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Shallow Marine Cenomanian-Turonian Benthic Foraminifera and Kerogen Type from Mangoule, Logbadjeck Formation, Douala/Kribi-Campo Basin, Cameroon, West Africa

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Abstract

An integrated benthic foraminiferal and organic matter analysis of samples obtained from sedimentary sections exposed in the Mangoule-Bonepoupa area, revealed a very shallow marine paleo-depositional environment for the sediments studied, with considerable influx of continental organic matter that were accumulated during the Cenomanian-Turonian age. With reference to the lithostratigraphic profile of the Douala/Kribi-Campo Basin, the age obtained reveals that the sedimentary sections studied belong particularly to the lower section of the Logbadjeck/Mungo River Formation, based on the following benthic foraminifera assemblage: *Ammobaculites jessensis*, *Ammobaculites benuensis*, *Ammobaculites coprolithiformis*, *Ammotium cf nkalagum*, *Ammotium nwalum*, *Haplophragmoides cf beuchensis*, *Trochamina taylorana.* A particularly very poor palynomorph assemblage was recovered and included no age diagnostic species: *Acrostichum aureum*, *Lycopodiumsporites sp.*, Fungal spore, *Lavigatosporites discordatus*, *Longapertites sp.*, *Verrucosisporites sp.* An organic petrographic analysis performed on these samples revealed Kerogen Type-II and Type-III. The entire data sets obtained from this area is remarkably poor and we suspect poor preservation as the cause viewing the extent of weathering. The paleo-depositional environment of these sediments was suggested both from the foraminifera and palynomorphs present and confirmed from the organic matter types and macrofossil contents. The studied sections are composed generally of dark to dark-gray shale beds. As one of the petroleum producing basins within the Gulf of Guinea in which exploration/exploitation activities are on-going, the current research is aim at providing more data useful in the continuous search for more potential source rocks in this basin.

Keywords

Assemblage, Cenomanian-Turonian, Foraminifera, Kerogen-Type, Palynomorphs, Recovery

1. Introduction

The general scarcity of fresh sedimentary outcrop sections and the inaccessibility to subsurface data (owned exclusively by the multinational oil companies) for studies in the Douala/Kribi-Campo Basin reveal just a few but major difficulties in carrying out geological studies in the basin., The few sections sedimentary sections encountered on the field are often very highly weathered yet, still permitted considerable studies to be made.

The Douala/Kribi-Campo Basin [1] is one of the Gulf of Guinea coastal sedimentary basins which has had a long history of hydrocarbon exploration but with much fewer records of successes compared to its eastern neighboring basins; the Rio Del Rey and Niger Delta to the west and the Gabon, Congo and Angola to the south (**Figure 1**). However, in 2018, the government of Cameroon announced a licencing round that provided several multi-national oil companies an opportunity to acquire large swathes of acreage within the only two currently hydrocarbon producers in the country; the Rio del Rey and Douala/Kribi-Campo Basins [2]. This has rekindled research activities in these two basins, most especially the Douala/Kribi-Campo Basin, the focus of this research. The Rio Del Rey Basin is an eastward extension of the Niger Delta Basin of Nigeria into the south western part of Cameroon and is known to be a mature basin with significant production compared with the Douala/Kribi-Campo Basin which is still relatively underexplored, although, there are clear indications of marked grounds for optimism in its petroleum potential reason why this work is aimed at providing more to the much-needed data as the exploration activities are progressing.

This basin includes oceanic and continental sections with both marine and non-marine sedimentary fills. It is generally known to be made up of two sub basins: the Douala sub-Basin to the north and the Kribi-Campo sub-Basin in the south (**Figure 2**). The present study area is located within the Douala sub-Basin (**Figure 3**) wherein some small to considerably thick sedimentary sections that are exposed mainly as roadside cuts along the Douala-Bonepoupa-Yabassi road under construction, were sampled for this work. As in most exploration basins, several key previous publications are known, which have contributed to the current knowledge of the tectono-stratigraphic evolution, biostratigraphy, and petroleum potentials of this basin: ([1]-[12]), amongst others. Only a few published works [11] [13] [14] are found in literature on the palynostratigraphy of this

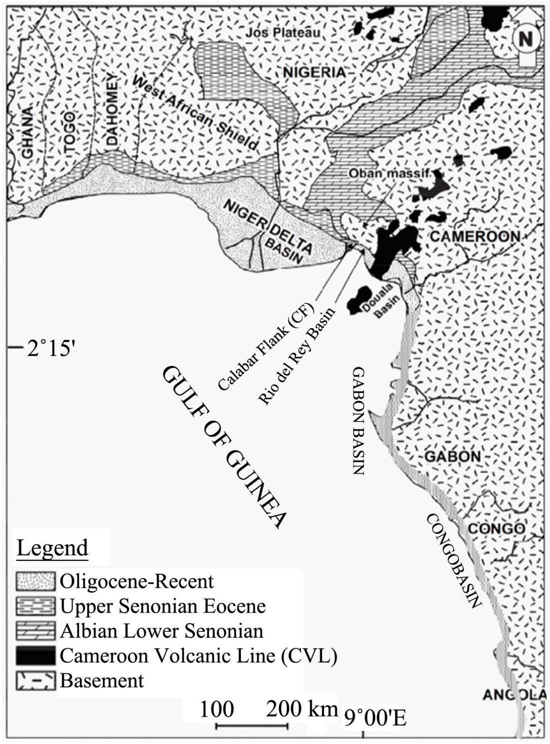

Figure 1. Map of the central part of the Gulf of Gunea, including the Douala/Kribi-Campo Basin and neighboring sedimentary basins to the west and south (Adopted from Njoh and Petters, 2008).

