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Relationships Between the Parameters of Geomorphology and Structural Features in the Pan African Fold Belt of Cameroon. Example of Kombé II-Mayabo Area

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Abstract: The study of satellite images or aerial photographs is often preliminary for geological field trips. Geologists, especially those in the undeveloped countries do not have access to landsat or aerial photographs. This study is intended to show that the use of geomorphological parameters like topographic maps can permit one to overcome such difficulties. Relations between morphology and rocks of basement are known and treated on physical geography and geomorphology revues and treaty. Correlation between structures, orography and river network in part of the Panafrican fold belt of Cameroon were studied based on the above relationships. The attitude of the topography is imposed by ductile deformation which builds up mega-structures. The hydrographic network is guided by the tectonic lines. This highlights the tectonic from hydrographic network It appears that geomorphological parameters are attributable to geologic factors. Thus, these parameters are to be taken as useful elements for structural cartography in the Pan African terrains. This methodology of cartography, involving a judicious study of topographic maps, is recommended as a preliminary work in areas without landsat images or aerial photographs and for researchers who do not have sufficient financial support to provide themselves with images or aerial photographs.

Key words: Geomorphology, topography, hydrography, cartography, structural, pan African fold belt, Cameroon, kombe II-Mayabo

INTRODUCTION

The study of aerial photographs and satellite images, which results are correlated on the topographic map, constitutes preliminary works for geological field trips. This preliminary study is not often easy, this for many reasons such as the lack of the financial support for the acquisition of satellite images or aerial photo-graphs (particularly in some underdeveloped countries), the poor quality of existing aerial photographs and the lack of these photographs or images. Thus, the present study dos not aim at a classical geomorphology description, but to show that the exploitation of the relationship between geomorphological parameters and geological factors can be used to side track the above difficulties.

The relationship between geomorphology and basement complex rocks are known and treated in physical geography and geomorphological revues and treaty: Chardonnet, 1965; Coque, 1977; Tricart, 1981; Derruau, 1988, 1990 etc. In this manner, one knows the karst relief, saline relief. The Appalachian relief is a particular type which does not only emphasize the nature of the rock, but also on the relation between morphology and the deformation of the rocks (Tricart and Cailleux, 1963). There is, therefore inversion of relief with perched synclines and anticlines. This type of relief is characteristic of the Appalachia mountain, in the East of USA, widely studied by John Rodger (1970, 1987), Dallmeyer (1989), Lafrance (1990). Bordonau and Vilaplana (1986) establish a relation between geomorphology and recent tectonic in the Val d'Aran (Spain). They show that the fracturation of the port of Vielha have been launch by neotectonic activity of the Maladetta Fault in connection with a probably isostatic uplift. Delcaillau (1986) studies the dynamic and the morphostructural evolution of the frontal ‘‘piemont’’ of the Himalaya and shows that the morphologic organisation of Siwaliks hills (Eastern Nepal) is controlled by the superposition overlapping and imbricate soils.

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The present work does not made a classical geomorphological study, widely study by Kuété (1990) in the southern part of Cameroon, but based on the correlations between geologic factors (mainly structural) and geomorphologic parameters, in a portion of the pan african fold belt of Cameroon (the Kombé II-Mayabo area), shows that these parameters constitute useful elements for structural cartography. The aim of our study is to show that when one lack aerial photographs or satellite images, it is possible to proceed to a structural cartography by a judicious study of topographic maps

Geological setting: The Kombe II-Mayabo is a small portion of the southern part of the pan African fold belt of Cameroon (Fig. 1). Weecksteen (1957) identified in the area (and its surrounding) quartzites, orthogneisses, metamorphosed mafic rocks, migmatite and hypersthen granulite. According to mvondo Ondoa (1983), at Bafia region, Ngnotue (1997) in the Ntui-Betamba area, Ganwa (1998) in the Kombe II-Mayabo area, Tchakounté (1999) in the Bayomen Etoundou area, the region is made up of NNE-SSW extensive granitoid massif, of gneisses, leptynites, amphibolites and micaschists. Structural study has been carried out in the Kombé II-Mayabo area at map and mesoscopical scales by Ganwa (1998), Ganwa *et al.* (2001). The area underwent three deformation phases; the first phase is characterised by S1 foliation and F1 folds; the second phase, tangential and shearing, is responsible of regional folds, S2 lineation, L2 stretching lineation and C2. The last deformation phase is essentially brittle with faults and diaclases.

