

Mineralogic Characterization and Petroleum Potential of Clays (Shales) of the N’Kapa Formation (Paleocene-Eocene) in the Douala Sedimentary Sub-basin (South-West Cameroon)

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ABSTRACT

The aim of this research work was to report a facies analysis of the N’Kapa formation, identified the clay minerals present in those facies and evaluate their oil potential. For that to be done, Lithostratigraphic descriptions were performed on three natural outcrops chosen in three different localities of the northern border of Douala sedimentary basin. Ten shaly samples were then collected on those outcrops and submitted to X ray diffraction and Rock-Eval pyrolysis. Lithologically, the N’Kapa formation is made up of dark to grey shales and fine to coarse sandstones. The mineralogic content of the shales is made up of Kaolinite, dickite, low quartz and vaterite. Those shaly facies present high amount of immature organic matter (average TOC content around 2%). The petroleum potential is fair to poor (average S2 for all the samples around 3.33 mg HC/g of rock) though some samples (M1 and M2) presenting a good petroleum potential up to 6.62 kg HC/t of rock and 6.44 kg HC/t of rock respectively. They have undergone a low degree of diagenesis (early to burying diagenesis). This is evidenced by the predominance of kaolinite and dickite, low quartz and vaterite which are minerals stable at low temperature.

Keywords: Mineralogy; Organic Matter; Petroleum Potential; N’Kapa Formation; Douala Sub-Basin

1. Introduction

The Cameroon Atlantic basin located in the Gulf of Guinea is one of the West African coastal basins. It comprises two major basins: The Douala-Kribi/Campo basin and the Rio Del Rey one.

However, these two sedimentary units are separated in onshore by the volcanic massif of Mount Cameroon form only one sedimentary basin in their offshore extension from which the name coastal atlantic basin of Cameroon is deduced. The Douala/Kribi-Campo (**Figure 1**) basin is in its turn subdivided into two sub-basins: the Kribi-Campo sub-basin in the south and the Douala sub-basin, the northern component.

Owing to the economic potential of this area, several studies have been carried out by scientist and petroleum industry, leading to the typification and the stratigraphy of the deposits. (Amonst: [1-19]. These works were based on many important field campaigns motivated by

the scientific interest, but also and predominantly the economic interest of the facies. Reference here is made to oil and natural gas.

All those works for the most part were very globalizing, ignoring the specificities of each sector of the basin. However, the structural dynamics that led to the establishment of the sedimentary basin of Douala Kribi/Campo like other basins of the West African coast has resulted in the sequence variability of deposits by sector considered. Moreover, many of the works are unpublished because of the known confidentiality characterizing the oil research domain.

Indeed, the establishment of the Douala sub-basin, linked to the gradual opening of the South Atlantic, resulted in a diachronism of deposits from South to North. Another consequence of this was a temporal and spatial variation of sedimentary environments along the West African coast and consequently facies characteristics. This situation does not permit to easily extrapolate results obtained on one sector to another. Reason why

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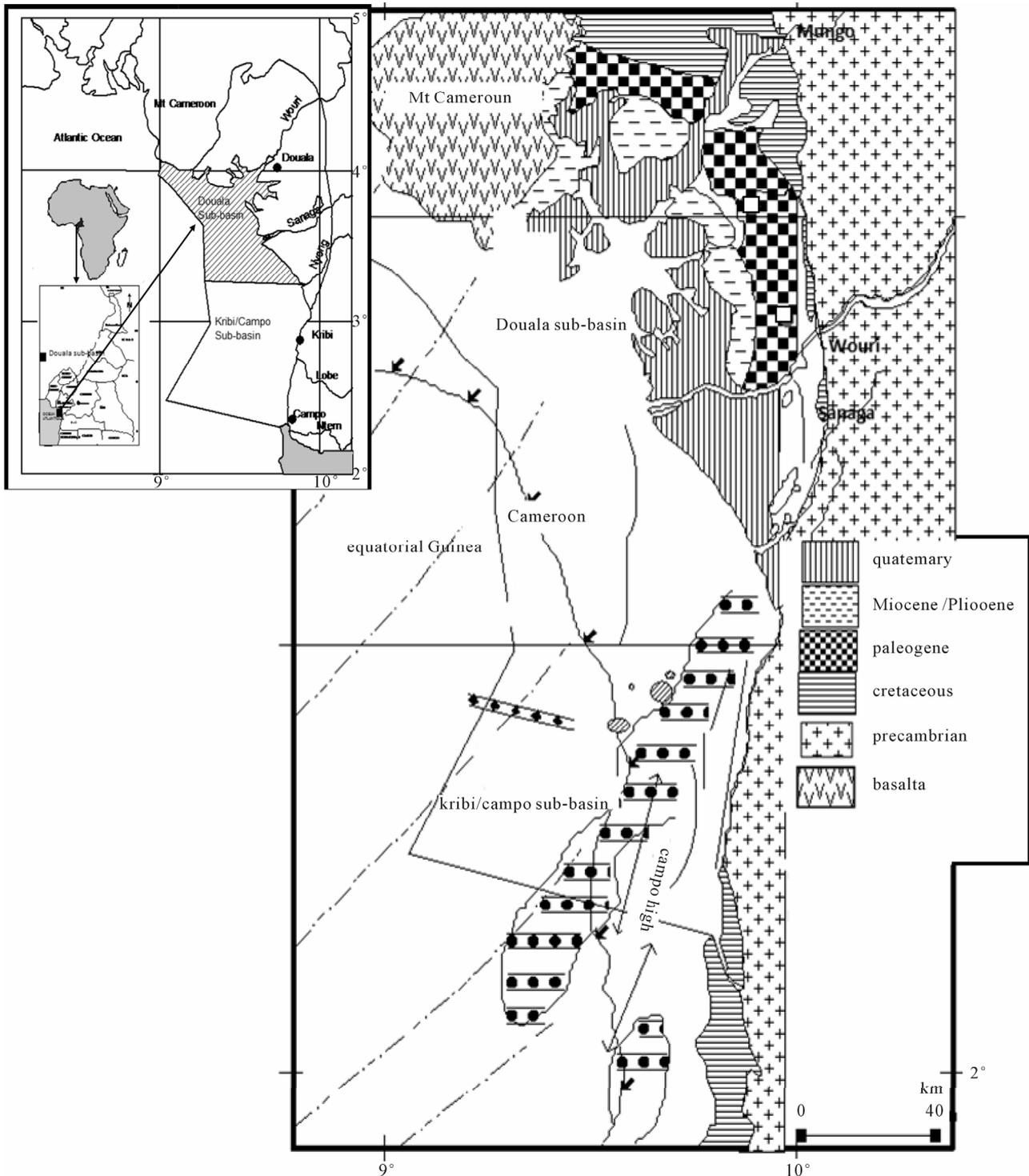


Figure 1. Location map of Cameroon (West Africa) and outlines of the Douala and Kribi/Campo sedimentary sub-basins. (Modified from SNH (1999)).