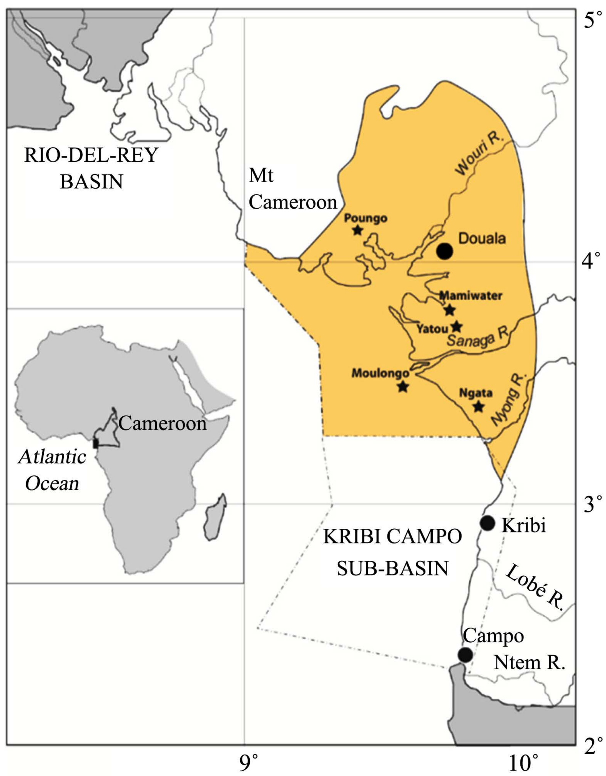

Figure 2. Map of the Douala/Kribi-Campo Basin, showing the two sub-Basins: The Douala Sub-Basin and Kribi-Campo Sub-Basin (Adopted from Ntamak-nida *et al.*, 2010).

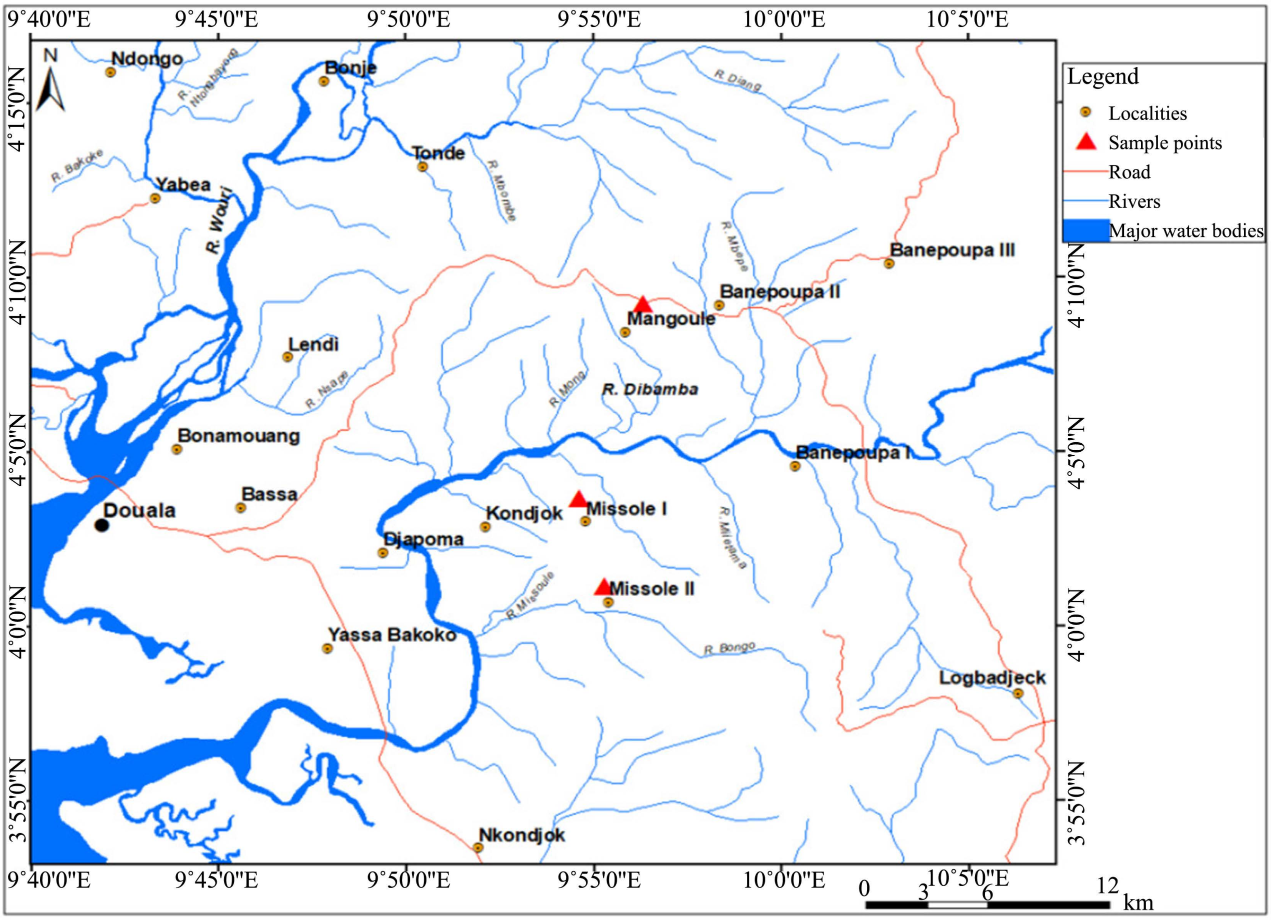

Figure 3. Outcrop location map of the Douala sub-Basin including Bonepoupa and Mangoule in the north eastern part.

basin and Foraminifera biostratigraphy [1] [12]. The present work is based on just a fair to poor foraminifera and the palynological data obtained from the studied sections. The organic matter types also assisted in the reconstruction of the paleo-environment of deposition of the sediments. The origin of the organic matter content of the sediments is indicative of the hydrocarbon potentials of the source rocks outcropping in this part of the basin.

