CYCLIC TRANSGRESSIVE AND REGRESSIVE SEQUENCES DURING CRETACEOUS TIME, NORTHERN ZELTEN PLATFORM, SIRT BASIN, LIBYA

Senusi M. HARSHA

Geophysics Dep., Faculty of Sciences, A l-Fateh University, B.O. Box 13379, Tripoli-Libya
sm_harsha@yahoo.com

ABSTRACT: Two marines transgressive and regressive cycles are recognized during the Cretaceous time; one is represented during Early Cretaceous, when the Sirt area was still an arch. In this cycle, the sedimentation had only taken place on the line base of the arch. The Jurassic sediments partially transgressed the arch but had their depositional edge on the flank of the arch. The other cycle is represented after the northern Tibesti-Sirt uplift collapsed in the beginning of the Early Upper Cretaceous and during the Upper Cretaceous (Campanian) time.
The Maestrichtian Sea encroached from the North and further to design the first flooding surface in the area. Thick of dark grey shale (Sirt Shale) followed by deposition of shallowing upward regressive carbonate of the Kalash Formation were deposited in the troughs. The Sirt shale acts as both a seal and source rocks for hydrocarbons trapped in the Cretaceous reservoirs and underlying the Cambro-Ordovician Gargaf Sandstone. The Upper Cretaceous formations are Bahi, Sirt, and Kalash in ascending order. The top of the Kalash Limestone marks the Maestrichtian/ Danian boundary in the study area.

Keywords: *Sequence, Bahi, Sirt ve Kalash , Sirt, Libya.*

Kuzey Zelten Platformunda (Sirt Baseni, Libya)
Kretase Dönemi Periyodik Transgresif ve Regresif Sekansları

ÖZET: Kretase döneminde iki adet denizel ilerleyen ve gerileyen istif yer almaktadır. Biri Sirt bölgesi hala yay konumunda olduğu Erken Kretase'yi temsil ederken diğeri de Erken Üst Kretase 'nin başlangıcı ve Üst Kretase (Kampaniyen) 'de ki, Kuzey Tibesti-Sirt yükseliminin sona ermesinden sonrasını temsil etmektedir.
Maestrichtian denizi, ilk sellenme yüzeyini kuzeyden gelerek şekillendirmiştir. Yukarı doğru gittikçe, gerileyen ve sığlaşan özellik gösteren Kalash Formasyonuna ait karbonatlardan daha önce oluşan koyu gri şeyler (Sirt şeyli) hendekte çökelmişlerdir. Hidrokarbonlar, Kretase yaşlı hazne kayaçlar ve alttaki Kambroordovizyen yaşlı Gargaf kumtaşları içerisinde hapsolmuşlardır. Sirt şeylleri bu hidrokarbonlar için hem örtü ve hem de hazne kayaç özelliği taşımaktadır. Alttan üste doğru Üst Kretase yaşlı formasyonlar, Bahi, Sirt ve Kalash formasyonlardır.

Anahtar Kelimeler: *İstif, Bahi, Sirt ve Kalash , Sirt, Libya.*

INTRODUCTION

Sirt Basin is located in the north central part of Libya; it was developed in the area between the Tethys Sea and the Saharan shield, by an active subsidence and block faulting as a result of the collapse of the Sirt Arch during the Late Cretaceous time (Abushagur, 1988). The Basin is generally regarded to be Cretaceous and younger in age. It contains most of the major oil fields in Libya and is considered the most prolific oil producing basin in North Africa. The study area is located about 50 Km South of Marsa al Braygah, in Northern Zelten platform in the central part of the Sirt Basin (Figure 1). It lies approximately 29° 30' to 30° E and 19° 30' to 20° N.

