

Sedimentological Characterization Of Subsurface Formations Of The Tertiary - Quaternary In The Dabou Region (South Of Ivory Coast)

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Abstract— About 239 samples of cuttings from two boreholes located in Dabou were the subject of sedimentological studies (lithological, granulometric and morphoscopic analysis) in this work. These studies aim to identify the origin of these sediments and to specify the factors and the phenomena which involved in their transport and their deposit during Tertiary - Quaternary. After a detailed lithological description of each sample, the sandy fractions were treated according to conventional particle size methods. The formations traversed in the two wells consist of lateritic clays, yellow clays, clay sands and coarse sands. The analyzed sands are coarse and testify to the different variations in the energy of the stream that transported the sediments. The hyperbolic granulometric facies is dominant in the study area, indicating a variation in streamflow during sedimentation. The predominantly round to sub-round quartz grains suggest a relatively distal supply source while their blunted appearance suggests a stay in the aquatic environment. The sediments of these two wells are therefore sands of fluvial origin, deposited in a shallow marine environment.

Index Terms— Dabou, sedimentology, tertiary - quaternary, facies

I. INTRODUCTION

Water is the most exploited natural resource in the world. It remains the most important commodity and of great human consumption. Access to safe drinking water in the world is a major problem, unresolved in many countries, and often linked to poverty.

Despite the abundance of water on the planet, the amount of fresh water available is a tiny fraction. Today, it is receiving a lot of attention because water is becoming increasingly scarce. The drilling project in the Dabou region has been set up to meet household and industrial needs for drinking water. These boreholes not only make it possible to cope with the ever-increasing needs for water, but also provide access to lithological, micropaleontological, palynological and hydrogeological approaches [1]. Some author such as [2], allowed to make a revision of the geology of the west of the onshore basin Ivorian. East of the onshore

basin is also known from the work of [3] - [4] - [5] - [6] - [7] - [1] - [8] - [9] - [10], based on outcrops and drill cuttings at Alépé, Bingerville, Samo, Adiaké, Eboinda, Assinie, Adjamé, Bonoua, Aboisso and Yopougon. The aim of these studies was to specify the lithostratigraphic characteristics of the formations encountered, their origin, and the factors and phenomena involved in sediment transport and deposition. The data on this part of the Dabou basin are scarce, like some works available in literature, [11] which worked on the quantitative and qualitative aspect of the groundwater of Dabou and [12] which worked on the characteristic hydrodynamics of these aquifers. It is in this context that the present study, "Sedimentological Characterization of Subsurface formations of the Tertiary-Quaternary in the Dabou Region (South Ivory Coast)," is in addition to earlier research, to give a scientific overview on the current state of the geology of the Dabou region with the objective of highlighting the nature of the formations crossed by the various boreholes. Its interest is to better know the geology of the region of Dabou thus facilitating the search for potential resources.

II. PRESENTATION OF THE STUDY AREA

Located in the south of Ivory Coast, west of Abidjan, the Dabou region covers an area of 1290 km² and lies between longitudes 4°16' and 4°60' West and latitudes 5°07' and 5°33' North. This region is limited to the north by the sedimentary-basement contact, to the east by the Agnéby and to the west by the Bandama. The Dabou region has two distinct geological assemblages: the basement formations largely represented by schists with some granites and sedimentary basin formations. The study area belongs to the bridge area. The different water holes were drilled in two localities namely Pakidié (121 m) and Toupah (118 m), whose geographical coordinates are given in Table 1

Table 1: Location of Drilling

Locality	Longitude (W)	Latitude (N)	Well (P)
Dabou	04°23'43.3''	05°18'31.3''	Pakidie (P1)
Dabou	04°34'51.8''	05°19'42.8''	Toupah (P2)