2. Geologic Setting

The Douala/Kribi-Campo Basin [1] in one of two coastal sedimentary basins in Cameroon, the other is the Rio del Rey and both are currently hydrocarbon producers. Mamfe and Koum Basins are continental sedimentary basins amongst other but are still seen as hydrocarbon prospects (**Figure 4**). This basin which was formerly known (s.l.) as the Douala Basin [15] with the two sub basins; the Kribi-Campo sub-Basin to the souths which is more geological related to the "Aptian Salt basins" of Gabon and Angola (**Figure 1**) which were recently grouped and known as the West-Central Coastal Province [16]. The Douala sub-Basin to the north is geologically related to sedimentary processes that prevailed during the build-up of the Benue Trough.

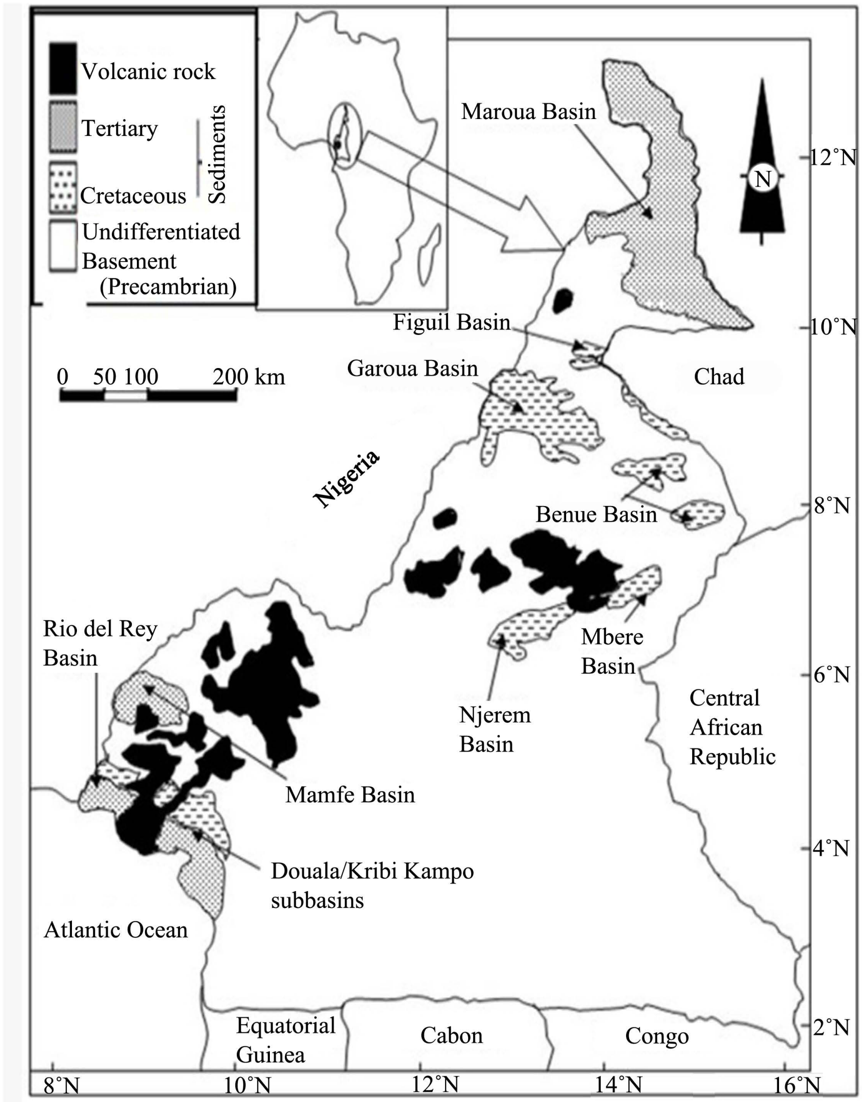

Figure 4. Map of Africa showing Cameroon and b) map of Cameroon showing all the sedimentary basins in Cameroon (Adopted from Njoh and Mesanga, 2016).

The basin is located between latitude 3˚03'N and 4˚06'N and longitude 9˚00' and 10˚00'E, covering a total surface area of 12,805 km^2 (**Figure 2**). It is bordered to the east and northeast by the Pan African Mobile Belt, to the west and northwest by the Cameroon Volcanic Line which separates it from the Rio del Rey and to the south by the coastal basins of Gabon and Rio Muni Basin of Equatorial Guinea (**Figure 1**). The Douala/Kribi-Campo Basin belongs to the NNE striking segment of the African coastline, closely associated with the opening of the South Atlantic Ocean during Early Cretaceous times [3] [17] [18]. It is well known that the South Atlantic Ocean opened progressively from south to north during the Late Jurassic to the mid-Cretaceous [19], making the basin the youngest of the series [3]. This basin and others of this sub region share common structural and stratigraphic characteristics and have undergone a complex history that can be divided into the three classical stages of the evolution of Atlantic-type margins: pre-rift stage (late Proterozoic to Late Jurassic), syn-rift stage (Late Jurassic to Early Cretaceous), and post-rift stage (Late Cretaceous to Holocene).

During the Albian, the separation between African and South American plates was completed and marked the passage from rift to post-rift phase which in the basin is not very conspicuous [5]. The post-rift stage took place during the Late Cretaceous and the Tertiary and was marked by the deposition of thick sediments, however, it experienced a short compressive episode, localized along the transform faults [8]. Older structures, especially the cross-faults, were reactivated by transpressional stresses and resulted in a folding and faulting deformation [8]. Post-rift deposits were affected by early gravity sliding (from Albian to Coniacian) and were followed during the Santonian by inversion and folding linked to a regional Santonian tectonic episode [20]. It is well noted in the Abakaliki area of Nigeria that produced the prominent unconformity of this age which is recognized throughout the West African margin. A gravitational instability during the Tertiary caused by phases of uplift was reported by [8].