Cameroonians sedimentary geologists and foreigners decided to conduct research program in each sector of the Cameroon Atlantic basin. It is in this context that Ntamak et al since few years has being developing an important scientific production in the Kribi-Campo sub-basin, [19]

has carried out a research topic on the palynostratigraphy of the Cretaceous facies in the eastern border of the Douala sedimentary sub-basin. No specific work had yet been carried on the Tertiary sedimentary facies of the northern part of the Douala sedimentary sub-basin.

Moreover, as mentioned above, there is no published data existing concerning petroleum potential of this sub-basin.

The purpose of this article is 1) to report a comprehensive facies analysis of the Tertiary deposits cropping out in the North of the Douala sub-basin; 2) to identify the minerals present in shaly facies; 3) to evaluate the oil potential of the clay facies and 4) to discuss and interpret all these in terms of level of diagenesis and oil productivity.

2. Geological Setting

The Douala sedimentary basin stretches on the South coast of Cameroon both onshore and offshore 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 km² (Figure 1). It has a crescent shape starting from the south-eastern border of Mount Cameroon where the onshore part is about 70 km wide (In the N20E direction) and extend throughout the atlantic coast with a gradual decrease in width of

the onshore part towards the South up to Londji (North of Kribi). It is limited to the South by the Cameroon volcanic line, to the East by the late Proterozoic Pan-African belt. The southern limit is more difficult to define. The onshore part of the Douala sub-basin has a trapezoidal shape and covers a total surface area of about 6955 km² while the offshore part covers an area of about 5850 km².

In a chronological aspect, the history of the Douala sedimentary sub-basin presents three major stages:

1) All begins with the Precambrian phase of cratonisation, granitisation and sedimentation followed by the pan-african orogenesis.

2) After this Cambrian phase, the geology of the Douala sub-basin is only known starting from the lower Cretaceous during which epicontinental sedimentation begins to field an afro-brazilian depression, site of the future atlantic basin of Cameroon. Sediments whose age varies from Cretaceous to Pliocene are discordant on the Precambrian pan-african basement (Figure 2). The sedimentation was accompanied by Plutonism (Cenomanian)

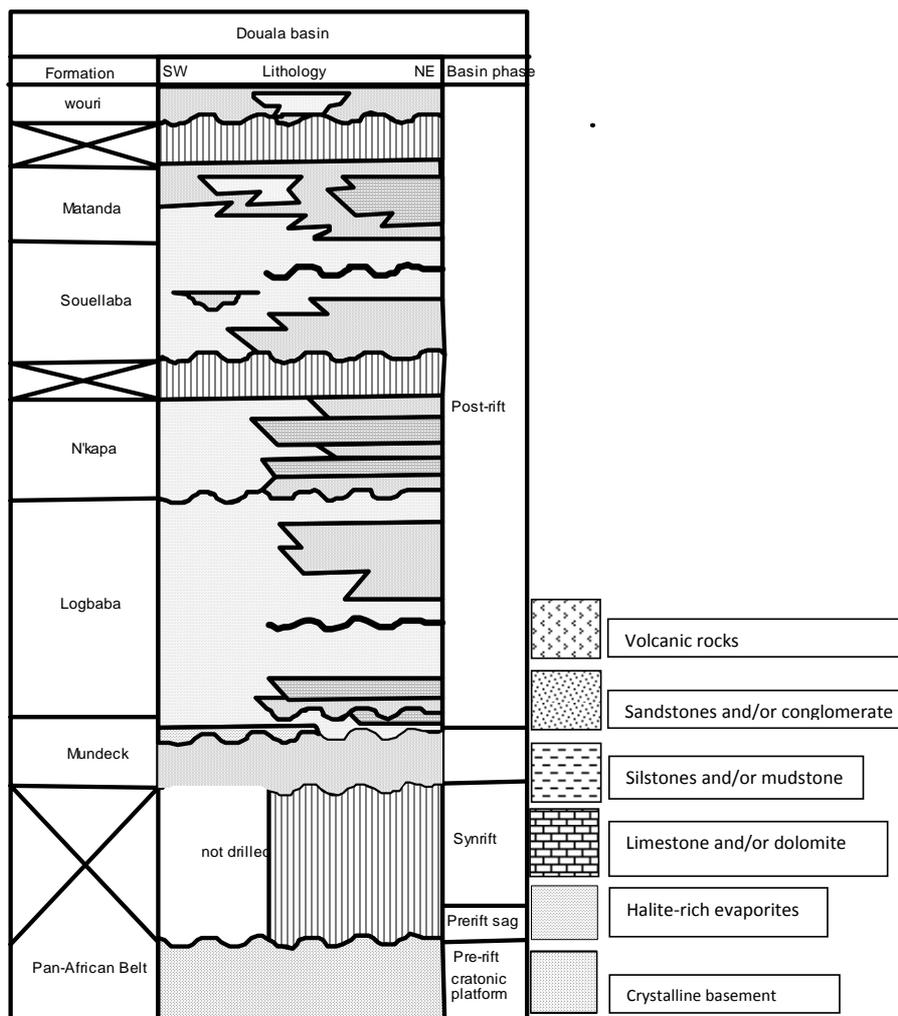


Figure 2. Tectono-lithostratigraphy of the Douala sub-basin (compiled from [20,42]).

And volcanism (Miocene) which products cover sediments in some area (e.g. Volcanic products of Mount Cameroon).

The complete tectono-lithostratigraphic sequence based on oil exploration seismic and drill data offshore comprises six formations from the barremian-Aptian to present deposited during the pre-rift, syn-rift, rift-drift and post-rift basin phases (**Figure 2**).

1) Pre-rift phase: Prior to the rifting of the Afro-American plate, Jurassic continental sediments were deposited in an afro-brasilian depression, an intracratonic sag basin that extended over the Gabon and Douala basins [20].

2) Rifting phase (Jurassic-Barremian): The stratigraphic sequence here appears to be controlled by listric faulting and associated roll over anticlines [21].