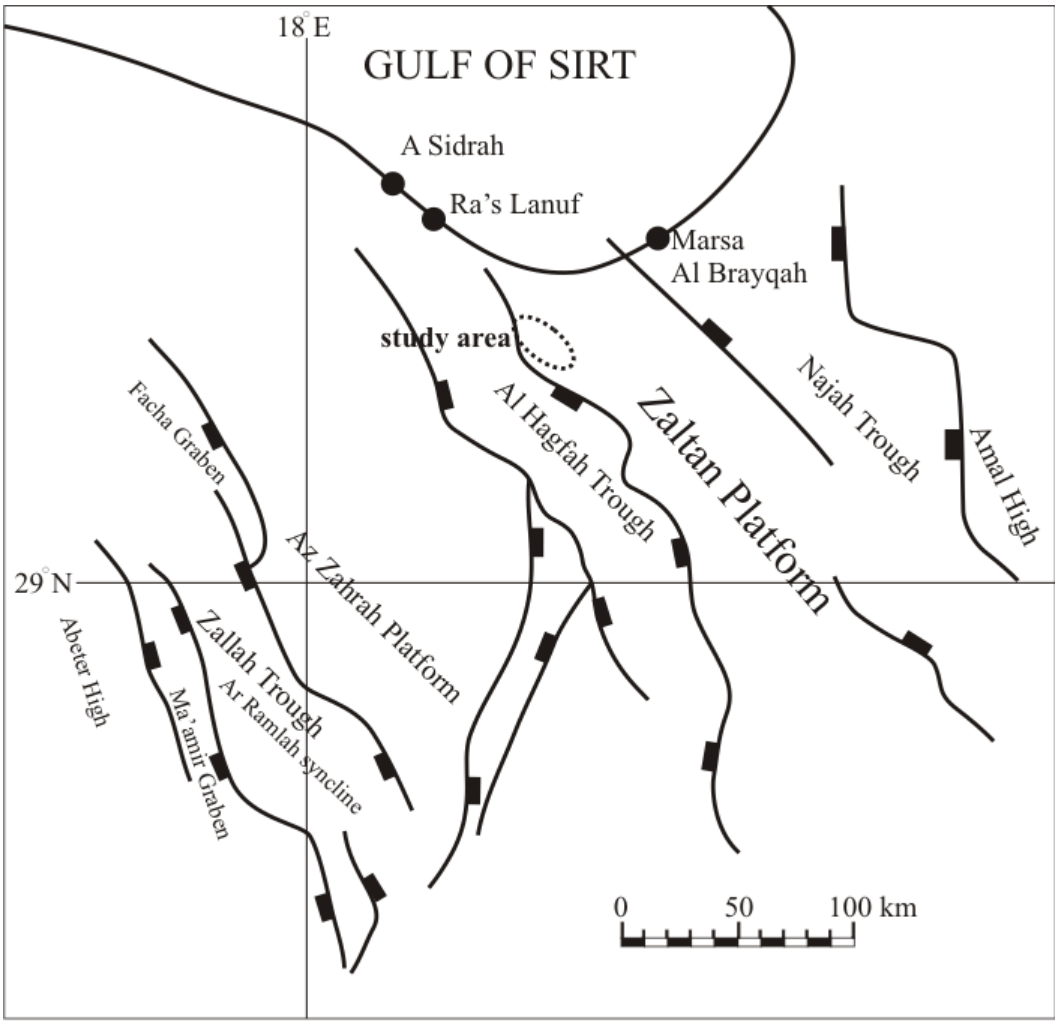

Fig. 1. Sirt Basin major tectonic element and location map of study area.
(Modified after Schroter, 1993)

GEOLOGICAL AND STRATIGRAPHIC SETTING

The Sirt Basin was most dramatic in formation. The basin underwent regional uplift, tensional and compressional faulting, and trough subsidence, resulting in a **NW** trending horst and graben structural style of considerable relief. The important structural element in the area of study is the major northwest-southeast trending normal fault (Figure 1), which extends along the southern flank of the area (Harsha, et. al, **2000**). Subaerially exposed, the horsts were weathered and eroded with accumulation of sediments in the grabens. These Cretaceous continental sands, Lancastrian and fluvial silts and shale of the Nubian and Bahi Formations in filled the grabens, by mid-to Late Cretaceous time the seas encroached from the north and further eroded the Gargaf horsts and reworked the basal Cretaceous sands producing the first calcareous sand and shale, with carbonate being the final stage of deposition for the Cretaceous. These marine sediments comprise the Bahi, Sirt and Kalash Formations. The Sirt shale is the hydrocarbon source rocks of the Cretaceous and Tertiary reservoirs.