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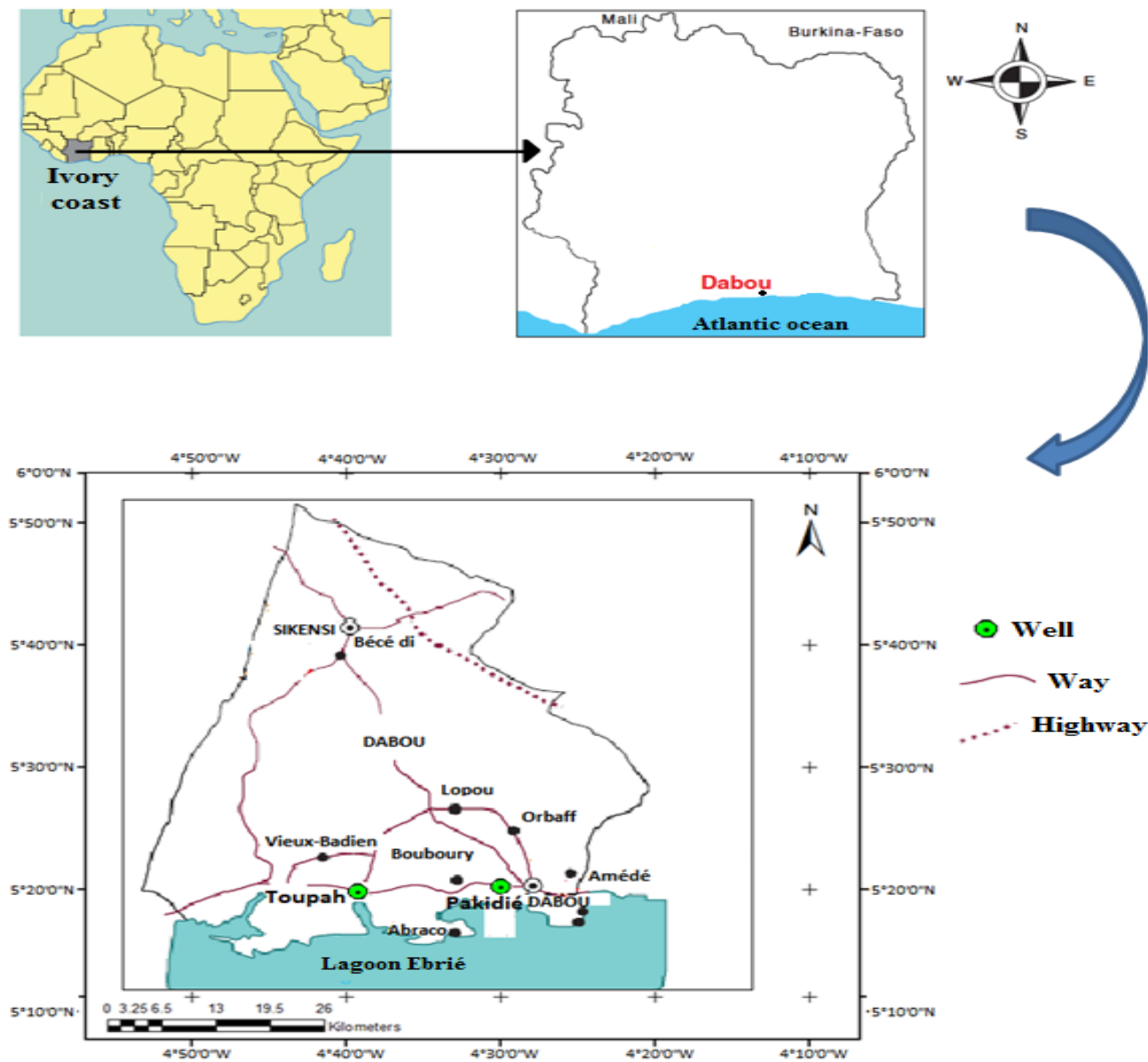