3) The syn-rift phase was responsible for the fracture pattern closely controlled by inherited structures of the Precambrian basement. This phase is characterized by an intensive erosion activity of the highlands and deposition in graben previously formed. In the Kribi/Campo sub-basin, these units named Lower Mundeck by [22] are exposed on the sea bottom or are shallowly buried by younger sediments [23]. They are made up of conglomerates, conglomeratic sandstones, organic matter-rich dark marls interbedded with thin limestones and black to dark grey shales. In the Douala sub-basin, Aptian syn-rift deposits overlie a narrow bench of attenuated continental basement [8,24-26]. Here, they are referred to as the Upper Mundeck Formation (**Figure 2**). The section drilled of the upper Mundeck Formation contains faunas which record the first marine incursion ([8] Reyre, 1966; [23,26,27]. Deposits are made up of continental polygenic conglomerates with arkosic sandstones cement showing rare interbedded ferruginous clay, an alternation of laminated silt or sand with black shales and arkosic medium grain sandstones. Their environments of deposition have been interpreted as ranging from terrestrial to lacustrine, through restricted to fully marine. Pre-Aptian syn-rift deposits and basement rocks have not been reached by drilling.

4) The rift-drift transition phase (mid-late Aptian).

This phase was marked by salt deposition and the transform direction resulting in a series of cross-faults which have segmented the rift structure [28]. Salt domes have been recognized through seismic campaigns in the Kribi/Campo sub-basin. They are located over the major western bounding fault system of the Kribi/Campo high. They overlie the Mundeck Formation from which they are separated by a probably breakup unconformity [29-31]. This suggests that salt was deposited in the final stage of continental rifting. In the Douala sub-basin, evidence of evaporites has not yet been well stated.

5) Post-rift phase (Albian-Present): Following salt deposition, post-rift sedimentation in the Douala basin

was dominated by marginal to clastic sedimentation, with shallow water carbonate deposition occurring as sporadic build ups between the Albian and Paleocene. From Aptian to Turonian, the juvenile South Atlantic ocean was filled with anoxic bottom waters presumably caused by restriction of open ocean circulation and ponding of bottom waters between Walvis Ridge and Rio Grande Rise in the South, and equatorial fracture zone topography in the North [32-37]. This led to deposition of black shales in the deeper part of the basin, and an intermittent carbonate deposition on the margins, above the oxygen minimum zone [25,31,38]. Unrestricted ocean circulation is thought to have commenced in the Turonian, when the North and South Atlantic gateways were joined. According to [29], the post-rift phase comprises three stages of drift:

a) The first one (Albian-Coniacian) is characterized by rotational fault blocks in the proximal part, salt movement [21,39,40], and gravity sliding. These structures are linked to gravitational instability of the margin and the presence of salt. Sedimentologically, this phase is marked in the Douala basin by a major regression leading to the decrease of the sea level. The consequence was the erosion of the Lower Cretaceous sequence thereby creating a surface of unconformity with an irregular topography. The unconformity at the base of Upper Cretaceous was followed by the deposition of the Logbadjeck formation (Cenomanian-Campanian), the Logbaba formation (Cenomanian-Maastrichtians) and the Nkapa formation (Paleocene-Eocene).

b) The second drift phase named Drift II was a discrete drift one linked to regional tectonic episode. During this phase, original rift-related structures were inverted and the platform sedimentary section was folded [41]. The Santonian unconformity separating the first and second drift stages is recognized along the West African margin as a result of the uplift during the Cretaceous episode.

c) The third drift stage (Eocene) named drift III has been linked to gravity sliding caused by uplift in the Tertiary. The Uplift and erosional unconformity are dated to about 30 - 40 Ma. This phase in the Douala sedimentary basin was marked by deposition of the Souellaba formation (Oligocene), the Matanda formation (Miocene) and the Wouri formation (Pliocene-Pleistocene).

The area considered in this paper constitutes the northern border of the Douala sub-basin (**Figure 1**). It corresponds to a strip of terrain limited to the north by clayish sand of Senonian age, to the East by river Wouri, to the West by Mount Cameroon and in the South by the Wouri river mouth. The sedimentary series known here is of Tertiary age [42].

3. Data Sets and Methods

The study whose results are presented here took place in

two main phases marking the approach chosen to achieve the goal:

3.1. Fieldwork

During this phase, lithostratigraphic investigations were carried out throughout the Tertiary formations in the northern part of the Douala sedimentary basin. As a result of these prospective campaigns, three outcrops were chosen as representative and selected for the study. Thus, after detailed description of the different lithofacies constituting each outcrop, lithostratigraphic columns were performed. This description allows identifying some basic characteristics of the depositional environments. This phase ended with the collection of samples for analysis.

3.2. Material

Ten samples (K1, K2, K3, M1, M2, M3, M4, M5, F2 and F4) were collected from the dark to grey shales strata of the N'kapa formation. They were taken from three natural outcrops located in three localities. Kompina, Miang and Fiko (Figure 3) of the northern border of the Douala sedimentary basin.

3.3. Laboratory Analysis

1) X-ray diffraction (XRD)

The different clay minerals have been determined on four samples collected on the three outcrops. The Bragg's law has been used to determine the "diffraction peaks" by the following formula: $2d \sin\theta = n\lambda$. With d = spacings, that is the distance between two crystallographic planes, θ = angle of incidence of X-rays, n = order of reflection, λ = wavelength of X-rays. The value of each peak characterizes a precise clay mineral.

2) Rock eval pyrolysis

Ten samples were collected from these outcrops, taking care to avoid weathered portions of the outcrop. The shaly samples were hard, thickly laminated, with texture indicative of low permeability, suggesting minimum risk of organic matter oxidization. In laboratory, the samples were reshaped using knife to eliminate surfaces that could be affected by alteration.

The samples were first treated with a mixture of water and liquid soap, washed with a column of two sieves (125 μm and 800 μm respectively) and then dried in a sweating room at 37°C during 24 hours. After drying the samples were sorted with a magnifying glass to remove the solid pollutants.

