summit levels are emphasized in the landscape, they can be subdivided by relief dissection level.

In general, Veredas are characterized as exudation areas, or, water table emergence in flat bottom concave valleys, filled by Gleisols with high concentration of organic matter. Buriti (*Mauritia flexuosa*) is the characteristic vegetal species from this environment, by adapting to constant hydromorphy in the core of Vereda, protruding in the landscape shaped in a chain format or scattered along the entire Vereda (BOAVENTURA, 2007).

The Veredas formation factors are described by Barbosa (1967), Boaventura (2007), Lima (1996) and Ferreira (2003) among others. All the authors point planation surfaces and climate oscillation as determinant elements to the occurrence of this geomorphological feature in Brazil central region. Moreira and Perez Filho (2017) present a synthesis from the different Veredas typologies and the necessary physical environmental conditions to its genesis, spatializing them according to the geomorphological characteristics of a specific hydromorphic basin. He concluded that Veredas typologies vary according to the pattern of the relief, possessing as base different planation surfaces.

Concave depressions found at summits are generally characterized by circular or elliptic micro-relief occurrence (mounds or little hills) with variable size, denominated murundus, above them, there is a common occurrence of bushes, small trees and termites (SCHNEIDER, 1996). These depressions are also known as murundus fields, however murundus are not exclusive geoforms of this environment, for they occur in other relief portions.

Depression areas constitute in small stream springs and possess superficial water table, which oscillates according to the rainy and dry periods of the year. As for the depressions evolution where murundus can be found Schneider (1996) points geochemical processes caused by water accumulation as the responsible factor that reduced the relief and formed the depressions, theory very similar to Veredas initial formation phase. Mamede et al. (1983) proposes another explanation to the occurrence of such depressions, considering them as residual “bajadas” from antique endorheic drainages, formed during a climate drier than the current.

The cited depressions frequently occur in flattened plateaus over the central region of the country, as the Veredas, however restricted to the relief summit level, flattened by the South American Surface, where occur Detritic-Lateritic Surfaces over the hardened layers, limiting water vertical infiltration.

Starting from geomorphological interpretations Penteado-Orellana (1980) proposes evolution scenarios for murundus formation, based on Holocene climate oscillations, being fluvial morphogenesis and pediment deposits at valley bottoms the protagonists, associated to hot/humid and hot/dry climate episodes. The author proposed a model for the river valleys evolution that explain the existence of murundus and Veredas associated to the drainage network. As basis, Fairbridge curve (1962) was used as support, signalizing relative positions to the sea level to the climate oscillations to South America, and in works carried out in São

Paulo peripheral depression (PENTEADO, 1968).

MATERIALS AND METHODS

To interpret and discuss the theoretical framework, reconstruction of the paleoenvironments in plateau reliefs, erosive cycles will be correlated to: Soil types, lithology, altimetry, surface coverings and geomorphological features, constructing qualitative relief and landscape models, based on topographic profiles, morphometric indexes and aerial photographs. To complement the data raised, fieldworks were carried out in the region to recognize the described processes, elaborate the models and photographic records.

The Uberlândia-Uberada plateau delimitation was carried out from the vectorization of flat top summit areas, taking into consideration the topographic and geomorphologic aspects, adapting the methodology from Baccaro (1991). To delimit the plateau, its erosive border was used as reference, where occurred abrupt contacts between different levels. Locations where this limit could not be perceived through topographic maps or SRTM (Shuttle Radar Topography Mission) images, the topographic elevation of 900 meters prevailed as a reference of the Plateau limits.

Hydrographic and drainage density analysis were also performed, those are important elements in the hydrographic and morphometric studies, assisting in correlations on structural aspects of the hydrographic basin contributing to the landscape characterization, genesis and evolution as pointed out by Himura and Ponçano (1994).

In order to perform the morphometric indexes, topographic maps 1:50.000 made available by IBGE (Brazilian Institute of Geography and Statistics) were used, having the purpose of restoring the drainage network of the plateau, surrounding areas and drainage network classification according to Strahler (1957). Posteriorly, circular samples with 2km radius were superimposed, uniformly distributed over the analyzed area, as indicated by Rodrigues (2006).