Figure 1: Geographical location of executed boreholes

III. MATERIALS AND METHODS

The material used to support this study consists essentially of 239 samples of water cuttings made by FORACO (Drilling Rational Construction). Their analysis focused on the lithological description, the granulometry of the sandy fractions and the morphoscopy of the quartz grains. The lithological analysis (macroscopic description and washing residues) made it possible to assess the relative abundance of the figured elements. The particle size analysis whose objective is to measure grain size and to know the statistical frequency of the different sizes was carried out on a column of 16 sieves (AFNOR) according to the classical procedure adopted in the recent work of [13]. The different parameters (mean, standard deviation and skewness) have been interpreted according to the laws of sedimentological analysis adopted by many authors [14] - [15] - [16] - [17] - [18] - [19]. The morphoscopic study of quartz grains carried out using the Scanning Electron Microscope (SEM) provides information on sediment wear and the nature of the transport agent.

IV. RESULTS

•Lithological of the Touphah well

This well is characterized by three facies (lateritic clays, yellow clays and coarse sands) which appear as follows: (i) laterite clays (3 to 13 m) with rare grains of pyrite and carbonaceous debris, (ii) coarse sands and coarse clay sands (13 to 78 m); (iii) yellow clays (78 to 91 m); (iv) sandy clays (91 to 96 m) and (v) coarse sands (96 to 118 m).

• Lithological of the Pakidie well

The lithology of the Pakidie well shows in the drilling direction three facies as well (lateritic clays, yellow clays and coarse sands). These are: (i) laterite clays (3 to 17 m) with rare grains of pyrite and carbonaceous debris; (ii) coarse sands and coarse clay sands (17 to 90 m); (iii) yellow clays (90 to 98 m); (iv) coarse sands (98 to 96 m) and (v) yellow clays (117 to 121 m).

• Lithological correlation

Correlations are, by definition, equivalences that can be established between geologic layers and are based on similarities in lithology, fossiliferous content, or logging characteristics. For the present study, only lithology has been

taken into account. The correlation of the lithological logs of the Pakidie and Toupah wells made it possible to identify five (5) lithological units which are:

- (i) unit 1, consisting of yellow clays (3 m) is only present in the Pakidie well;
- (ii) unit 2, consisting of coarse sands. These sands have a thickness of 21 m in the Toupah well and a thickness of 19 m in the Pakidie well;
- (iii) unit 3, consisting of yellow clays and sandy clays. Its thickness is 12 m in the Toupah well and 8 m in the Pakidie well;
- (iv) unit 4, consisting of alternating coarse sands and clay sands. This unit has a thickness of 73 m in the Pakidie well and 66 m in the Toupah well;
- (v) unit 5, consisting of laterite clays of orange-yellow color. This unit has a thickness of 15 m in the Pakidie well and 12 m in the Toupah well.