By the end of the Cretaceous, shallow epicontinental seas covered the horsts and from the Paleocene through the Eocene, the sediment deposition was of a shallow marine environment. Limestone, marl, shale, and

evaporates were cyclically deposited with sands being deposited only in the Oligocene. The principal reservoir rocks of the Sirt Basin within the vicinity of Northern Zelten Platform include the Ordovician to Cretaceous Gargaf, the Upper Cretaceous sands and carbonates, the Paleocene shale and carbonates, the Eocene carbonates and the Oligocene sandstone and carbonates (Figure 2).

ZELTEN PLATFORM

The Zelten Platform is one of the most important tectonic units of the Sirt Basin. It covers an area of approximately over 4000 sq. kilometers. Most of the largest and important oil and gas fields are located on the Zelten Platform (Fraser 1967) (Fig. 3).

The high productivity of the Zelten Platform is probably because it is adjacent to deep Agdabia trough, where huge quantities of hydrocarbons have been generated in the Sirt and Hagfa Shale. The Zelten Platform is separated from the Jahama Platform in the north by a right-lateral wrench fault. The Hateiba gas field which is the largest gas field in Libya is located on the Jahama Platform. The study area is located in the northern part of the Zelten Platform (Figure 3) whereas Defa, Nasser, and Waha oil fields are found in the South.

TRANSGRESSIVE AND REGRESSIVE CYCLES

The Paleozoic-Mesozoic sandstones are distributed in Libya basins which flank the Tibesti-Sirt uplift, the Ghadamis, Murzuk, Kufra basins and Cyrenaica platform , (Figure 4). Sandstones in these basins are much less altered than those on the crest of the Tibesti-Sirt uplift (Hea 1969). The deeply eroded Sirt arch may have been fractured during Mesozoic opening of Tethys (Mediterranean Sea), but it did not collapse into numerous horsts and grabens until Early Cretaceous time (Van Houten 1980). Kogbe (1980) suggested that, there was an inland sea across the Sahara during the Cretaceous time; the Saharan Seas were extensions of the Tethys (Mediterranean Sea) and the South Atlantic Ocean into the African continent during Middle Upper Cretaceous (Turonian) and top of Cretaceous time.

Two marine transgressive and regressive cycles during Late Cretaceous (Cenomanian-Campanian) times are recognized across the area under study (Figure 5).

THE FIRST CYCLE

During Early Cretaceous when the Sirt area was still an arch, transgression was represented during this time, the sedimentation had only taken place on the line base of the arch, that is, Jurassic sediments partially transgressed the arch but had their depositional edge on the flank of the arch. The first transgression usually starts with basal sands known as Bahi Formation (Cenomanian).

THE SECOND CYCLE

The second cycle of the Transgression was represented after the northern Tibesti- Sirt uplift collapsed in the beginning of the Early Upper Cretaceous and during the Upper Cretaceous (Campanian) time. The Maastrichtian Sea encroached from the North and further, to design the first flooding surface in the field. This sea eroded the Gargaf horst and reworked the basal Cretaceous sand. Thick shale of the Sirt Formation followed by deposition of shallowing-upward regressive carbonate of the Kalash Formation was deposited in the troughs; the top of the Kalash Limestone marks the Maastrichtian/ Danian boundary in the study area.

CONCLUSIONS

The transgressive shale (Sirt shale) represents the main source rocks for hydrocarbons trapped in the Cretaceous reservoirs and underlying the Cambro-Ordovician Gargaf sandstone. The Bahi-Gargaf is the principal reservoir representing the most important commercial gas bearing interval in the area under study.