The topographical units: The Kombé II-Mayabo area can be describe as a parallelogram delimitated by latitudes 4°24' and 4°35' north and longitudes 10°40' and 11°00' East. It consists of hills, plateaux and plains. These topographical units with chains, western plateau and eastern plain are shown in Fig. 2.

Two chains (western chain and eastern chain) stretching NNE-SSW can be seen in the area. The western chain stretches on 9 km between the village Kombé II and the northern edge of the study area. It is bordered to the west by the river Mbadi and to the east by the river Liwa. The western chain shows asymmetrical hillsides,

Fig. 1 : (a) Position of the Bafia area in the Pan-African fold belt of Cameroon. CL: Cameroon Line; SF: Sanaga Fault; CCC: "Cisaillement Centre Camerounais". Jegouzo, 1984, modified by Nzenti *et al.*, 1984.
(b) Geological sketch map of Bafia area (redraw after Weecksteen, 1961) showing the Kombé II-Mayabo area. 1- Tertiary volcanism; 2-Cretaceous Sediments; 3- Granite; 4-"Embrechite gneiss"; 5-Micaschist and quartzite; 6-Undiferenciated gneisses; 7-Amphibolites, pyroxenites; 8-Hypersthene granulite facies; 9-Dip and strike; 10-Tectonic lines; 11-Faults

Fig. 2: (a) Map showing the topographic unit (deduced from the topographic map) of the Kombé II-Mayabo area. W.C. Western Chain; E.C.-Eastern Chain; W.P. Western Plateau; E.P. Eastern Plain; C.C. Central Corridor. (b) Bloc diagram of the Kombé II-Mayabo area showing the topography of the area

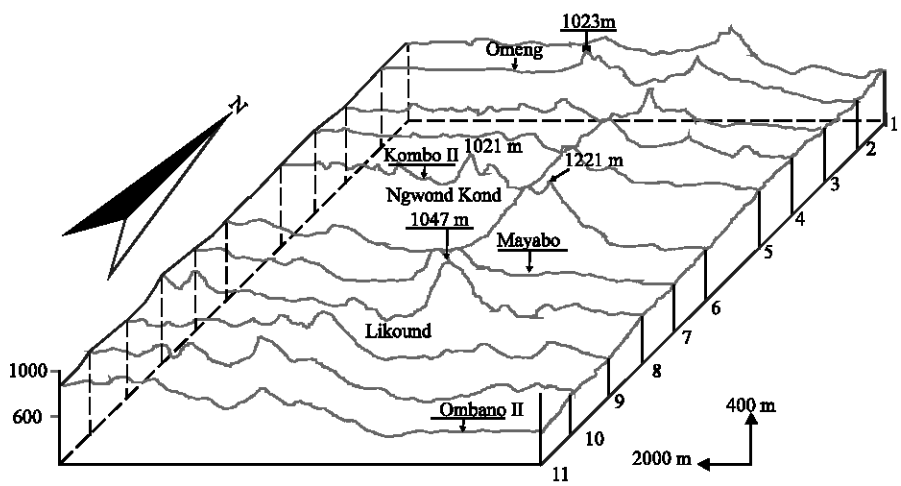

Fig. 3: Series of East-West profiles across the kombé II-mayabo area

the western slopes being higher than the astern slopes Fig. 3, Table 1. The dip direction of the western hillsides is opposite to of the basement rock's one; This basement rocks shows the same dip direction as the eastern hillsides. The higher points are located at Kombe II (1021 m) and Omeng (1023 m). The eastern chain (16 km long) shows a narrow stretching part and a massive part with "hook" shape. It is also characterised by asymmetrical hillsides Fig. 3, Table 2. The higher points are represented by the crowns Kolie (1221 m) and Ngwond Kond (1047 m). At the top of the chains crops out muscovite and biotite quartzite. Mica form beds of mm to many cm thick. Below 900 m appears gneiss with inliers of amphibolites, micaschist and quartzite.

Table 1: East and west slopes (in degree) of the western chain along the topographic profiles 1 to 6 of the Fig. 3

	Profiles					
Slopes	1	2	3	4	5	6
west	10	52	45	62	66	42
east	29	49	41	40	49	40

Table 2: East and west slopes (in degree) of the eastern chain along the topographic profiles 1 to 8 of the Fig. 3

	Profiles							
Slopes	1	2	3	4	5	6	7	8
west	50	45	62	58	49	59	61	66
east	35	21	51	34	41	48	27	47

Lying to the west of the chains, the Western Plateau (W.P.) has on its eastern edge a hilly topography with relative flat surfaces, more or less dissected by streams.

