Geology of Ketatna Formation, Offshore Reservoir, Oligocene- Early Miocene, Tripoli-Sabratah Basin, Nw Libya

Fateh Belhaj[1], Osama Hlal[2] (*)

1Geology Department, Faculty of Science, University of Tripoli, Tripoli, Libya

2 Geology Department, Faculty of Science, University of Tripoli, Tripoli, Libya

Abstract

The Ketatna Formation (Dirbal Formation) of Oligocene to Early Miocene age is composed of mainly carbonate sequences which are present in the subsurface of north-west Libya, offshore. The type section is represented by well A1-NC41 drilled by Agip Oil Company. The lithology of The Ketatna Formation can be subdivided into two main

(*) Email: fatehbelhaj@yahoo.com

units, an upper wackestone-packstone unit and a lower grainstone-boundstone unit. The lower unit of Ketatna Formation consists of mainly, grainstone-boundstone. The upper units consist mainly of alternating white-greyish wackestones and packstones. Locally Ketatna Formation consists of reefal facies characterized by abundance of dissolution cavities. Ketatna Formation base is composed of nummulites beds unconformably overlain by Al Mayah Formation and overlies Tellil Group unconformably.

The purpose of this paper is to evaluate the Ketatna Formation reservoir for future drilling into Metlaoui main reservoir in the area of offshore Libya. Wells A1, A2, J1-NC41, K1, B1a-137, K1, D1a and J1 drilled in the offshore area encountered three major sequences facies separated by major unconformities. It represents three major phases of reactivated paleohighs probably initiated during Triassic time. The unconformities associated with possible tectonic pulses causing the sea level to drop as represented by the Formation of Ketatna and evidenced by three facies of marl shale locally silty, deposited in a distal environment of Salammbo Formation. The fine to coarse grained packstone is composed of skeletal debris of Echinodermata, Hydrozoa, Algae facies, and benthonic foraminifera probably deposited on the build-up flanks of fore-reef-slope facies of Ketatna Formation. These three main facies represent dolomitic shale interbedded with skeletal pack-Grainstone probably deposited in a shallow internal lagoon.

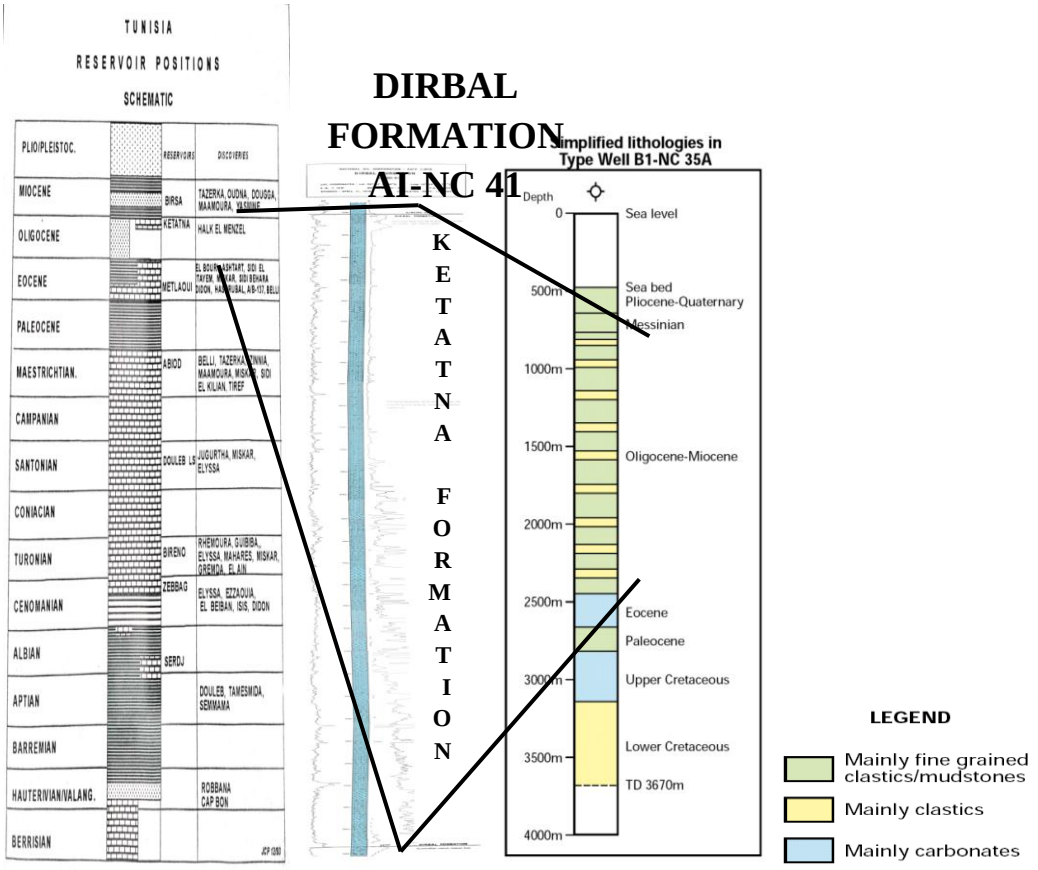
The Boundstone-grainstone composed of Hydrozoa and other frame-build-up and Packstone-Grainstone containing skeletal fragments coated by micrite rims, Crinoidea, Ostracoda, Algae, interaclasts with