ACKNOWLEDGMENTS

The authors wish to thank Sirt Oil Company Libya for providing the essential enough data for this study.

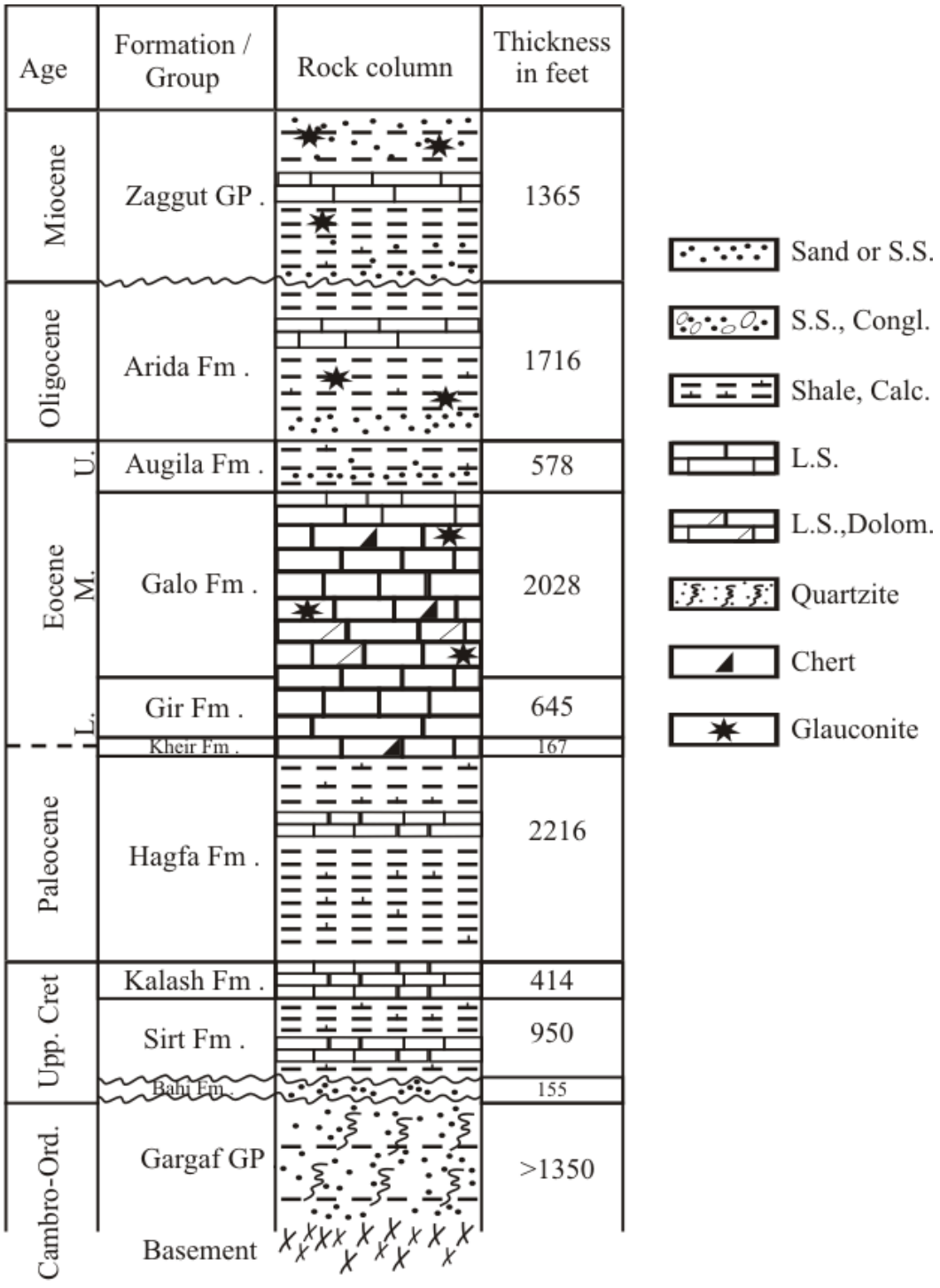

Fig. 2. Generalized stratigraphic column of stud area, Sitr-Basin, Libya.