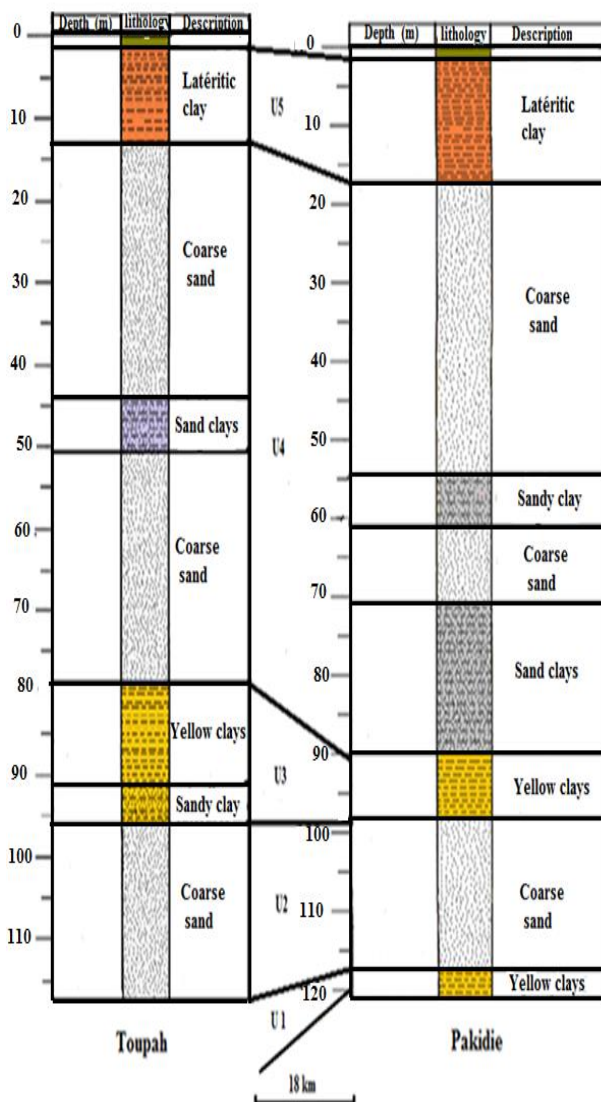


Figure 2: Lithological synthesis of the Toupah and Pakidie wells

• **Granulometric facies**

The cumulative semi-logarithmic curves of the Toupah and Pakidie sands present mostly a sigmoid-like appearance. This is the deposition facies by excess of charge. This facies indicates a gradual reduction of the transport agent.

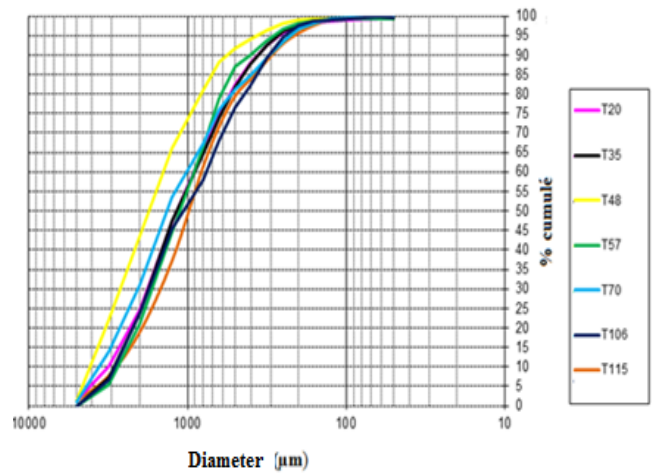


Figure 3: Semi-log cumulative curves of Toupah sands

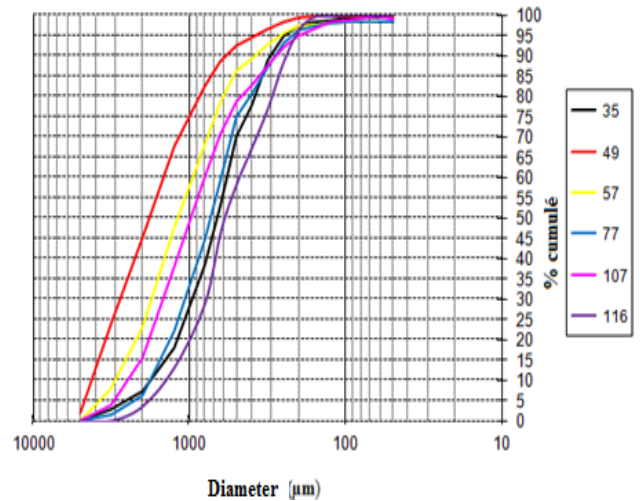


Figure 4: Semi-log cumulative curves of Pakidie sands

• **Granulometric parameters**

The calculation of the mean, the standard deviation and the skewness made it possible to characterize the sands of Toupah and Pakidie (Tables 2 and 3). This characterization reveals that the sands are for the most part of coarse size, symmetrical to asymmetrical towards the fine elements and very well classified.