pellets of subordinated hydrozoa and molluscs fragments, is interpreted as possible back-reef facies.

Keywords: *Ketatna Formation, offshore reservoir, Oligocene to Early Miocene, Tripoli-Sabratah basin, Libya.*

1. Introduction

The Ketatna Formation is well preserved in drilled well A1, A2, A3-NC41 in the offshore of Tripoli-Sabratah basin "A" Structure. The Tripoli-Sabratah Basin is a deep trough elongate which extends from the Gulf of Gabes to the northwestern margin of the Sirt Basin (Figure 1). The Basin is intensively faulted with major faults are parallel to the Jefara fault that located along the shore line of Tripoli. The faults in the offshore are closely spaced closer to the shoreline and largely spaced towards the northeast areas of the basin. Oil and gas-condensate discoveries in the basin are concentrated in the south and southwest area of Tripoli-Sabratah Basin.



Figure(1): Simplified sketch of the type wells sections of Ketatna Formation located in Libyan-Tunisian territories of Gabs-Tripoli-Sabratah Basin

The main potential reservoirs in Tripoli-Sabrata Basin are the lower Eocene of El Garia Formation of the Metlaoui group and Abiod Formation. El Garianummulitic bank composed of grainstone-packstone facies and the equivalent units where the underlying geological units composed of dolomite and skeletal limestone having average net thickness of around 600 ft. in the Basin area with effective porosity of up

to 30%. El Garia facies pinches out towards the inner shelf along the southwest margin seaward of the shelf edge at the northern limits of the Basin areas. The top of the El Garia Formation is at depths ranges from 5,000 ft. in the southwest to about 12,000 ft. in the basin center and ranges in depth from 9,000 ft. to about 10,000 in the northern parts of the Basin areas.

Cretaceous reservoirs considerations based on stratigraphic projection from few wells in the western part of the Tripoli-Sabratah Basin and the northwestern part of the Sirt Basin indicate the presence of several attractive secondary reservoir targets such as Ketatna Formation of the Oligocene age. The Cenomanian-Turonian of lower and upper Zebbag Formation geological units such as important reservoirs of shallow-shelf skeletal limestone and dolomite facies.

The seals are shale and argillaceous limestone (mudstone-wackestone) beds provide effective seals for the underlying Cretaceous to Eocene-Oligocene reservoirs throughout most of the eastern, northern and northeastern sectors of the basin.