Fig. 4: Map of Kombé II-Mayabo area showing relationship between structures and topography. 1- trajectory of S1 foliation; 2- stricke and dip of S1 foliation; 3- Direction and plunge of L2 lineation; 4- direction and plunge of A2 folds axes; 5- cracks and Faults

This alignment of hills with mean altitude of 920 m shows a concavity to the north east. Beyond the hills, western plateau has an altitude of 760 to 780 m. At the top of certain hills, over 900 m, appears quartzite which becomes crushed with alteration.

The Eastern Plain (E.P.) plain with altitude of 600 to 680 m is drained by many sources of the river Nobomo. It is made up of leptynite and gneiss with inliers of amphibolites and micaschist.

In the kombe II-Mayabo area, weathered products are evacuated through a "Central Coridor" (C.C.) which stretches from north to south.

Influence of tectonics on the relief: The relations between tectonic and geomorphologic parameters appear clearly when one superimposes structural map and the map of contour lines of the study area (Fig. 4). The reorientation of S1 foliation materialises regional folds. In the centre North, the trajectories of foliation are parallel to the stretching direction of the chains. The two branches of the northern part of the eastern chain are superimposed on the limbs of one megafold. The crest line is parallel to the foliation's trajectories and lead to the coincidence between the periclinal ends of regional folds and the southern edge of the chains. This type of relation between trajectories of foliation and relief can be seen in the occidental chain and the occidental plateau at the level of Nsé. Based on the above relationships, structural features can be deduced from the behaviour of the relief.

Fig. 5: Map of the Kombé II-Mayabo area showing the relationship between structures and hydrographic network. 1-: Rivers; 2: Trajectories of S1 foliation; 3: Fracture cleavage; 4: Cracks and fractures

Influence of tectonics on the hydrographic network: The Kombé II-Mayabo area is a tiny part of the Sanaga basin, which has approximately a demijohn shape linked to the gulf of Guinea (Olivry, 1986). The hydrographic network is subdendritic to dendritic (Fig. 5) with permanent regime rivers and sources. The main collector is the River Liwa, which follows a corridor until the River Sanaga at the level of village Piparla. Rivers follow N-S, NNW-SSE and NNE-SSW direction.

Relationships between tectonic structures and hydrographic network are more apparent when one superposes hydrographic and structure's maps (Fig. 5). Rivers can be grouped in two categories: rivers concordant with structures and rivers discordant with structures. The first category is made up of rivers which are parallel to the trajectories of foliation or lineaments. An example is given by the River Liwa which is parallel to the foliation's trajectory to the north before following a NW-SE stretching fault to the south. The rivers Nobomo and Mbadi follow faults trajectories in the north east and centre of the study area. The second category of rivers is constituted by sources and rivers which cross the trajectories of foliation and fractures. These rivers are often found in the periclinal ends of the regional folds.

On the western plateau and the eastern plain, sources are located at the core of folds and flow obliquely to perpendicularly to the trajectories of foliation. This foliation serves therefore as a percolation surface which guides water to the resurgences. The sources which crosscut the trajectories of foliation at the periclinal ends of regional folds could materialise traces of a mega fracture cleavage due to the relaxation of the stress at the transition period between the second deformation phase (ductile) and the third deformation phase (brittle).

CONCLUSION

The Kombé II-mayabo area is made up of NNE-SSW stretching chains with asymmetrical hill sides, plateau and plain. The hydrographic network ranges from dendritic to subdendritic. This area underwent three deformation phases; during the second deformation phase the reorientation of the foliation leads to the edification of the regional folds. The last deformation phase is brittle. The behaviour of the topographic is imposed by the ductile deformation. The feature of the relief is therefore highlight by tectonic lines. The rivers and sources paths follow the trajectories of foliation, fracture cleavage or the fractures. Furthermore, relationships between basement rocks type and topography had been demonstrated by Ganwa, 1998.

The relashionship between the tectonic lines, topography and hydrography are very tight. This relation could lead one, in case of absence of the structural maps, to deduce the tectonic feature from the geomorphology parameters (relief, hydrographic network). Thus a good study of a topographic map in the Pan African domain is advice as preliminary work to side track the lack of aerial photographs or landsat images.

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