Table 2: Granulometric characteristics of the sands of the Toupah well

Depth (m)	Mz	So	Sk	Description
35	1436,67	0,35	0,26	Coarse sand, well ranked asymmetry towards the fine element
50	2033,33	0,34	0,14	Coarse sand, very well ranked asymmetry towards the fine element
66	1283,33	0,41	0,28	Coarse sand, well ranked asymmetry towards the fine element
111	1303,33	0,38	0,15	Coarse sand, well ranked asymmetry towards the fine element

Table 3: Granulometric characteristics of the sands of the Pakidie well

Depth (m)	Mz	So	Sk	Description
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40	1700	0,38	0,26	Coarse sand,well ranker asymmetry towards the fine element
58	1440	0,34	0,18	Coarse sand,very well ranker asymmetry towards the fine element
76	866,67	0,31	0,05	Coarse sand,well ranker asymmetry towards the fine element
109	1133,33	0,35	0,16	Coarse sand,well ranker asymmetry towards the fine element

Sedimentation was therefore carried out in a marine beach environment where the coastal dunes are formed.

• Mode of transport of sediments

The diagram of [17], applied to the soft sediments of the Toupah well and the Pakidie well, shows four (4) populations (P1-P2-P'2-P3). Saltation (74.5%) is the dominant mode of transport for Toupah Well sediments, while this mode represents (83%) the transport of sediments from the Pakidie Well. The coarse sands are transported mainly by thrusting and saltation. The average sands meanwhile are transported by saltation and suspension, while the fine sands by suspension.

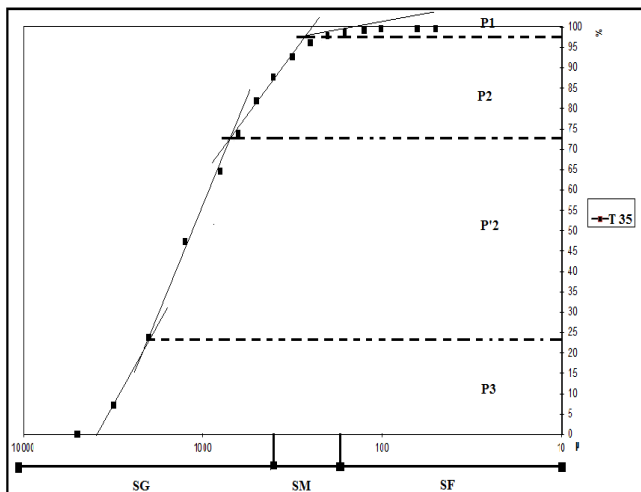
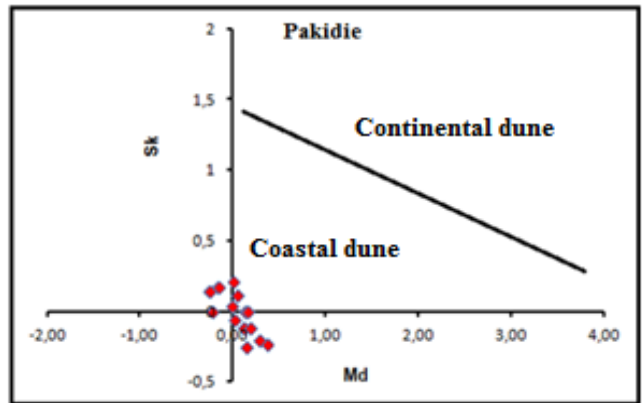
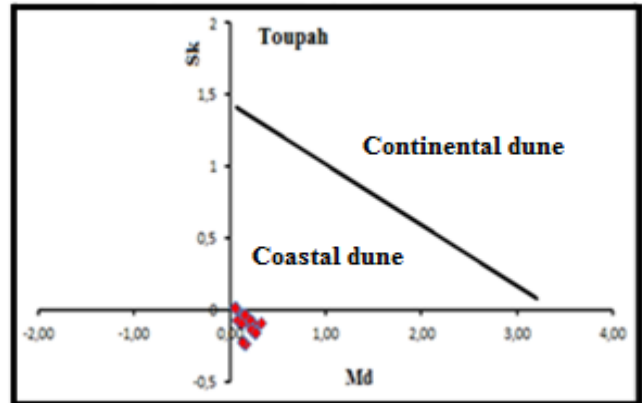