To elaborate the evolutional phases from Uberlândia-Uberada plateau in block diagrams, the baseline information collected during the literature review regarding the rocky substrate and surface coverings was used, summing to the model proposed by Penteado-Orellana (1980), that through river valleys morphological interpretation, explain the origin of murundus and Veredas as Holocene forms, Fairbridge curve (1962) and Penteado (1968) configured the theoretical basis of this model. Recent works utilizing absolute geochronology such as Salgado-Laboriau (1994), Behling (1995), Boaventura (2007), Storani e Perez Filho (2015) e Dias e Perez Filho (2015) reaffirmed the chronology and environmental characteristics proposed in the model, detailing the importance of Holocene climatic oscillations described by Penteado (1968), being fundamental to construct the scenarios proposed.

The softwares ArcGIS 10.5.1, Corel draw 2018 and Global Mapper 18 were used to produce the profiles and models, aggregating the information gathered over the course of the research, in the discussions and presented results.

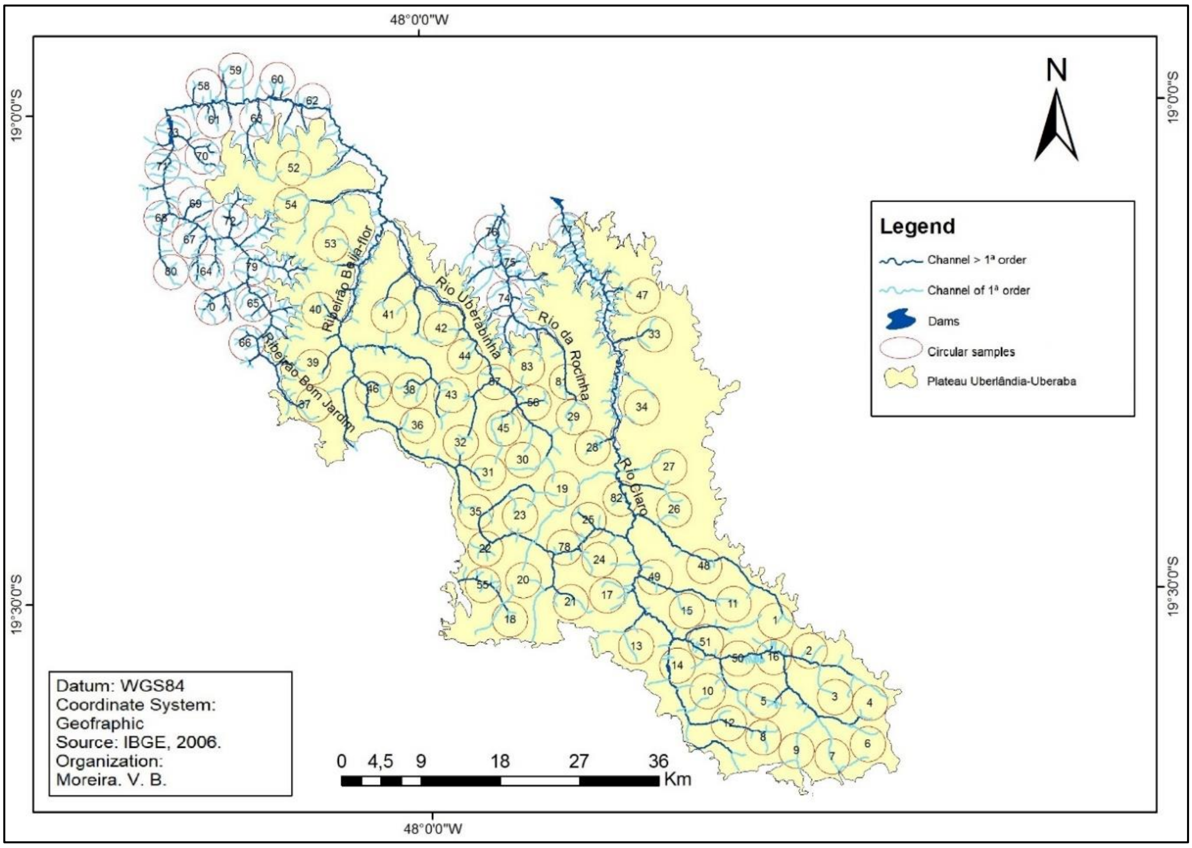
RESULTS AND DISCUSSIONS

Morphometric parameters