The sedimentary build-up of this basin is described as follows; the basal unit is the Mundeck Formation [1] which is Berremian–Aptian to Albian in age and uncormformably overlies the Precambarian basement complex. It comprises basal conglomerates, conglomeritic sandstones, siltstones, claystones and shales that were deposited in a continental fluvio-lacustrine setting. The Logbadjeck Formation (also known as the Mungo River Formation) is directly overlying the Mundeck Formation. It ranges in age from Cenomanian to early Campanian [1] and lithofacies include; sandstone, sillstone, limestone, marlstone and shale. The two names (Mungo River and Logbadjeck Formations, respectively) for this formation are concurrently being used thus, constituting one of the problems plaguing the stratigraphy of the Douala Basin. Several authors consider Mungo River Formation as only a member of the Logbadjeck Formation while others have treated both formations as simply lateral equivalences of each other [1]. The Logbaba Formation tops the Cretaceous section of the basin and is late Campanian-Maastrichtian. It is made up of shale, sand and sandstone and in places, limestone and shale alternate.

The first Tertiary formation is the Paleocene-Eocene N'kapa Formation which is predominantly calcareous to slightly silty claystone and limestones that are locally inter-bedded with shale, sandstone and glauconitic claystone. Overlying the N'kapa Formation is the Souellaba Formation, age Oligocene-Miocene. It comprises claystone with inter-bedded sandstones and sand, locally calcareous, argillaceous and glauconitic. The next is the Matanda Formation whose age is late Pilocene-Pliestocene. Its lithology is made up of gravels, sands with inter-bedded claystones and clays and sometimes calcareous. At the top of this basin is the Pleistocene-Holocene Wouri Formation which directly overlies the Matanda Formation. It is composed of sands, sandstones, claystones with local development of tuffs and lavas (**Figure 5**).

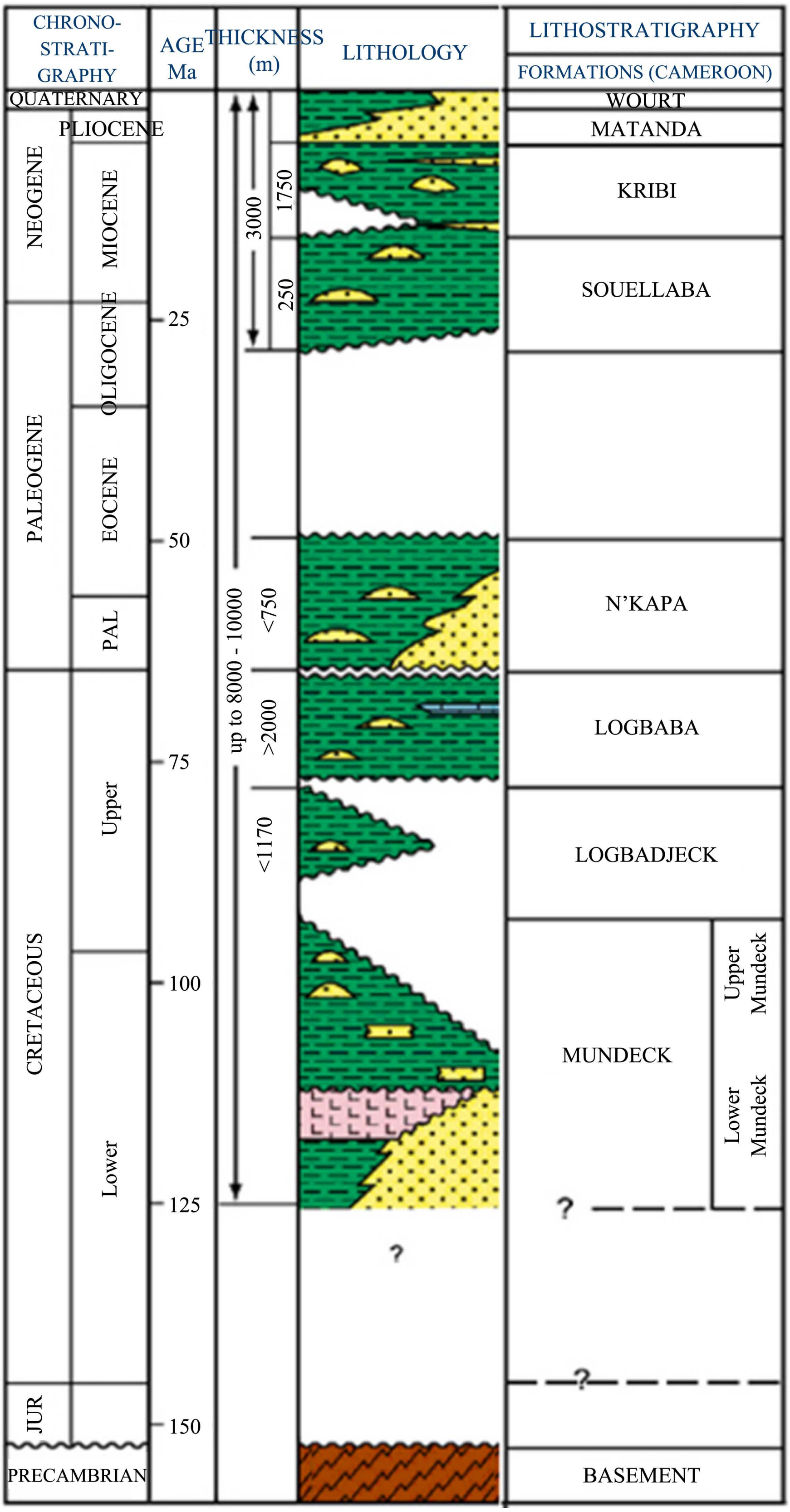

Figure 5. The lithostratigraphic scheme of the Douala Sub-Basin (Modified from Ntamak-nida *et al.*, 2010).