Total Organic Carbon (TOC, wt%) was determined using a Rock éval 6 apparatus by combustion of 20 g of sample up to 600°C under inert atmospheric conditions (presence of nitrogen and hydrogen), without previous decarbonation; the resulting CO_2 was quantified by

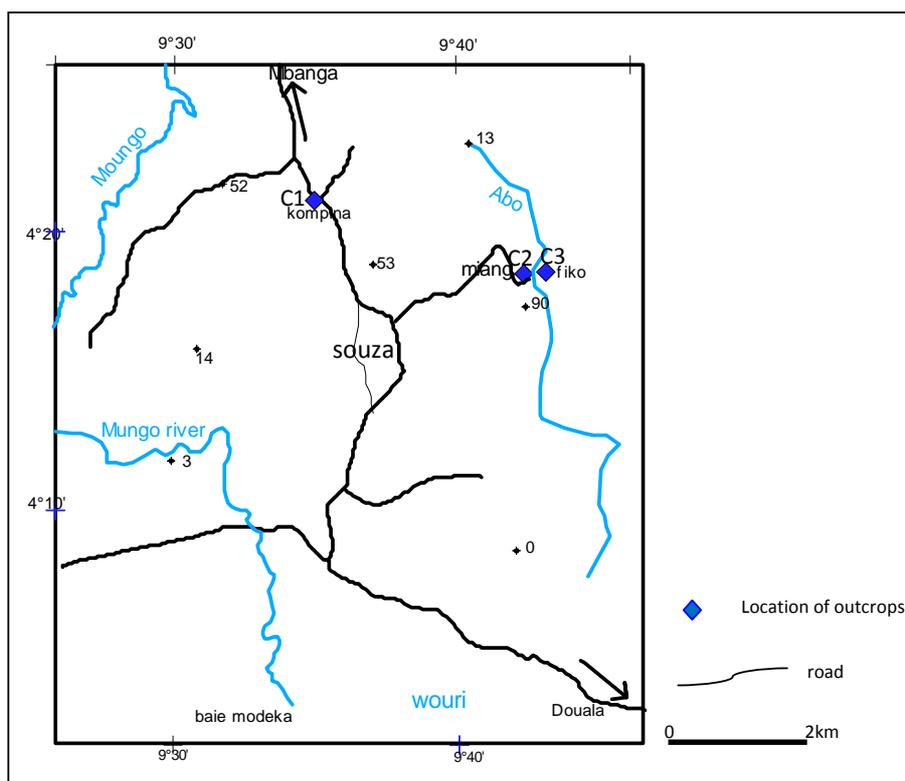


Figure 3. Map showing the location of the area studied, onshore northern Douala, and the studied outcrops.

infrared detector. Calcium carbonate content (CaCO₃, wt%) was determined using a calcimetric bomb by HCl digestion of 20 g of sample; the resulting CO₂ was determined by pressure measurement.

Total Organic Carbon content (TOC, wt%) is calculated by determining the difference between total carbon and carbonate carbon, assuming that all carbonate is pure calcite and represents the unique source of inorganic carbon. Informations on the type and thermal maturity of the organic matter were obtained using Rock-Eval pyrolysis with an Oil Show Analyser device under standard conditions (see all details about Rock-Eval pyrolysis and parameters in [44]).

Hydrogen Index (HI, mg HC/g TOC), Tmax (°C) and Petroleum Potential (PP, kg HC/t) were determined.

4. Results and Interpretations

4.1. Facies Analysis: Lithostratigraphy

Three outcrops among which one at kompina (C1), one at Miang (C2) and one at Fiko (C3) were used as the basis for the study. The description of the lithostratigraphic succession in these outcrops was carried out from the base to the top taking into consideration the following parameters: lithology, texture, thickness, and fossils content and sedimentary structures. The synthetic lithostratigraphical sections of each outcrop are presented in **Figures 4-6**. Some details characteristics of outcrops C1 and C2 are illustrated in **Figure 7**.

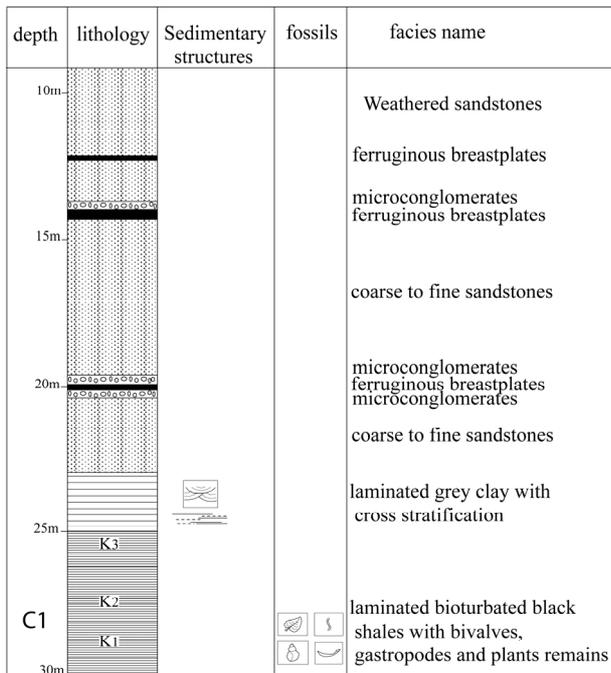


Figure 4. Lithostratigraphic section of outcrop C1 showing the stratigraphic position of the dark to grey shales and the investigated samples.

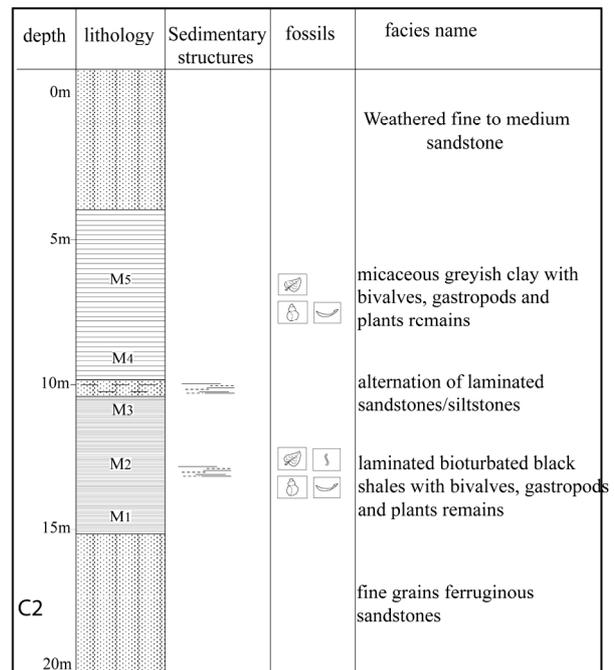


Figure 5. Lithostratigraphic section of outcrop C1 showing the stratigraphic position of the dark to grey shales and the investigated samples.