The source mature organic-rich type II source beds have been identified in four Formations in the Tripoli-Sabratah basin. The best known and probably the most important is the Turonian argillaceous limestone, with a TOC of 1–10%. The distribution and thickness of this rich organic sequence in the area of southern Basin but the Turonian strata is expected to have an average thickness of more than 400 ft. in the area of northern areas of the Basin based on few wells located in the area.

The trap types expected in northern area of the Basin include faulted anticlines, horsts and tilted fault blocks, drape anticlines over

carbonate buildups or faulted relief, and up dip lithology or permeability pinch-outs. No evidence of the presence of Triassic salts from the data available. The Eocene-Jurassic volcanic belt that extends from the eastern Sirt Basin to the area of these volcanic anomalies in the offshore area of Tripoli-Sabratah Basin may provide the bases for more detailed seismic acquisition as semi leads to be ranked to prospects.

The lower Eocene El Garianummulitic limestone, which is the major producing Formation in the basin, reservoir potential includes a numerous dominantly carbonates Lower and Upper Cretaceous Formations. Different tectonics has induced number of known faulted structures, drape anticlines, structural-stratigraphic combination traps involving facies pinch-outs, onlap terminations, and unconformity truncations. The Ketatna Formation is best known to be distributed in the subsurface of the southern areas of the offshore of Tripoli-Sabratah basin which was encountered mainly by drilled wells during the exploration for oil and gas by the different oil companies working in the area for the deeper exploration targets such as Metloui and Abiod Formations. Ketatna Formation is of Oligocene to Early Miocene in age is reported by the paleontological age dating by work from oil companies exploring and developing the area of Tripoli-Sabratah basin offshore which is generally composed of mainly carbonate sequence Gray 1971, Bailey et al 1989.

After the well A1-NC41 was drilled by Agip Oil Company 1980, the section of Carbonates section penetrated which was designated as Dirbal Formation by Stratigraphic Nomenclature of the Northwestern offshore of Libya by Hammuda et al as proposed type section 1985 (Figure1). The Ketatna Formation (Dirbal), which is present in the

subsurface offshore of Tripoli-Sabratah Basin north-west Libya. The Type well log of A1-NC41 is located at geographical coordinates of Long: 12° 24' 24" E and Lat: 33° 31' 15" N. The type section penetrated at a depth of 4108-6970 feet (1252 m–2124.5 m) which, corresponds to a subsea depth of 4006–6868 feet (1219 m-2091 m). Barr and Weegar 1972; Hammuda et al 1985; Sbeta 1983; Sbeta 1984; Anketell 1996, Taktak 2017.

2. Regional Setting of Ketatna Formation

The Ketatna Formation is composed of shallow marine carbonates of Late Oligocene transgression which is a facies of the Salammbo shaly sequence (Figure 6) The Salammbo sequence consists of fine grained Siliciclastic sediments and marl widely distributed over Conc. NC41. The Ketatna Formation is identified by Agip regional group to be restricted to the area and the surrounding of "A" structure formed by shallow water carbonates, which give the rise to well defined positive structure on seismic sections. The Ketatna Formation is also identified based on log interpretation which was deposited in open to shallow marine platform conditions and restricted to few wells drilled in the offshore of Tripoli-Sabratah Basin (A1, A2, J1-NC41 and K1, B1a-137). From available date, the style of the carbonate build-up is not widely distributed in the southern areas of Tripoli-Sabratah Basin but more confined to smaller structural highs such as the 'A' structure (Figure 2).This carbonate complex subsequently was buried in facies of mudstones and siltstones of the Salambo Formation. The Ketatna Formation also distributed in eastern offshore of Tunisia around the Mahdia area of the offshore which

is a part of the Mesozoic - Cenozoic platform with local highs characterized by dominated carbonate shale deposits during the Jurassic to Mid-Miocene Anketell 1996; Taktak 2012; Taktak 2017.