To analyze the desired environmental variables two morphometric indexes were preliminary applied over the drainage network of the study area, the figure 2 presents the distribution of circular samples over the drainage network of Uberlândia-Uberaba plateau and its surrounding areas, thereby, it was possible to measure the drainage density and hydrographic density average values through this technique.

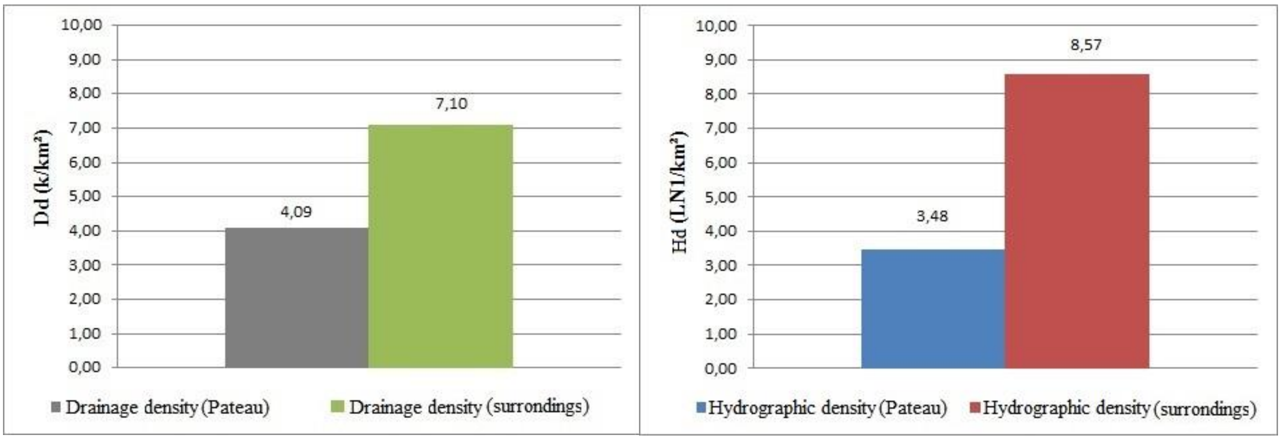
Drainage density and hydrographic density average values (Charts 1 and 2), leave no doubts as to the importance of the Detritic-Lateritic Cover to maintain the current hydrologic equilibrium of the plateau in the study area. The covers delay erosive processes maintaining the drainage network slightly branched, so the number of first order channels is much lower in relation to the surrounding area analyzed. In this context, concretionary sub-layers and local base level, described by authors such as Baccaro (1991), Schneider (1996), Penteado-Orellana (1980), among others, has an important role as agents that slow down surface erosive processes.

Figure 2 – Sampling of Uberlândia-Uberaba plateau and surrounding areas drainage network.



Source: IBGE, 2006, adapted by the authors.

