

Salt Units of The Kribi-Campo Sub-basin Revisited, Using Off-shore 2D Seismic and Boreholes Data: Depositional Context and Petroleum Implications.

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Abstract: This work re-examines the salt unit through the Kribi-Campo Sub-basin on the southeast part of the Cameroon Atlantic Margin. The results obtained from borehole data analysis show the occurrence of evaporitic unit, localized in the Kribi area. The well to seismic-tie analysis reveals that this unit is observed beneath the Top Albian Unconformity and between the Flooding and Maximum Flooding Surfaces. Two characters of salt dome and salt strips are described. Their depositional context seems to be related to a significant sea-level drop induced by a margin uplift during the Aptian. Concerning the petroleum implications, the target units constitute good potential of stratigraphic traps in the study area, due to the observation of flatspot indicators.

Keywords: Kribi-Campo Sub-basin; Cameroon Atlantic Margin; salt unit; salt diapir; salt strip; Albian; Aptian; petroleum

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1. Introduction

The Kribi-Campo Sub-basin is a segment of the Cameroon Atlantic Basin, which is the southeast part of the Cameroon Atlantic Margin (CAM) located in the Gulf of Guinea (Figure 1). Previous studies explored the geoscientific and hydrocarbon aspects of the basin [1-11,30]. The offshore deepwater domain of the Kribi-Campo Sub-basin is covered by up to a 5 km thick sedimentary fill [3,8,9]. The literature on the southern Cameroon Atlantic Basin shows controversies regarding the presence of salt units.

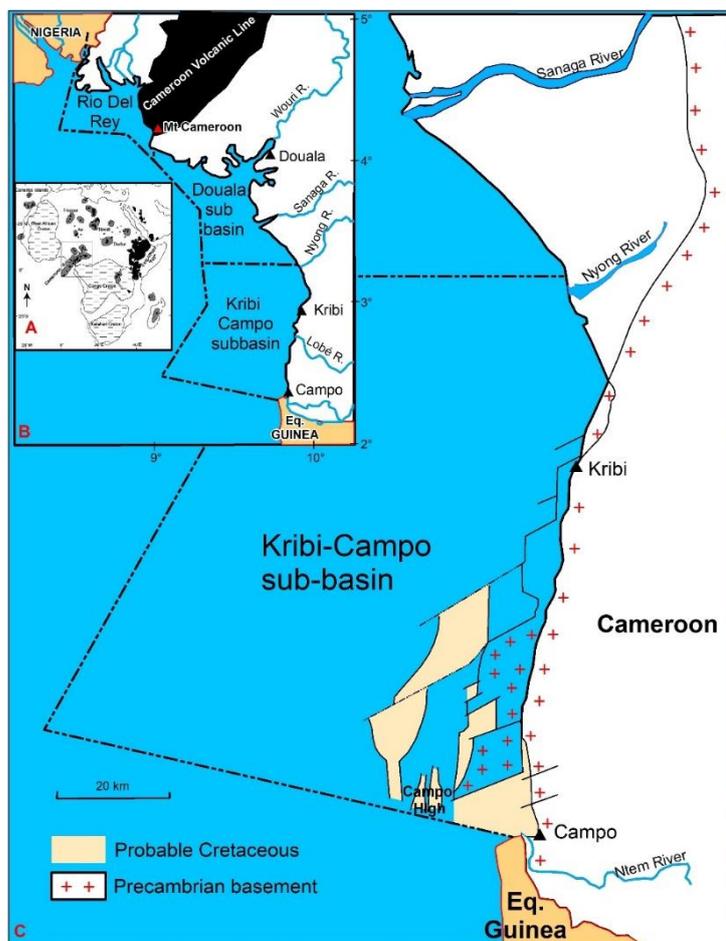


Figure 1. A) Location of the Cameroon Volcanic Line (CVL) in Africa. B) Segmentation of the Cameroon Atlantic Basin in the Gulf of Guinea; Rio Del Rey, Douala sub-basin, and Kribi-Campo sub-basin. C) Location of the Kribi-Campo sub-basin showing the Precambrian basement exposure along the shore and probable distribution of Cretaceous units [9].

Some authors [12–15] stated that the salt unit does not exist in the Atlantic domain. Particularly, the works of [13] and [14] described that the extent of salt units does not exceed 1°N latitude. The formation of folds observed in this segment is associated with the reactivation of transfer faults and not formed by salt tectonics. However, other studies [4, 6–9, 16–23] highlighted salt units in the southern Cameroon Atlantic Basin. These studies date the saliferous sequence to the as older than Cenomanian. The works of [4] described a salt diapir in the Kribi-Campo domain, and the recent study of [8] indicated despite the results of those previous authors, the existence of strip-shaped salts in the deep marine domain.