The siliciclastics deposited during the Mid-Late Neogene. This platform was affected by Mid-Cretaceous to Late Miocene compressional stresses and associated with folding and Pliocene block faulting with nearly east - west trends of subsiding grabens and pronounced horsts. The primary reservoirs are the Senonian Abiod chalky limestone and Aptian Serdj carbonates. The secondary targets include the Mid-Miocene Ain Grab and Oligocene Ketatna bioclastic limestone, Mid-Albian Allam limestone and Jurassic Nara dolomites. The Source Rocks in the offshore Mahdia is the Albian Fahdene shales and limestone provides the primary potential source in the area. Further potential is provided by the Mid-Cretaceous argillaceous limestone and Jurassic middle Nara black Shales. The presence of gas shows in Alfil-1 well and an oil column in the Halk El Menzel field, immediately west of Mahadia area indicates that source rocks are being mature in the area. Also the primary reservoirs are the Upper Senonian Abiod chalky limestone and Aptian Serdj carbonates. Also the secondary targets include the Mid-Miocene Ain Grab and Oligocene Ketatna bioclastic limestone, Mid-Albian Allam limestone and Jurassic Nara dolomites. Most of these reservoirs tested oil and gas or gave oil and gas shows in the wells drilled within the block and in the adjacent area Mansour 1980.

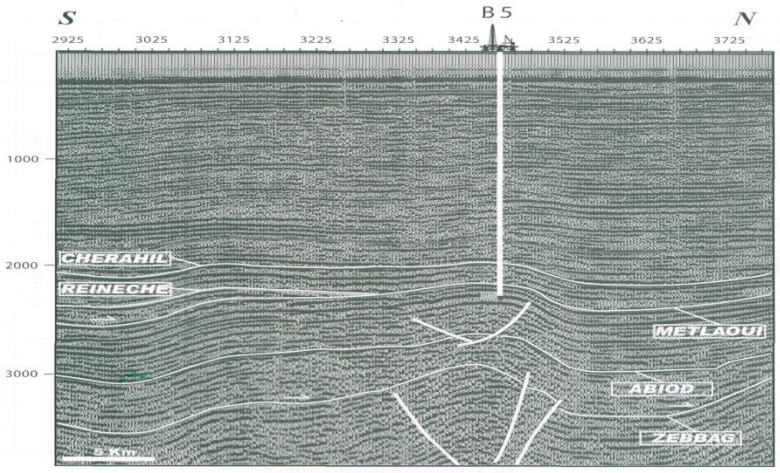


Figure (2): Seismic line running through Bouri Field showing the major reflectors on top the different the Formations known in the area of Tripoli-Sabratah offshore Basin.

The main purpose *of this paper is to highlight the Ketatna Formation in Tripoli-Sabratah Basin by evaluating the Ketatna Formation based on limited and available information available and to understand the nature of Ketatna Formation to avoid the drilling problems encountered in the previous drilled wells A1, A2, and A3 wells drilled in "A" structure. Also to set recommendations for future drilling targeting deepener reservoirs such as Metlaui and Abiod for the reason of economics and time saves.*

3. Lithstratigraphy of Ketatna Formation

The lithology of Ketatna Formation in the proposed type well A1-NC41 Hammuda et al 1985, can be subdivided into two main units, upper wackestone-packstone unit and a lower grainstone-boundstone unit. The lower unit of Ketatna Formation consists of mainly, grainstone-

boundstone (Figure 1). The upper units consist mainly of alternating white-greyish wackestones, packstones. Locally Ketatna Formation consists of reefal facies characterized by abundant of dissolution cavities (Figures 4 & 6). Ketatna Formation base consists of nummulites beds unconformably overlain by Al Mayah Formation and overlies Tellil Group unconformable.