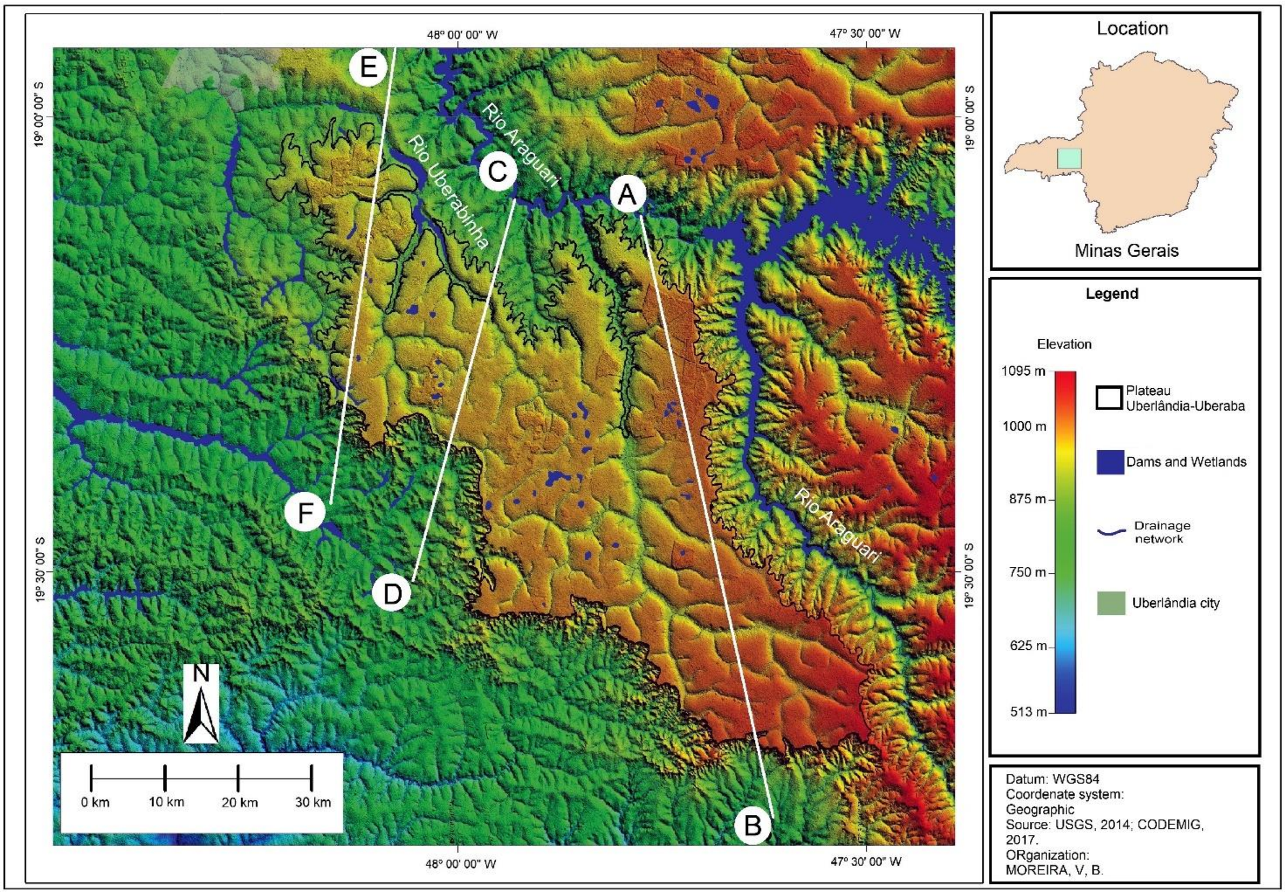
Charts 1 and 2 – Hydrographic density and drainage density average values.



Source: Created by the authors.

Referencing on SRTM radar images with 30 meters spatial resolution (Figure 3), which represents Uberlândia-Uberaba plateau was elaborated in red and yellow tones, predominantly possessing a higher altimetry to the West.

Figure 3 – Transects and regional elevation of Uberlândia-Uberaba plateau.



Source: USAF, 2014, adapted by the author.

Complementing morphometric information, three transversal topographic profiles were produced on different points of the plateau starting North of Araguari river, regional base level, ending at the South of the plateau. Associated with the profiles, were added bars representing the underlying lithology throughout the profile to assist in its interpretation. Three sub-divisions were added to the profiles, representing the planation surfaces according to the referenced bibliography.

A-B, C-D and E-F transects provide the location of profiles produced to identify topographic levels affected by erosive cycles, since the local base level, Araguari river, until levels posterior to the plateau.