The salt unit is a central element in understanding the structure and stratigraphic framework of the CAM, and the sedimentary evolution of basins along the SW African Margin. This work aims to re-examines the occurrence of salt units in the Kribi-Campo Sub-basin, using 2D seismic reflection and borehole data while investigating its depositional context and associated petroleum implications.

2. Materials and Methods

Data used in this study were provided by the National Hydrocarbon Corporation of Cameroon (NHC). It includes four 2D-seismic depth migrated reflection profiles (SS1-SS4) and fifteen boreholes (W1–W15, in Figure 2). All those data have been acquired from the continental-shelf to the deep basin. They cover an area of 7200 km². The seismic profiles

extend down to 10 km, and boreholes depth vary from 1 to 4 km below seabed, penetrating down to Aptian/Albian age units. We analyzed the data seeking evidence for salt units beneath the Top Albian unconformity and mapping their spatial extent.

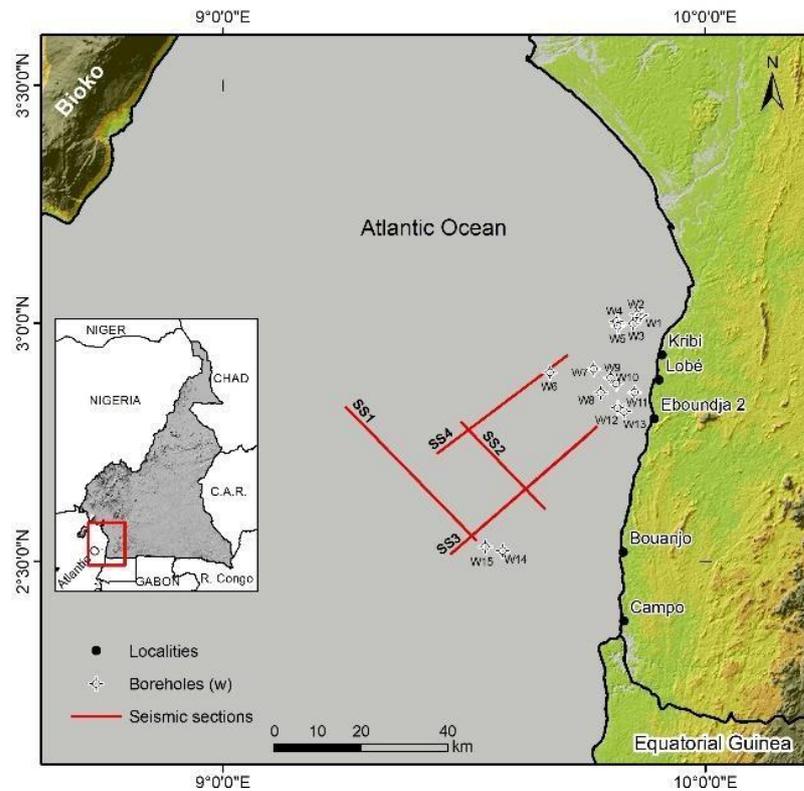


Figure 2. Location of seismic reflection profiles (SS1–SS4) and boreholes (W1–W15) in the study area (revised from [9]).

The methodology included tying seismic with well data, and prospecting of internal and external forms of salt facies on the seismic data. The first step consisted of mapping the Top Salt surface on seismic profiles. Then, salt facies were identified based on seismic stratigraphy concepts [24–26], guided by observations from recent studies [27–29]. This method has the potential to identify salt units and highlight their external configurations.

3. Results

3.1. Borehole Data Analysis

The analysis revealed a salt unit only in one borehole—the Kribi Marine-1 (W6 in Figure 2). In this well-known borehole the saliferous unit thickness exceeds 1500 m (the bottom of the unit was not recovered). This unit also exhibits thin dark shale streaks and traces of anhydrite of Aptian age (Figure 3).

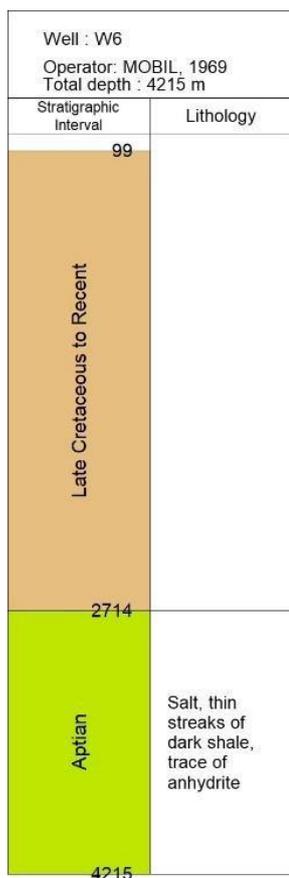


Figure 3. Profile of Well W6 (Kribi Marine-1), showing salt units in the Aptian section (2714–4215 m) of the Kribi offshore domain (see Figure 2 for location).