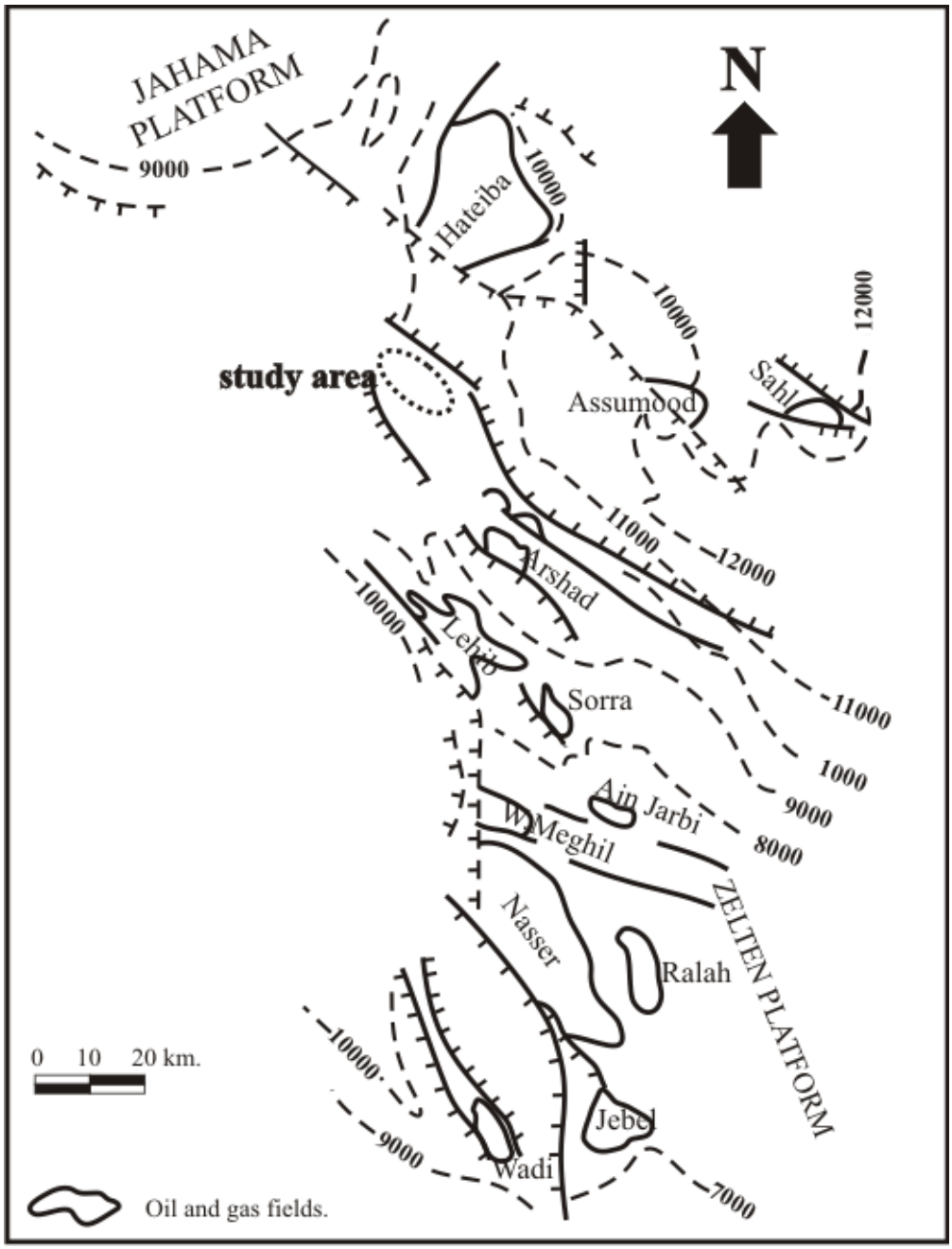

Fig. 3. Simplified contour near top of Cretaceous and main oil and gas fields in Zelten platform, Sirt-Basin, Libya (Modified after Keskin, 1988).