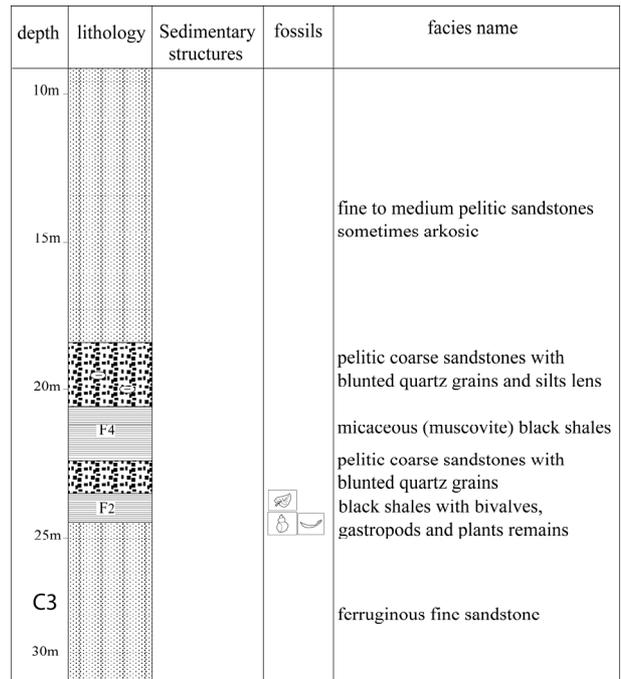


Figure 6. Lithostratigraphic section of outcrop C1 showing the stratigraphic position of the dark to grey shales and the investigated samples.

4.2. Results of X-Ray Diffraction Analyses

The minerals found within the samples are: Kaolinite (Al₂Si₂O₅(OH)₄), Dickite (Al₂Si₂O₅(OH)₄), Vaterite (CaCO₃)

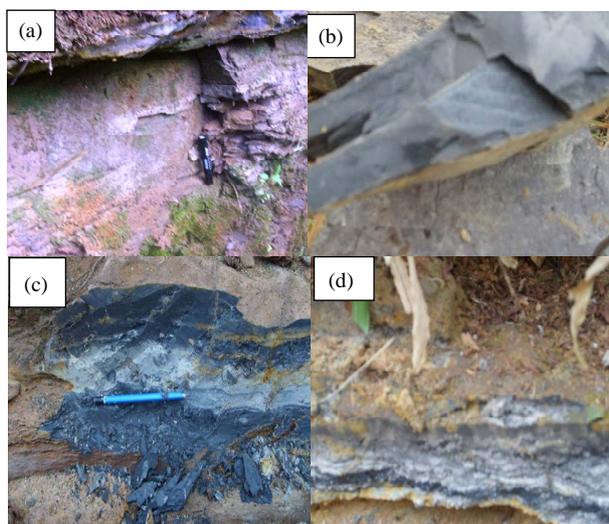


Figure 7. Shaly and silty facies of the Nkappa Formation cropping out at Kompina and Miang showing some sedimentary structures: (a) Massive dark clay of outcrop C1; (b) Leaves imprints in dark clay of outcrop C2; (c) Silty lens in dark clay of outcrop C2; (d) Alternation of silty and clay laminae in outcrop C2.

and low quartz.

Diffraction showing the peaks of different clay minerals are presented in **Figure 8**.

4.3. Organic Matter Analyses: Rock-Eval Pyrolysis

Ten sedimentary rock samples were subjected to pyrolysis Rock-Eval 6 to determine the geochemical parameters of their organic matter. These samples come from outcrops of three distinct localities: Kompina (3 samples: K1, K2, and K3), Miang (5 samples: M1, M2, M3, M4 and M5)

Table 1. Geochemical parameters for samples of outcrop C1.

Samples	Depth (m)	S1 (mg HC/g roche)	S2 (mg HC/g roche)	S3 (mg CO ₂ /g roche)	T _{max} (°C)	HI (mg HC/g TOC)	OI (mg O ₂ /g TOC)	TPI (S1/S1 + S2)	TOC (% pds)	MINC (%)
K1	20	0.41	0.27	0.3	395	123	136	0,6	0,22	0,11
K2	25	0.4	1.69	0.66	411	86	34	0,19	1,95	0,15
K3	28	0.71	2.94	0.86	415	123	36	0,2	2,38	0,17

Table 2. Geochemical parameters for samples of outcrop C2.

Samples	Depth (m)	S1 (mg HC/g roche)	S2 (mg HC/g roche)	S3 (mg CO ₂ /g roche)	T _{max} (°C)	HI (mg HC/g TOC)	OI (mg O ₂ /g TOC)	TPI (S1/S1 + S2)	TOC (% pds)	MINC (%)
M5	7	0.16	1.24	1.36	410	70	77	0.12	1.76	0.15
M4	9	1.48	3.8	0.37	416	355	34	0.28	1.07	0.15
M3	11	0.41	2.08	3.33	413	67	107	0.16	3.12	0.26
M2	13	2.05	6.44	1.55	412	199	48	0.24	3.23	0.25
M1	15	2.8	6.62	1.74	409	150	39	0.3	4.42	0.27

and Fiko (2 samples: F2 and F4).