3. Materials and Methods

Outcrop sections encountered in the locality of Mangoule-Bonepoupa within the central part of the Douala/Kribi-Campo Basin were sampled. Studies of these sections provided the data for the lithologic variations, stratigraphy, sedimentary structures and their paleontological content. Conventional sedimentary field methods were employed to obtain all the field data and spot sampling was adopted during sample collection. Samples that were selected for foraminifera, palynological and organic matter type analyses included mudstones, shale and the clayey siltstone intervals of these sections. They were all processed according to the various standard laboratory techniques. The conventional maceration technique for recovering acid insoluble organic-walled microfossils from sediments which involved the digestion of each sample with Hydrochloric acid (35% - 38%) and Hydrofluoric acid (40%) to remove the carbonate and silicate contents of the sediments respectively [21]. This was followed by centrifuging and the use of Zinc bromide (ZnBr) with specific gravity 2.2. Only the samples intended for their palynomorph content were thereafter oxidized using conc. Nitric acid (HNO_3) for a short while before neutralizing with Potassium Hydroxide (KOH). After thoroughly washing with distilled water, the residues were preserved by adding a drop of glycerin to each of well-labeled phials. The samples were then placed on slides and examined under a Zeiss Photomicroscope with a standard stage and at 400× magnification. Photomicrographs were taken with a digital camera attached to the microscope. The dispersed organic matter obtained was further studied to ascertain their kerogen types.

On the other hand, the conventional procedure for sample preparing for their foraminifera content were used. Each sample was washed free from mud and the very indurated samples were disintegrated using an agate mortar and pistle. Next was the treatment of small quantities (about 20 - 30 g) of each outcrop sample with one teaspoonful of anhydrous sodium carbonate for thorough disintegration. Enough water was added to cover the sample and allowed over-night. The soaked sample were then washed using a 53 µ mesh sieve. Each washed sample is dried at a minimum temperature of 20˚C and sieved into coarse, medium and fine fractions. Picking and splitting was done to be followed by the description and identification.

The lithologic descriptions, foraminifera, palynological data obtained enabled the interpretation and reconstruction of the paleo-environments of deposition of the sediments studied and supported by the determination of the Organic matter type.

4. Results

1) Field description

Outcrops are generally scarce, poorly exposed due to thick vegetation, swamps and are very highly weathered. Exposures are seen mainly along roadside cuts and a few river channels and access to fresh samples proved to be very difficult.

From the field, only two representative sequences from this locality were found worthy to be described and from which proper sampling was possible. The predominantly siltstone-sandstone sections observed in the Bonepoupa area were exposed along the Bonepoupa-Yabassi road under construction. This outcrop extends along this road for over 1.5 km and this roadside cut measures at its highest point, 3.7 m. This generally exposed sub-parallel beds of massive, muddy siltstones with mud clasts, overlain by a medium to coarse grained sandstone bed, equally with mud clasts. A thinly bedded fine grained sandstone bed with mudstone lenses is then overlain by massive poorly sorted cross bedded sandstone (Figure 6)

A few small sections were encountered and studied in the Mangoule area, with one major high and extensive outcrop from samples and other useful data were collected and used for the present work. This exposure as observed in the Mangoule locality occurs as small to relatively high escarpments along the Douala-Mangoule-Bonepoupa-Yabasi road. It extends discontinuously along this road for over two kilo meters, its highest point measures up to about 4 m in height. It comprises mainly thick parallel massive beds of dark to dark-gray shale and mudstone (Figure 7) that are sometime are laminated, showing varying degrees of fissility. The beds generally dip about 8^0 in the SE and are generally very fossiliferous.

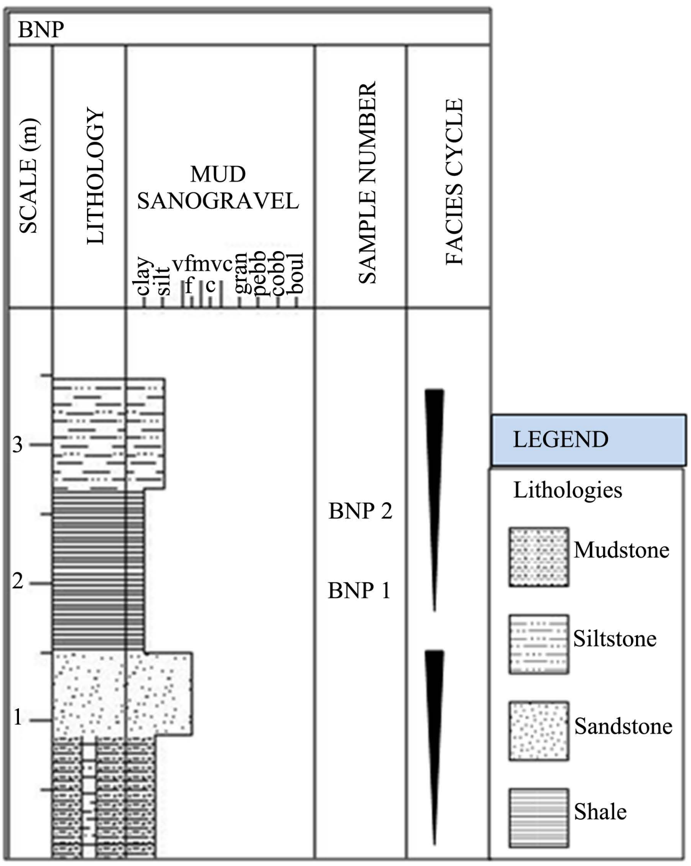

Figure 6. Logged section of the outcrop at Bonepouba with sample points as indicated.