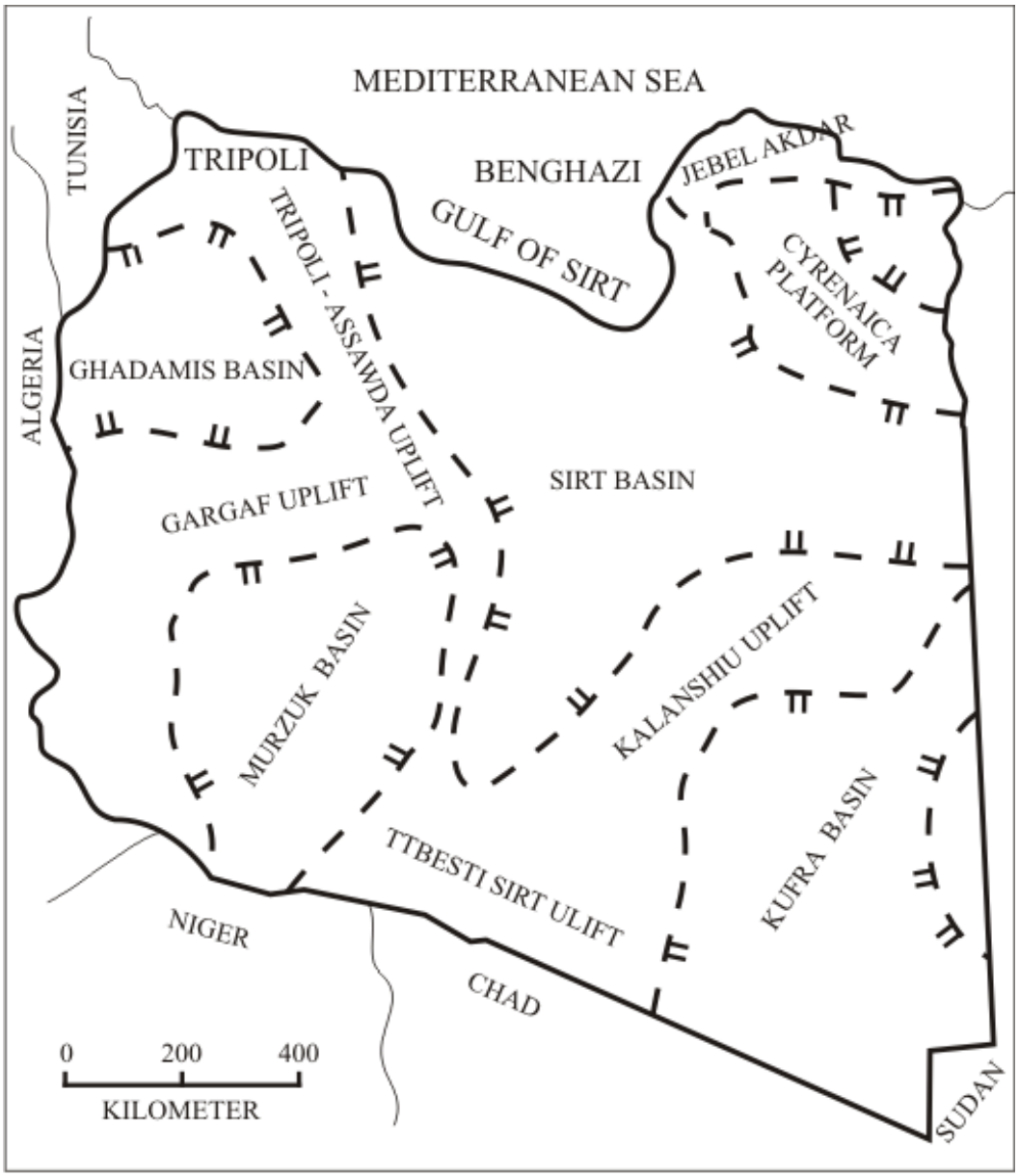

fig. 4. location of uplifts and basins in libya.