Figure 4 – A-B, C-D and E-F transversal topographic profiles.

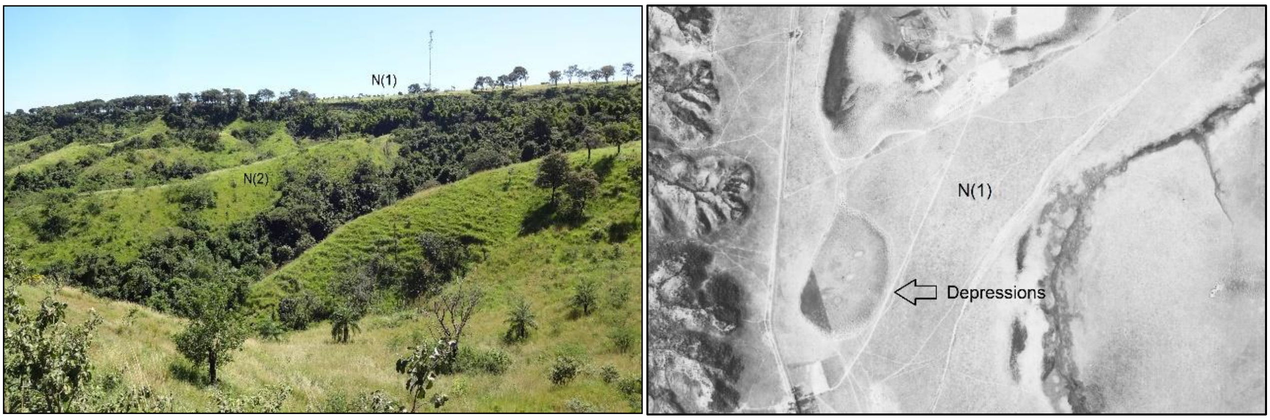
Source: Produced by the authors.

The topographic level represented N(1) acronym in the presented transects indicates generalized planation occurrence caused by the South American erosive cycle, being the oldest and highest level of the regional relief. This level possess peculiar characteristics that differentiate and emphasize it on the landscape, Detritic-Lateritic Covers were confirmed as the main lithological substrate occurring at this level, however, sandstones from Marília Formation are to be found above the plateau, mainly on lower elevation areas. In C-D and E-F profiles is possible to observe that Uberabinha river and its main tributaries dissect the plateau, isolating South American surface parts, common characteristic of the plateau relief geomorphological evolution, causing subdivisions in the flattened surface and increasing the edge erosive processes.

The main springs of the rivers that drain the region appear in N(1) topographic level, possessing shallow and wide valleys, their limits are highly demarcated by abrupt contacts in relation to other levels (Photograph 1) in these contacts were also identified recent river captures, which indicate the progress of erosion.

The main geomorphological feature of the characteristic surface from N(1) level are the summit depressions populated by murundus (Photograph 2), they are seasonally flooded and contribute to supply the first order channels of Uberlândia-Uberaba plateau, fulfilling the role of springs, characterizing itself as the initial phase of the Vereda.

Photographs 1 and 2 – Abrupt contact between N(1) and N(2) surfaces and area horizontal view.



Source: Authors; USAF, 1964.

N(2) surface is represented by more dissected areas in the surroundings of Uberlândia-Uberaba plateau, embedded valleys and dense drainage network resultant from Velhas cycle are highlighted in the ladscape. The lithology is characterized by the contact between sedimentary rocks from Marília Formation and basalts from Serra Geral Formation, being both lithologies source for soils origin material. There are several typologies of Veredas in this level that occupy the springs and follow the river channels during long extensions.

N(3) is the last identified surface and it is the lowest portion of the analyzed relief, suffered from the bygone erosive cycle pointing to the region the Paraguaçú Cycle, that exposed Serra Geral Formation and Uberaba Formation in the analyzed frame, establishing Araguari river as the local base level. This unit is characterized by fluvial channels densification and higher relief dissection, possessing lower elevation levels than N(2) surface.