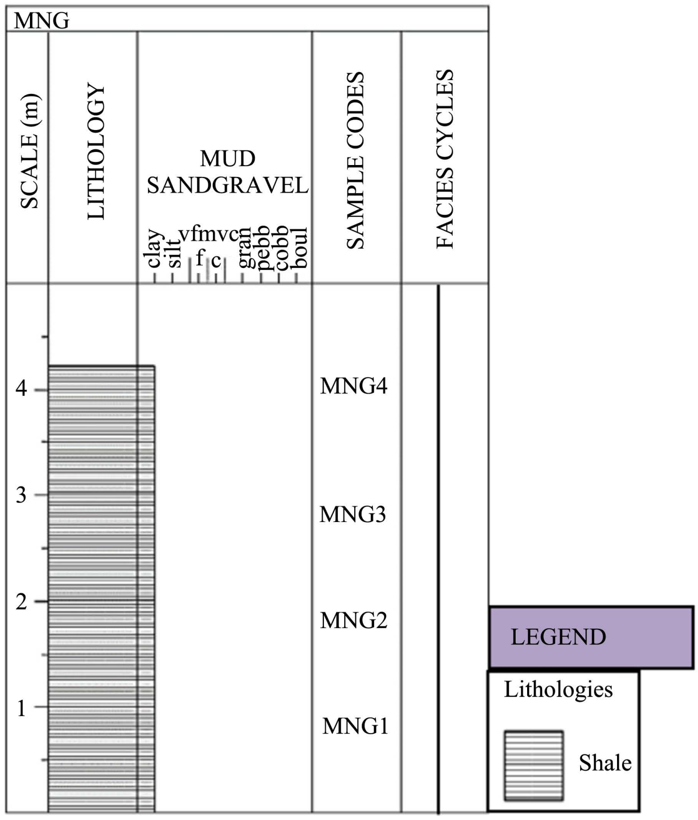

Figure 7. Logged section of the outcrop at Mangoule with sample points as indicated.

2) Paleontology

a) Macro- and trace fossils

Samples collected from the studied sections can generally be described as very fossiliferous. The presence of different types of macrofossils and their molds are very prominent. These include several taxa of gastropods and bivalves which are common in almost all the beds of the sections, in hand specimens and in the processed samples. Some of the molds are strongly ribbed, clearly planispirally coiled cephalopod shells (ammonites) which occurrence is restricted to the sections studied in the Mangoule area. Although, the macrofossils are not the focus of the present study, their prominent occurrences will assist in the interpretations of the broad age and paleo-depositional environment.

b) Foraminifera Data

The 14 samples from a very poor yielded of palynomorphs as seen below, were also processed for their foraminifera content. The foraminifera yield was equally very poor to fair, comprising only 11 forms recovered from 12 of the 14 samples analyzed. This assemblage comprises an almost exclusively agglutinated benthic foraminifera, no calcareous but for a lone planktic species. The agglutinated foraminifera species included amongst others: *Ammobaculites jessensis*, *Ammobaculites benuensis*, *Ammobaculites coprolithiformis*, *Ammotium cf nkalagum*, *Ammotium nwalum*, *Haplophragmoides cf beuchensis*, *Trochamina taylorana*, while the lone planktonic form was identified as *Heterohelix globulosa* (**Plate 1**).

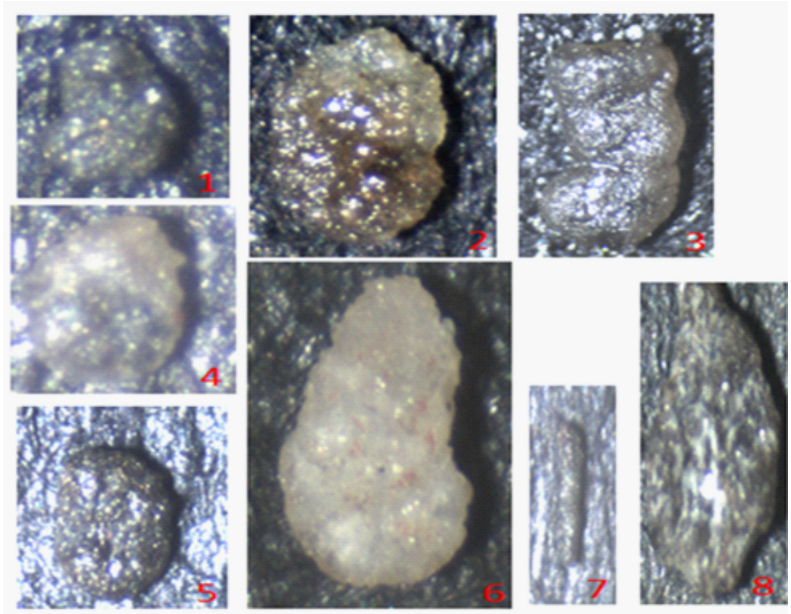

Plate 1. Photo micrographs of some diagnostic forms of the benthic foraminifera recovered from the sediments studied: 1. *Ammotiumnwalium* (Petters, 1979f) Side view (×500), 2. *Ammotiumnkalagum* (Petters, 1979f) Side view (×400), 3. *Ammobaculitescoprolithiformis* (Schwager, 1868) Side view (×350), 4. *Haplophragmoides bauchensis* (Petters, 1979f) Spiral view (×350), 5. *Ammobaculitessp* (Cushman, 1910) Side view (×500), 6. *Ammobaculitesbenuensis* (Petters, 1979f) Side view (×300), 7. *Reophaxsp* (De Monfort, 1808) Side view (×600), 8. *Ammobaculitesjessensis* (1979f) Side view (×300).

c) Palynological data

Three sedimentary outcrop sections were sampled and processed to obtain their palynological content. Of the 25 samples, 14 yielded a very poor palynological assemblage while rest were either barren or yielded only some unidentifiable organic matter. The palynofacies recovery include the following palynomorphs: *Acrostichum aureum*, *Lycopodiumsporites sp*., Fungal spore, *Lavigatosporites discordatus*, *Longapertites sp*., *Verrucosisporites sp*., and amorphous organic matter. The palynomorphs which are generally known to be long ranging forms are predominated by the sporomorphs which are mainly spores of land bearing plants and a few fungi spores. The yield is completely void of the short-ranging age diagnostic species. Others, included in this palynological assemblage are the acritarch, dinoflagellate cysts and foraminifera linings. These organic matters of marine origin are seen to be much lesser in abundance, they persisted in all the samples. The amorphous components were identified to be of the kerogen types II, III and IV distributed either as mixtures of different or the same kerogen types in the sedimentary samples involved in this study. Table 1 shows the distribution of organic matter in the samples collected from the section in Mangoule (Figure 8).