Figure 5: Application of the Visher test to Toupah soft sediments

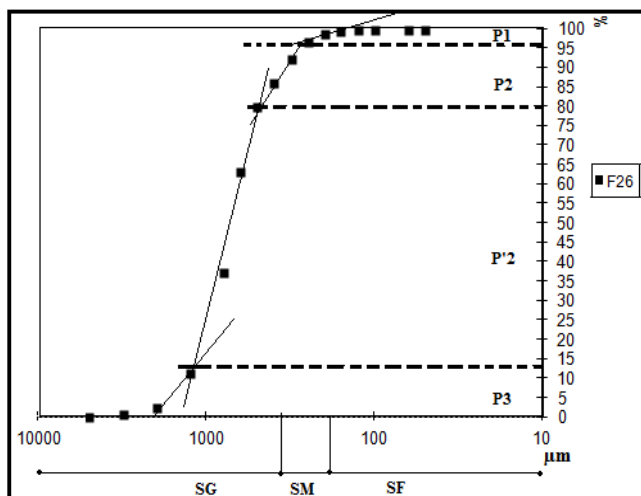
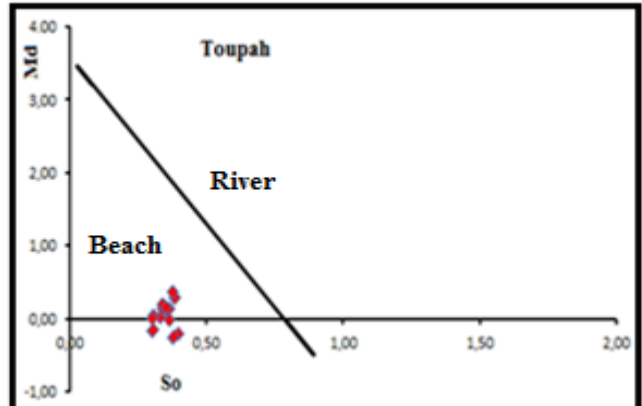