4.4. Samples from Outcrop C1

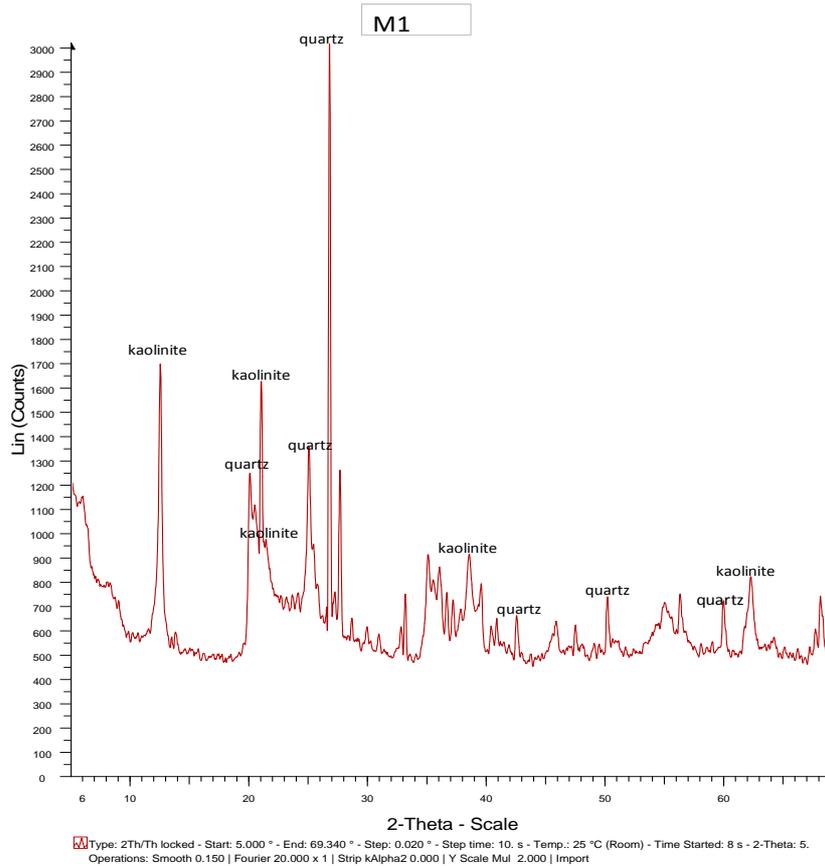
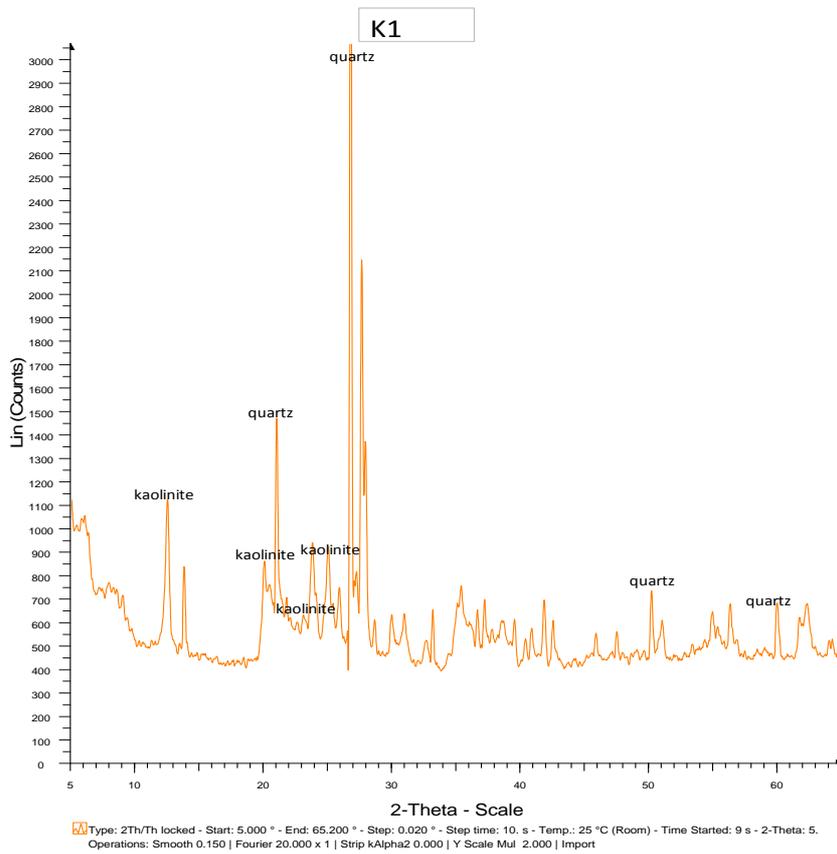
Organic matter in these samples is sterile (poor) for sample K3, but there is a good concentration of organic matter for samples K2 and K3 (**Table 1**). Its petroleum potential (S2 varies between 0.27 and 2.94 mg HC/g of rock with an average of 1.63 mg HC/g rock) is globally poor. This dispersed immature organic matter is of type II and III (**Figure 9**), from terrestrial origin and consists of fragments of higher plants.

4.5. Samples from Outcrop C2

Samples of this outcrop have good accumulation of organic matter (TOC ranging from 1.07 to 4.42 wt% with an average of 2.72 wt%). This organic matter with a mean petroleum potential (samples M3 and M4) to good (samples M1 and M2) is immature (mean T_{max} = 412°C). Samples of this outcrop have a globally dispersed organic matter of type II and III (**Figure 9**). This suggests that the organic matter contained in these samples is rather of terrestrial origin and consists of fragments of higher plants and sometimes of type IV. It is noticed the presence of non-native oil for samples M1 and M2, materialized by the high values of S1 and TPI in those samples (**Table 2**).

4.6. Samples from Outcrop C3

Samples of outcrop C3 have a good amount of organic matter of type II (**Figure 9**) for sample F2 and Type II for sample F4 with an average generation potential (average S2 = 4.33 mg HC/g rock). This organic matter is immature (mean T_{max}: 417°C) and shows traces of oil especially for sample F2 (**Table 3**).