5. Biostratigraphic Analysis

1) Cenomanian age

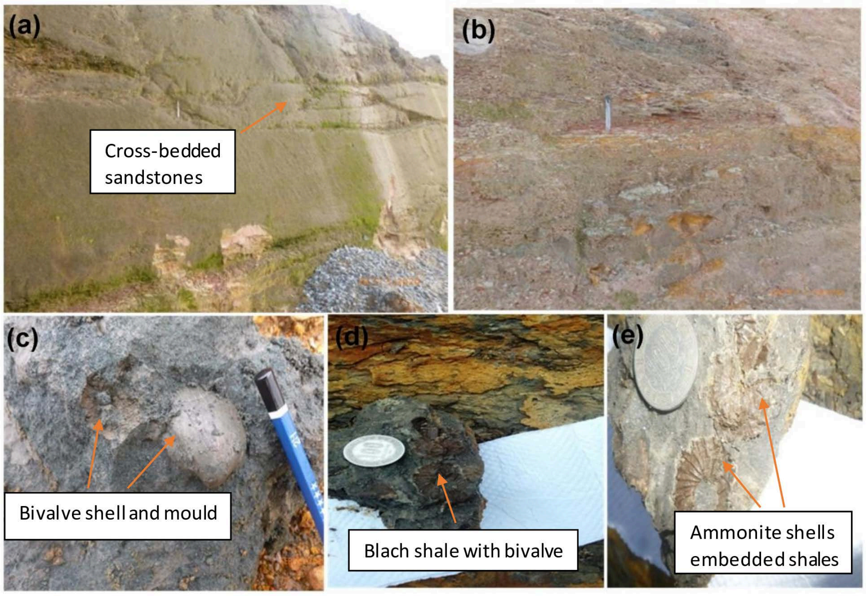

Figure 8. Outcrop sections in Bonepoupa and Mangoule: (a) Roadside-cut at Bonepoupa showing cross beds, (b) Ferrugenous sandstone with mud lenses, ((c)-(e)) fossiliferous dark-gray to black shales at Mangoule with moulds and body fossils of bivalves and ammonites.

Table 1. Organic types distribution in samples from the Mangule section.

S/No	Sample	Organic Matter Type
1	MNG I	III
2	MNG II	III
3	MNG III	III/IV
4	MNG IV	II

Haplogragmoides and Textularia species are reported to have been dominant in the upper Cenomanian sediments of the westernmost Colorado Plateau, Utah [22] while the common occurrences of species of Haplogragmoides and Ammodiscus amongst other benthic foraminifera, in association with the Cenomanian diagnostic planktic species: *Rotalipora appeninica* and *Rotalipora gandolfii* led to the recognition of this age penetrated by the Kudu bore-holes offshore Namibia [23]. Ammobaculites was noted [24] to commonly occurs with other agglutinated foraminiferal genera Haplophragmoides in the Cenomanian sediments of Abu Had Member of the Raha Formation in west central Sinai in Egypt. As [25] reported and has been well documented from elsewhere in Nigeria, the presence of *Trochamina taylorana* is very indicative of the Cenomanian age. The co-occurrence with this species with others like: *Ammobaculites jessensis*, *Ammotium cf nkalagum*, *Ammobaculites benuensis*, *Ammotium nwalum*, *Haplophragmoides cf beuchensis*, most probably confirms the penetration the Cenomanian-Turonian age in the sedimentary sections studied.

2) Turonian age

Apart from the species, *Trachomina taylorana* all the other foraminifera forms list here above generally range in age from Cenomanian to Turonian. *Ammobaculites coprolithiformis* is typically a Turonian restricted form and so confirms this age and the fact that it occurs in association with other forms which cannot any be older than the Turonian and so further support also for these sediments. Because the forms that are indicative of the Cenomanian age and those known to be restricted or range up to the Turonian co-occur in almost all the samples of these

Palynomorph recovery was very poor and the few that were recovered are long-ranging and many of the samples yielded practically no palynomorphs. Because of the paucity of index species, interpretation of the age base on the palynomorphs was impossible as the samples were undiagnostic and therefore interpreted as indeterminate.

3) Paleo-environment of deposition

The benthic foraminifera association in ancient sedimentary deposits commonly plays the role of the major tool for paleo-environmental, paleo-ecological and paleo-oceanographic studies because of their morphological diversity, the narrow ecological tolerance of single species, good preservation potential, and abundances in marine sediments. Hence the presence of each benthonic foraminifera indicates a range of possible water depths which the fossilized organism could have tolerated, species diversity helps to indicate how conducive the ancient environment may have been for some foraminiferal taxa to populate therefore, low numbers of species suggest environmental stresses while high diversity suggests equable conditions [26]. The main factors that influence the distribution of these benthic foraminifera as seen in both past and modern oceans are the oxygen content of bottom water, nutrient availability, the bottom-water temperature and salinity, amongst others [27] [28].

The entire paleontological recovery from the study area include: an entirely agglutinated benthic assemblage, but for a lone planktonic form of the species *Heterohelix globulosa*, a palynological association of mostly spores of terrestrial plant bearers and a marine element including the dinocysts and foraminifera linings, the organic amorphous matter identified as Kerogen types II, III and IV, respectively, a rich occurrence of oysters (bivalves), gastropods and molds of ammonites, all of which bear a paleo-environmental significance.