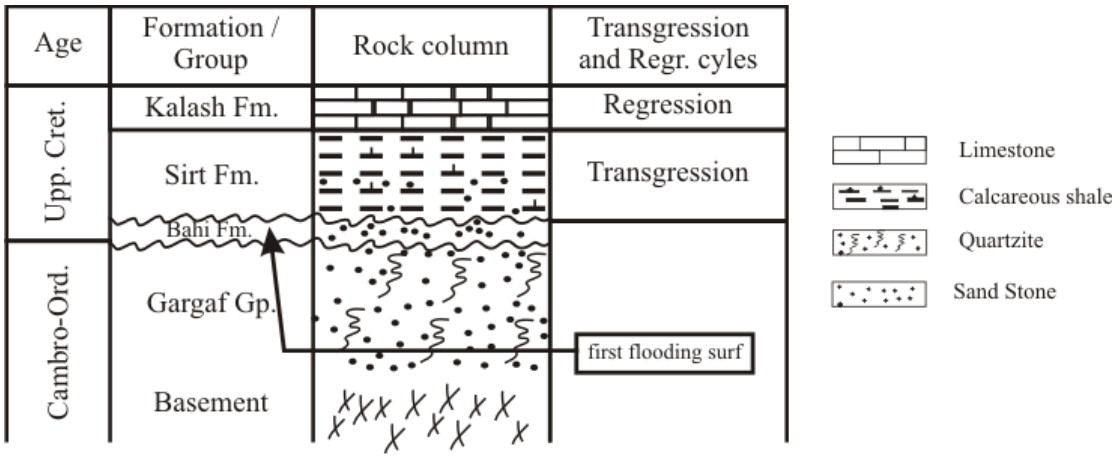

Fig. 5. Transgression and regression cycles, cretaceous time, of study area Sirt-Basin, Libya.

REFERENCES

Abushagur, S.A., 1988, Cycle Transgressive and Regressive sequence and their Association with hydrocarbons, Sirte Basin, Libya (Abstract): Bull. AAPG, **72** (8): 983

Fraser, W.W. 1967. Geology of the Zelten Field, Sirte Basin, Libya. Proc. 7th World Petrol. Congr. **2**: 259-264. Elsevier, Amsterdam.

Harsha, S. M., and Owaina, F. 2000. Seismic interpretation of Gargaf Group Palaeostructures, NW of Concession 6, Sirte Basin, Libya. Petroleum Research Journal. Volume 12: 18-24. Tripoli, Libya.

Hea, J. P. 1969. Petrography of the Paleozoic-Mesozoic Sandstones of the Southern Sirte Basin, Libya. In: The Geology of Libya. Ed. C. Cray. First Symposium: 107-125. Tripoli, Libya

Keskin, C. 1988. Geological report (217). Exploration Department, Sirt Oil Company (SOC) Libya. (Unpublished report).

Kogbe, 1980. The Trans-Saharan Seaway During the Cretaceous. In: The Geology of Libya. Eds. Salem, J. M., and Busrewil, T. M. **1**: 91-95. Tripoli, Libya. Academic Press, New York.

Schroter, T. 1993. Tectonic and Sedimentary Development of the Central Zallah Trough (West Sirt Basin, Libya). In: Geology of Sirt Basin, first symposium. Ed. Earth Science Society of Libya (ESSL), Tripoli, Libya.

Van Houten, F. B. 1980. Latest Jurassic-early Cretaceous regressive facies, northeast Africa craton. Bull. AAPG **64**: 857-867.