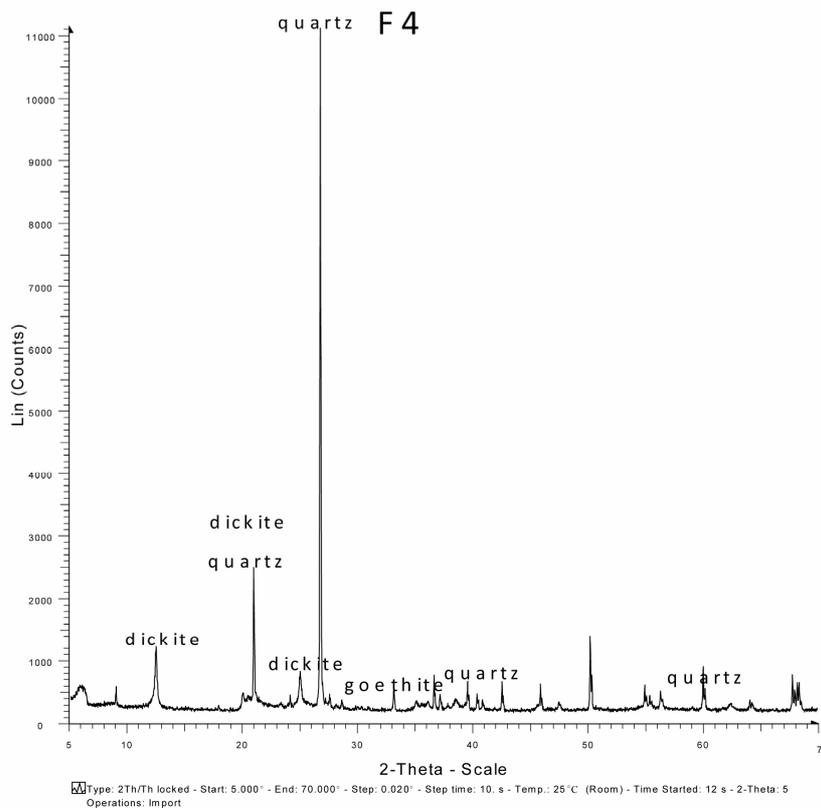
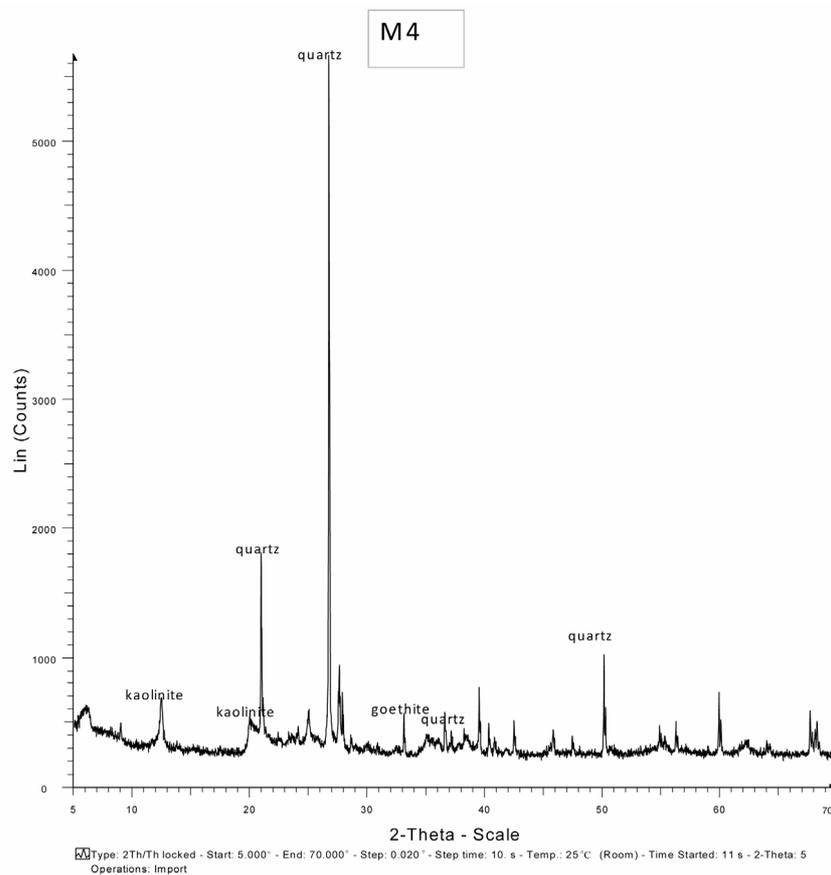


Figure 8. Identification of clay minerals present in samples K1, M1, M4 and F4.

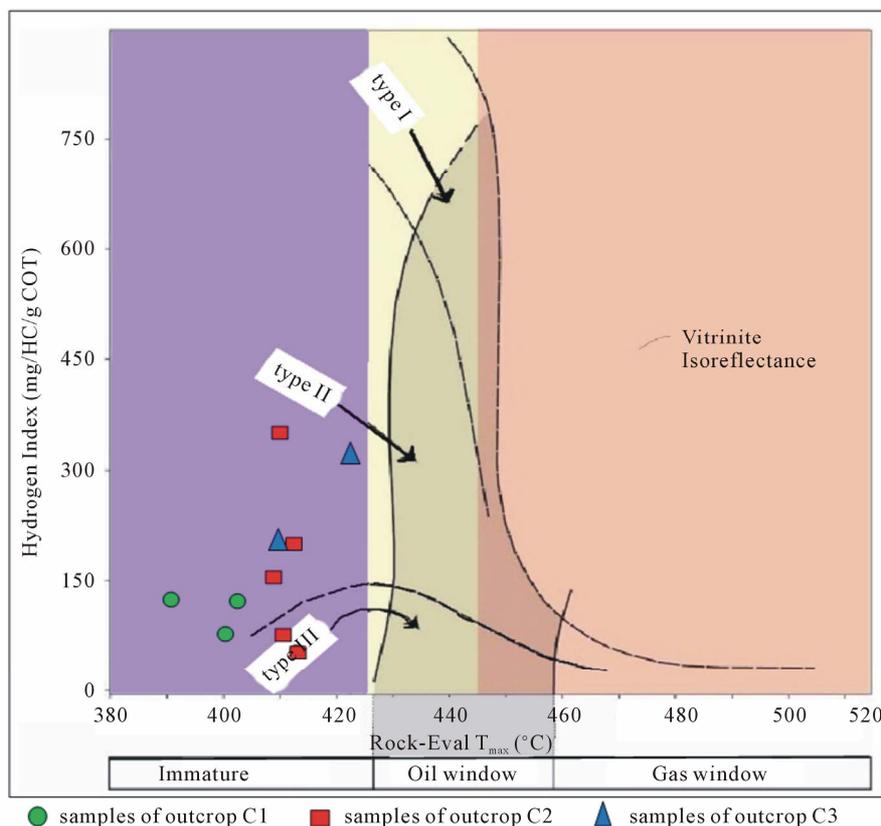


Figure 9. HI/T_{max} diagram showing the type and maturity level of organic matter for the samples studied.

Table 3. Geochemical parameters of samples of outcrop C3.

Samples	Depth (m)	S1 (mg hc/g roche)	S2 (mg HC/g roche)	S3 (mg CO ₂ /g roche)	T _{max} (°C)	HI (mg HC/g TOC)	OI (mg O ₂ /g TOC)	TPI (S1/S1 + S2)	TOC (% pds)	MINC (%)
F2	21	2.27	3.84	0.22	423	326	19	0.37	1.18	0.16
F4	23	1.12	4.82	0.47	411	207	20	0.19	2.32	0.18

5. Discussion

Petroleum source rocks are the primary component of the petroleum system [45] and constitute the precursors of oil and gas which, under favourable conditions, may ultimately migrate to reservoirs and be trapped to form accumulations. The TOC is the primary parameter in source rock appraisal, with a threshold of 1 wt% at the immature stage for potential source rocks [46,47]. The average value of 2.72% in the studied samples of outcrop C2, 1.75% in the studied samples of outcrop C3 and 1.51% in the studied samples of outcrop C1 exceeds this threshold. Such a value indicates a good to very good conditions for the preservation of organic matter which took place during deposition. This is certainly related to several factors all of which have contributed to the enrichment of organic matter. First of all, the productivity was probably high, as it is the case in the cretaceous clay deposits of the Douala sedimentary basin and the Ma-

hakam delta [48] and the Maastrictian-Albian deposits of the Ivory Coast sedimentary basin.