Figure 6: Application of the Visher test to Pakidie soft sediments

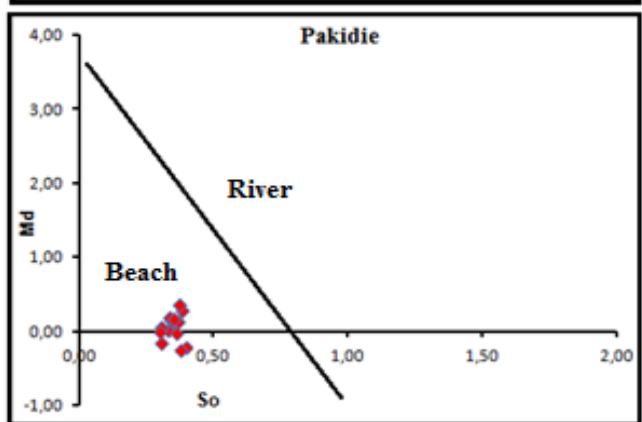


Figure 7: So / Md and Md / Sk diagrams of the sands of Toupah and Pakidie wells

• Deposit environments

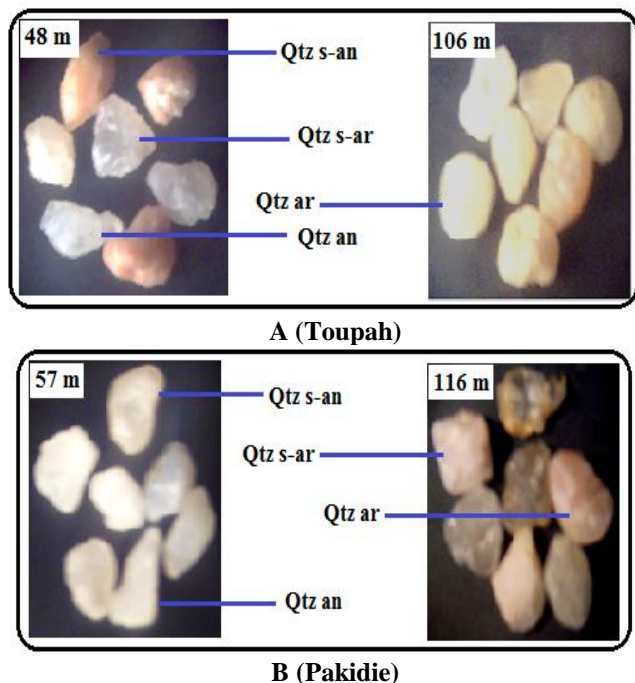
The Md / Sk diagram shows that the dispersion is 100% in the coastal area for both wells. The So / Md diagram also shows that the dispersion is 100% in the range domain.

• Morphoscopy of quartz grains

The morphoscopy of the sand grains of the different wells reveals a variation of the shapes of the grains studied. Indeed, in the Toupah well, the sand grains have shapes of rounded

(42.25%), sub-rounded (38.50%), sub-angular (13.5%) and angular (5.75%). They are translucent with yellow, orange to light gray tints (Figure 8 A).

The quartz grains of the Pakidie well also have four morphological types of grains. They are rounded (31.5%), sub-rounded (45.5%), sub-angular (15.5%) and angular (7.5%). They are translucent with shades of gray to white (Figure 8 B).



Qtz: quartz, ar: rounded, s-ar: sub-rounded, an: angular, s-an: sub-angular Magnification 400 μm x 120

Figure 8: Morphoscopy of quartz grains from Toupah (A) and Pakidie (B) wells

V. DISCUSSION

Sedimentologically, all of the sediments analyzed in the two localities are essentially lateritic clays, coarse sands and yellow clays. The sands are coarse to very well classified with asymmetry towards the fine elements. These results are consistent with those of [1] - [20], which indicate that these sands were deposited with very high energy. The hyperbolic facies, allowed to characterize the type of deposit. Thus, according to [21], in [13], the hyperbolic facies indicates a progressive reduction in the strength of the transport agent. This agent, which was initially capable of transporting grains of a certain size, is no longer so because of a reduction in its speed. As a result, he abandons the grain on the spot. For [22] - [2] - [20], this facies indicates well-graded sands in a medium with fine particles evacuation. The test of [16] indicates that the transport of the sediments studied in the two wells is ensured by saltation and by rotation. The sands observed are mostly rounded to sub-rounded and minor to sub-angular to angular. These results are in line with the work of [20], which states that the rounded and sub-rounded shapes evoke a distant clastic source and relatively long transport, while the sub-angular and angular forms reflect a medium of deposit close to the source generating sands. Most of the grains encountered in the different units have a blunted appearance. Thus, sediment transport was carried out in an aqueous medium.

VI. CONCLUSION

The sedimentological study of the Pakidie and Toupah wells revealed three main facies: clay facies, sandy facies and facies of mixed sediments (clay sands and sandy clays), all covered with a lateritic layer. These two wells have clayey levels of yellowish color. The sands of the Pakidie and Toupah wells are generally coarse, well classified, very well classified and generally asymmetrical towards the fine elements. They present sigmoid type facies translating a free accumulation sedimentation and a saltation transport. The quartz grains are mostly sub-rounded to rounded suggesting a relatively distal supply source while the shiny blunted appearance of the grains confirms their stay in the aquatic environment and their deposition in the shallow marine environment.

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