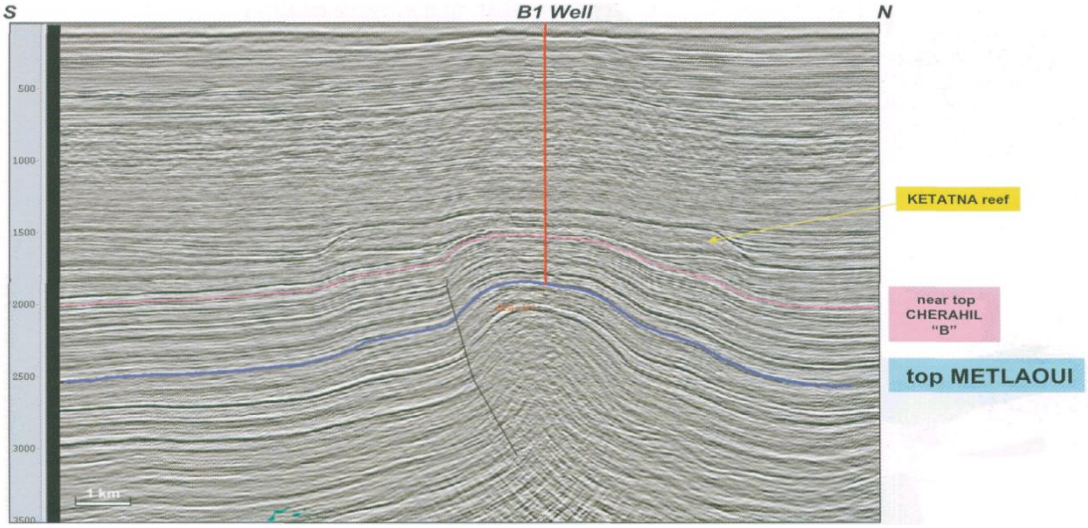


Figure (3): Seismic line through Bouri Field of B1 well showing the reflectors on top of Ketatna Formation of Tripoli-Sabratah offshore Basin.

Ketatna Formation distribution occurs in wells K1-137, A1-NC41 and Bla-137 drilled by oil companies working in the area of offshore Tripoli. Ketatna Formation mainly occurs in the subsurface of northwest offshore represented by deposits of shallow marine environment of Late Oligocene carbonates transgression sequence of Salammbo Siliciclastic shaly facies sequence (Figure 4 & 5).

Ketatna Formation in the subsurface have been reported encountering difficulties during the drilling of the drilling of Agip Oil Company well A3-NC41 due to possibly a combination of unexpected over pressure zone coupled with heavy mud losses possibly due to intersecting of minor faults identified by seismic high resolution. The result was a possible release of pressure and heavy mud losses in the Ketatna Formation. Lack of literature to present date available and the lack of detail studies due to its economics value relative to deeper targets such as Meloui and Biod. The Ketatna Formation section is best found in the "A" Structure. The A3-NC41 well located in the north-eastern rim of "A" structure target to test the gas/oil/water contacts of the north-eastern culmination of "A" structure as Meltloui reservoir primary target. While drilling well A3-NC41 targeting the deeper reservoir of Meloui while penetrating the Ketatna Formation of a part of trough combination of high pressure zone and intersection of two faults in the upper part of the Ketatna Formation (Figure 4). Heavy losses were encountered in this zone at depth 4800 ft. Severe problems of this high pressure zone were also encountered in Ketatna Formation while drilling wells of A1-NC41 and A2-NC41. Both wells were side-tracked more than once which was reflected also of the increase of well cost and drilling time loss. With the corporation of Agip regional team then abled use to analyse the equivalent zones correlation A1-NC41 and A2-NC41 which were correlated to A3-NC41 well.