3.2. Seismic Analysis

3.2.1. Well to seismic-tie

The well to seismic-tie analysis reveals that salt units are located beneath the Top Albian unconformity (Red line, Figure 4), which truncates the pre-Cenomanian period. These units appear in the early to mid-Aptian strata. The fence diagram in Figure 4 illustrates the spatial distribution of the salt unit and its upper surface.

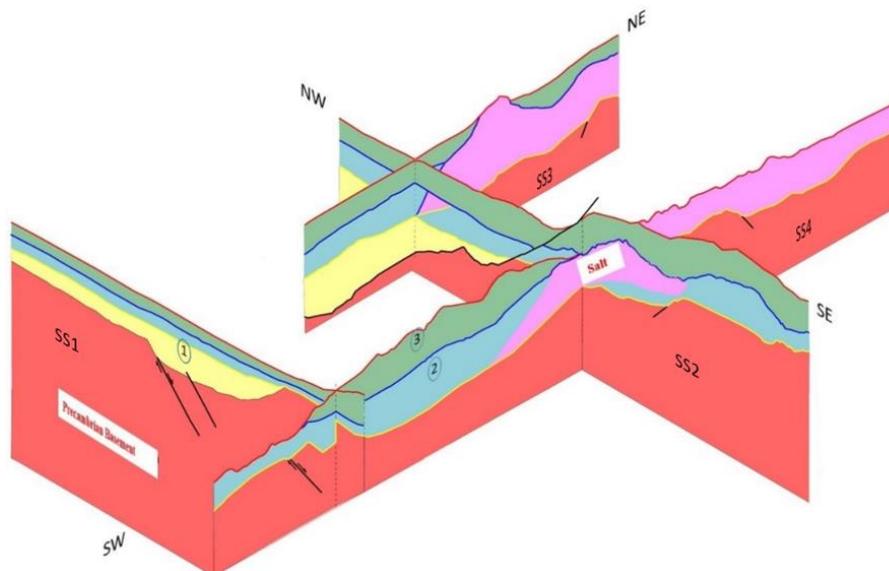


Figure 4. A fence diagram showing the spatial distribution of salt units on SS1-SS4 Profiles (pink layer) in the Kribi-Campo Sub-basin, based on an integrated seismic-borehole interpretation (see Figure 2 for section location). Yellow unit ① indicates the Early Aptian transgressive sequence covering the Precambrian basement (red). Blue line ② indicates the top salt horizon of Late Aptian age. Red line ③ indicates the Top Albian unconformity.

3.2.2. Seismic data analysis

The NW-trending SS1 seismic reflection profile is located in the deeper domain provides no evidence of a salt unit.

In the NW-trending SS2 profile, the salt unit is well observed and characterized by a localized portion of chaotic facies, which is associated with wavy internal reflections of average amplitudes and variable frequency. Its external configuration shows a diapir shape. Its thickness varies along the section and reaches ~3 km above the Kribi-Campo High. This salt diapir is associated with faults.

Additional evidence for salt units appears in the NE-trending profile SS3, showing similar seismic facies in SS2. These units lie directly over the basement unit (Figure 4). It exhibits two patterns—diapir and strip-shaped. Its thickness reaches the value of 4 km towards the coastline. This salt body is also associated with faults developed at its top.

The NE-trending profile SS4 exhibits similar seismic characteristics to the NE part of parallel line SS3. The salt unit appears under the continental shelf domain in varying thicknesses, reaching 2 km to the east. Diapir and strip shapes of salt units are observed.

4. Discussion

The results obtained in this study show the presence of several salt units in the offshore domain of the Kribi-Campo Sub-basin. Its three-dimensional body comprises diapir and strip shapes. These observations are in accordance with some of the previous studies [7, 9, 30]. This study [8] also shows that the salts were deposited during the rift-drift period following the marine incursion. In comparison with [9] and [30], the depositional context of the salt units seems to be associated with a significant sea-level fall induced by a margin uplift, which probably occurred during Aptian times [30].

The diapir structure can form oil and gas traps, an important type of petroleum plays [7]. Some seismic characteristics identified within the salt unit might reflect DHIs. These observations correspond with those of [7], which identified similar hydrocarbon indicators in the offshore Kribi-Campo Sub-basin.

5. Conclusion

Seismic and borehole data confirm the presence of Aptian salt units in the offshore domain of the Kribi-Campo Sub-basin. The units appear as diapir and strip shapes. Their formation relate to a significant sea-level fall induced by a margin uplift, which occurred during Aptian times. These salt units may form stratigraphic hydrocarbon traps.

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Conflicts of Interest: The authors declare no conflict of interest.

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