The genera Ammobaculites, Ammotium, Happlophragmoides, Miliammina and Ammotium are infaunal deposit feeders that live on muddy/sandy substrates in brackish to normal marine salinities from marsh to bathyal environments. [22] recognized in the westernmost Colorado Plateau, southwest Utah these two amongst four paleoecological associations of agglutinated foraminifera: 1) a marsh assemblage dominated by Trochammina and Miliammina and 2) a central estuary assemblage dominated by Ammobaculites and Trochammina. While studying the paleoenvironmental changes of the Cenomanian-Early Turonian shallow marine carbonate platform succession in west central Sinai, Egypt. [29], recognized that there is a common occurrence of Ammobaculites with other agglutinated foraminiferal genera, particularly the Haplophragmoides, within the Abu Had Member of the Raha Formation. These robust, partly ornamented agglutinated foraminifera were encountered amongst very rare calcareous benthic foraminifera and [30] had earlier noted that such an association usually live in very shallow water of the inner ramp and shoals (10 to 50 m water depth in the photic zone. The almost entirely agglutinated foraminifera assemblage, void of any calcareous benthic, recovered from these studied sections may be indicating even shallower or inner neritic zone with water depths much lesser than 10 m. The Heterohelix, represented in this recovery by a lone species; *Heterohelix globulosa*, like the Hedbergella, is generally known to be environmentally very tolerant and can support such stressful ecologies.

On the other hand, palynomorphs are characterized by the dominance of the sporomorphs of continental origin in association with the dinocysts and foraminifera linings of marine origin depicts a typical nearshore marine to transitional environment, especially viewing the ratio of the sporomorphs to the marine palynomorphs. The organic matter identified as Kerogen Type-II, Type-III and Type IV often were derived as a mixture of both types either from the same sedimentary samples or same outcrop, indicative of a predominance of the deposition of terrestrially derived organic matter into a nearshore, shallow marine environment. Ammonites like the foraminifera are exclusively marine, hence the sediments from which they were recovered were undoubtedly deposited in a marine environment. However, their appearance within these typically very shallow marine sediments may mean that they might have been swept in during some moments of flashfloods. The abundant occurrence of several taxa of bivalves (oysters) and gastropod supports a very shallow marine environment, typically a sheltered area. [31] [32] recalled that oysters flourish commonly in shallow sublittoral (inner to middle ramp) environments that are faunally restricted environments they tolerate a wide range of environmental conditions.

6. Hydrocarbon Source Rock Potential

The quantity, quality and thermal maturation of the organic matter in sedimentary samples are often the conventional "quick look" methods to assess their hydrocarbon potentials. The quality of the organic matter, also expressed as the kerogen type when plotted on the modified Van Krevelen diagram, usually from Rock-eval pyrolysis, provides the pathways each of kerogen types plots on the diagram and indicates the type of hydrocarbon likely to be yielded if all other conditions were in place.

The sedimentary sections studied generally composed of dark to dark-gray shales and mudstones of considerable thicknesses. It was therefore necessary to have a preliminary understanding of the quality of the organic matter content of these rocks. An organic petrographic analysis was performed on the samples and revealed Kerogen Type-II and Type-III. The kerogen Type II sediments as mentioned earlier are known to be commonly of marginal marine, usually a mixture of both continental and marine planktonic organic matter that are generally oil prone. The Kerogen Type III is of humic organic matter from terrestrial deposits and is gas prone. This points to fact that the sedimentary sections studied in this area especially the outcrop at Mangoule are composed of possible source rocks that if all the necessary conditions were in place and at the right time, they are capable to have yielded oil and gas.

7. Discussion

The debate is still on as to whether the nomenclature: Logbadjeck Formation or the Mungo River Formation should be used to refer to the lithostratigraphic unit of the Douala/Kribi-Campo Basin, dated as Cenomanian-Campanian or both names should be allowed be in use. Issues as to whether or not, these names refer to one formation or the two lateral equivalent formations or if one is a member of the other, still remains a challenge. However, Logbadjeck is the name used mostly by those working on this part of the development and for now is herein adopted for this work.

The sedimentary sections studied for this work have yielded foraminifera that are almost entirely benthic [30] [33] and apart from the lone planktonic form, they all comprise an agglutinated benthic foraminifera assemblage. The yield which included some age diagnostic foraminifera species and reference to some key existing publications [34] aided in the assignment of the Cenomanian-Turonian age to this unit under study. As indicated earlier, the Logbadjeck Formation of the Douala/Kribi-Campo Basin is known to range in age from Cenomanian to Campanian. Therefore, these sedimentary sections belong to this formation and more so, the lower part.

Though the low palynomorphs recovery couldn't confirm the age that has been assigned based on the foraminifera yield, they rather supported the inference of the paleo-depositional environment. The ammonite molds on the other hand were abound but could only indicate that these sedimentary sections are not younger than the Cretaceous age, since they all went into extinction before the close of the Cretaceous and so their co-occurrence with Mid-Cretaceous foraminifera, suggest that those from which the molds were formed are the age equivalent.

8. Conclusion

The data available from this work which include: foraminifera, palynomorphs, organic matter type, macro- and trace fossils, support the reconstruction of a nearshore, shallow marine paleo-environment most probably a sheltered coast into which the sediments of the studied sections were deposited. The identification of the Kerogen types of the organic matter isolated from these sediments reveals contribution of this work to the on-going hydrocarbon exploration activities in the Douala/Kribi-Campo Basin wherein potential source rocks are not only substantially identified but have also been dated from outcrop sections which may be the prelude to the search of their equivalent beds in the subsurface. We conclude here by noting that the facies of the sequences described, and the paleo-depositional environment reconstructed corroborate with the organic matter isolated from the sediments.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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