Recent landscape evolutional phases in Uberlândia-Uberaba plateau

For the purpose of synthetize part of the information raised and discussed by this work regarding surface geomorphological features, five scenarios of Uberlândia-Uberaba plateau were elaborated, figure 5, referring to evolutional phases where climate pulses are emphasized as relevant transformation agents of Holocene landscapes, along with other geomorphological processes analyzed, considering the planation surfaces and Detritic-Lateritic covers establishment, adapting the model from Penteado-Orellana (1980).

The initial scenario analysis "A", establishes itself in the limit between Pleistocene and Holocene, period characterized by the Last Glacial Maximum strong influence 12.000 to 10.000 B.P. (Before present). Characterized by flattened tabular relief retouched by glaciations with low incision of river channels attributable to poor hydric availability, depression absence and spaced vegetation (SALGADO-LABORIAU, 1994).

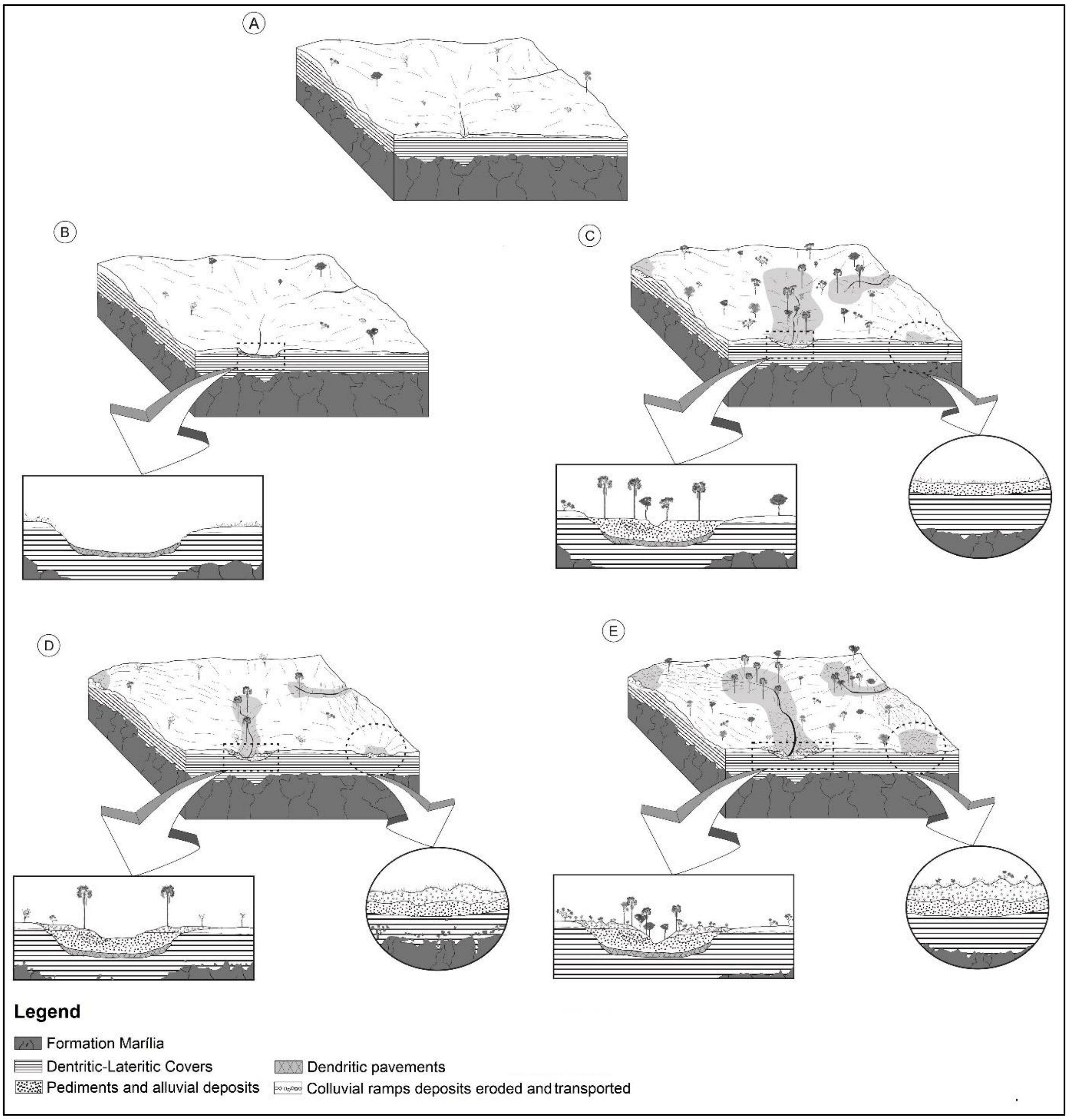
During phase "B", a period of drier climate yet prevails, remnants of the Last Glacial Maximum influence, however, starts the phase of valleys pediplanation with predominance of valley widening processes with formation of dendritic pavements at the base, as a result of torrential rain. Vegetation retraction, predominance of grasses and shrubs, low presence or arboreal sized vegetation 9.000 to 6.000 years B.P.