Secondly, the conditions were probably anoxic in these environments as evidenced by the traces of partially decomposed organic matter. This can also be related to a high sedimentation rate which may have allowed a rapid burial of the sedimentary succession and the preservation of its organic matter content. It should be noted that this organic matter is immature (all IP values are greater than 0.1 though the T_{max} values are less than 435°C).

The second prerequisite for a good petroleum source rock is the quality of its organic matter. Bulk geochemical parameters obtained by Rock-Eval pyrolysis (S2, HI) show that with the exception of samples M1 and M2 whose oil potential is good (5 < S2 > 10), all the others S2 values are less than 5 indicating that the clay facies studied have a poor to fairly good oil potential.

Samples M4 and F4 have a HI greater than 300 indicating that the organic matter was of marine origin. M2 and F2 have a HI value comprised between 150 and 300 meaning that the organic matter was a mixture of terrestrial and marine plants producing oil and gas. The rest of samples (K1, K2, K3, M1, M3 and M5) have a HI value below 150 indicating that the organic matter was from terrestrial origin made up of plants debris, thus generating gas.

All these portray geochemical characteristics of a poor to moderate petroleum source rock (**Figure 7**). But it is to notice that the quantity of hydrocarbon (oil and gas) is of interest for outcrop C2 and C3 since the mean S1 value is greater than 1 mg HC/g of rock, and negligible for outcrop C1 (mean S1 < 1 mg HC/g of rock).

Kaolinite present in samples studied is either of detrital or diagenetic origin. In the case of detrital origin, it results from hydrolysis of alkaline feldspars highly represented in precambrian rocks under humid and hot climate. In the case of diagenetic origin, kaolinite is the product of dissolution of potassic feldspars. The detrital origin for this study is expected because of permanent association of kaolinite with high quantity of quartz which is resistant to alteration and concentrate in sediments transported and deposited in sedimentary environments by rivers. The minerals results probably from weardering of Precambrian rocks of area surrounding the northern and eastern borders of Douala sub-basin. The presence of kaolinite indicates that the oil window has not been reach [49]. It then indicates the low degree of diagenesis (early diagenesis). The latter affects the surface sediments where the chemical properties of water are under control of the surface environment. The temperature during this phase can exceed 150°C and the depth not greater than 2 km [50]. The presence of dickite which is a polymorph of kaolinite and vaterite shows the increase in temperature (up to 250°C) and pressure and consequently the degree of diagenesis (burying diagenesis) [51,52]. During this phase, compaction and thermal maturation of organic matter occur. Sample F4 which contains dickite has the highest thermal maturity temperature ($T_{max} = 423^{\circ}\text{C}$).

These characteristics are the same as those of (the petroleum potential here is globally poor) some source rocks of surrounding basins that were deposited under the same tectonic event (opening of the South Atlantic) but at a different period, namely:

The Kissenda Formation from the South and North Gabon basins consisting of organic shales interbedded with siltstones and carbonaceous shales. This formation contains mostly Type III or Type II/III kerogens and has an average TOC content of 1.5% - 2% [31]. Reference [16] mentions that gas-prone source rocks are common in the Lower Cretaceous of the Mundeck formation (basal deposits of the Douala, Kribi/Campo basin), whereas

oil-prone source rocks are rare. He found that in the Mundeck formation, TOC varies between 1% and 3.5% (four samples) and HI-values fluctuate from 100 to 200 mg HC/g TOC. Reference [53] identifies source rocks in four wells from the Kribi oil-field.

The oil potential of the samples studied is globally weak compared to those of the large majority of West Africa coastal basins [54]. Those are:

1) The Bucomazi Formation in the offshore Lower Congo and outer Kwanza basins of Angola contains Type I kerogens and displays a wide range of TOC percentages (5% on average and up to 20% [55]. The upper unit of the Bucomazi Formation is less organic-rich (2% - 3%) and contains Type I and Type II kerogens, although some organic-rich levels contain more than 10% TOC [56,57].

2) The Pointe Noire Formation and the upper part of the Djeno Formation of the north Congo basin contain Type I and Type II kerogens. The organic content fluctuates from 1% to 5%, although some levels reach 20% TOC [58].

3) The Melania Formation of the offshore South Gabon sub-basin. The source rock consists of varved, pyritic shale and has an average TOC content of 6% and values as high as 20% have been measured [31]. Organic matter consists predominantly of Type I and intermediate Type I-II kerogens.

4) The "Serie des Schistes" in the Interior basin of Gabon, where the organic matter is related to Type II to I with TOC contents up to 22% [59].

5) A Kissenda-equivalent formation is found in the Rio Muni basin of Equatorial Guinea [39,60]. These facies constitute the regional primary source rock, consisting chiefly of algal kerogen with TOC contents as much as 6%.

6) The lower Mundeck Formation around the Campo locality has a fair to good petroleum potential [55], although the organic-rich facies are thin and immature. The Lower Mundeck Formation along the coast is composed of thin organic-rich beds within sand dominated beds, but significant source potential could exist.

6. Conclusion

The dark to greyish clay of the Tertiary outcroppings in Kompina, Miang and Fiko have been characterised for their oil potential using both Rock-Eval pyrolysis and X ray diffraction. The black to dark grey clay present a good concentration of organic matter (except K3, %TOC > 1). The HI versus T_{max} diagrams indicates that this organic matter did not experience high temperatures during burial. They did reach the thermal maturity of the oil window. This is confirmed by the presence of kaolinite, dickite and low quartz which are minerals of low tem-

perature and constitute the most abundant in the samples studied. The studied samples then represent immature organic-rich beds with a poor to fairly good oil potential, although samples M1 and M2 have a good petroleum potential up to 6.62 kg HC/t of rock and 6.44 kg HC/t of rock respectively. The thickness and lateral extension of those beds must be evaluated. This would enable analyses on more samples and therefore to determine precisely the mean value of the petroleum potential of this part of the basin in view to correlate with the other parts of the Douala basin just as the other West African coastal basins.

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