Posteriorly, during the third evolutional phase "C" predominates a sub-humid climate pulse, possessing as characteristics: incision of pedimented valleys and alluvial deposits. Geochemical dejection processes activation in interfluves directed by substrate fractures; Expansion of Cerrado vegetation, gallery forests and Buritis formation; First Veredas appearance at the border of the plateau with current characteristics; 6.000 to 4.000 B.P.

Upon returning to a drier period during phase "D", between 4.500 to 2.000 years B.P. approximately, occurs a new pediplanation phase in valleys and depressions, forming colluvial ramps; Valley inlay and widening; Cerrado vegetation retraction in relation to the bygone phase, rarefaction of arboreal vegetation and mechanical morphogenesis predominance.

The present evolutional phase "D", retakes a wetter period with thalweg incision, resumed by erosive processes, colluvial ramps sectioning by differential erosion; establishment of murundu microreliefs associated to depressions and valley bottoms; Intermittent connection establishment between depressions and first order channels in the plateaus, processes stabilized in the last 2.000 years.

Figure 5 – Possible Uberlândia-Uberaba plateau Holocene evolutional scenarios.



Source: Penteado-Orellana, 1980; Moreira, 2017. Adapted by the authors.

FINAL CONSIDERATIONS

The results achieved by methodology and applied techniques usage evidenced compatibility with the bibliography analyzed, enabling positioning in such a complex theme which is the landscape evolution in plateau reliefs.

Therefore, past these Tertiary/Quaternary planation events it can be concluded that several planation surfaces were established, Uberlândia-Uberaba plateau being correspondent to the highest surface in the region. Detritic-Lateritic covers overlayed some of the surfaces characterized by clayey material, which gave origin to surface coverings of texture with the same characteristic, basis to all the processes that occurred in the plateau afterwards. Posteriorly, caused by the tabular relief characteristics with low permeability, there was a high humidity concentration, where predominated geochemical processes over the plateau during the humid periods that have succeeded.

From faults and fractures of the rocky substrate (Marília Formation), preferential locations for the emergence of closed depressions have been established, formed by geochemical dejection of the relief. Several depressions were interconnected by rainwater runoff, due to overflow in rainy periods and subsequently connected to river channels, caused by heardward erosion.

During the Holocene, climate pulses returned to interfere in the modeling of the plateau relief, this time superficially. Between described dry and humid periods the Detritic-Lateritic cover was reworked forming pediments and colluvial ramps in the depressions and valley bottoms established during the bygone phase.

Projecting a future scenario, the referred plateau tends to disappear with the geomorphological processes advancement, for currently is configured as a relict of the extension it once had. The headward erosion active at the edge of the plateau, creates new drainage network captures and tends to remove major part of the humidity, inverting some channels that drain to the North (Rio Paranaíba basin), to the South (Rio Grande basin). And, from this moment, new processes that can generate new landscapes will be established.

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