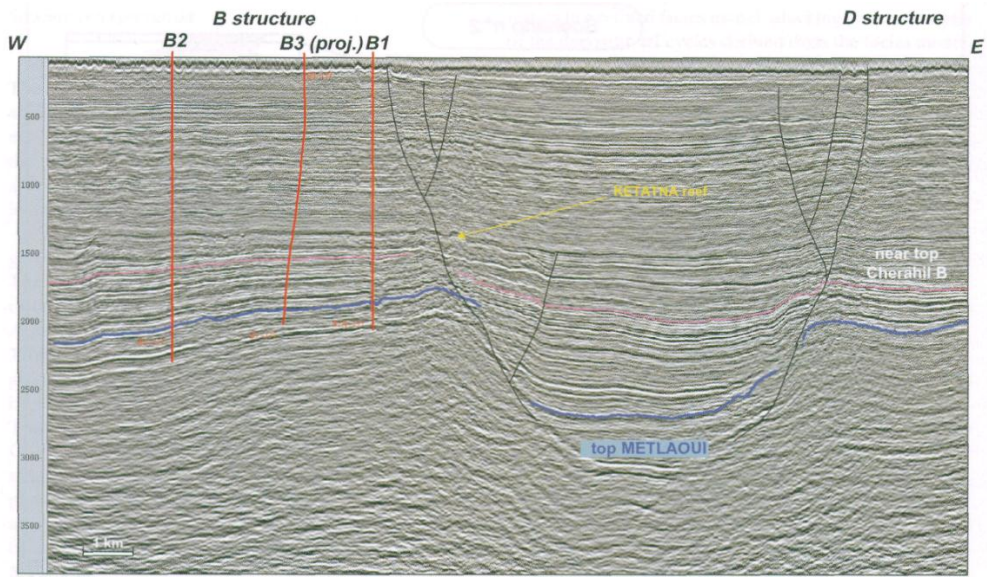


Figure (4): Seismic line through wells B2, B3-NC41Bouri and "D" Fields showing the reflectors on top of Ketatna Formation of Tripoli-Sabratah offshore Basin.

The Ketatna Formation also distributed in eastern offshore of Tunisia around the Mahdia area of the offshore is part of the Mesozoic - Cenozoic platform with local highs characterized by dominated carbonate shale deposits during the Jurassic to Mid-Miocene and siliciclastics deposits during the Mid-Late Neogene. This platform was affected by Mid-Cretaceous to Late Miocene compressional stresses and associated with folding and Pliocene block faulting with nearly east - west trends of subsiding grabens and pronounced horsts. The primary reservoirs are the Upper Senonian Abiod chalky limestones and Aptian Serdj carbonates. The Secondary targets include the Mid-Miocene Ain Grab and Oligocene Ketatna bioclastic limestones, Mid-Albian Allam limestones and Jurassic Nara dolomites. Most of these reservoirs tested

oil and gas or gave oil and gas shows in the wells drilled within the area and in the adjacent area of offshore. The Source Rocks in the offshore Mahdi is the Albian Fahdene shales and limestones provide the primary potential source in the area. Further potential is provided by the Mid-Cretaceous argillaceous limestones and Jurassic middle Nara black shales. The presence of gas shows in Alfil#1 well and an oil column in the Halk El Menzel field, immediately west of Mahadi area indicates that source rocks are being mature in the area. Moreover the primary reservoirs are the Upper Senonian Abiod chalky limestones and AptianSerdj carbonates. Also the secondary targets include the Mid-Miocene Ain Grab and Oligocene Ketatna bioclastic limestones, Mid-Albian Allam limestones and Jurassic Nara dolomites. Most of these reservoirs tested oil and gas or gave oil and gas shows in the wells drilled within the block and in the adjacent area.

4. Suggested Geological Module of Katatna Formation

From the limited available analysis of the available cuttings from A1 and A2-NC41 five facies associations have been identified by the regional group of Agip oil company laboratory of the Ketatna carbonate build-up is represented by three major sequences (Figure 5). These sequences are separated by three major unconformities which represents the three major phases of the reactivated paleohigh of probably of Triassic age (Figure 5). The possible tectonic pulses and the association of sea level changes in the Ketatna Formation have been identified by the presence of unconformities within Ketatna Formation. These unconformities were not clearly identified by seismic but can be observed

in the area of 'A' structure. The lower sequence is characterized by relatively low production of sediments and a low-relief build-up on the surroundings areas where the top is marked by a minor unconformity. The middle sequence is characterized by high production of carbonate and more pronounced relief where the top is marked by a major unconformity Agip Oil Company.

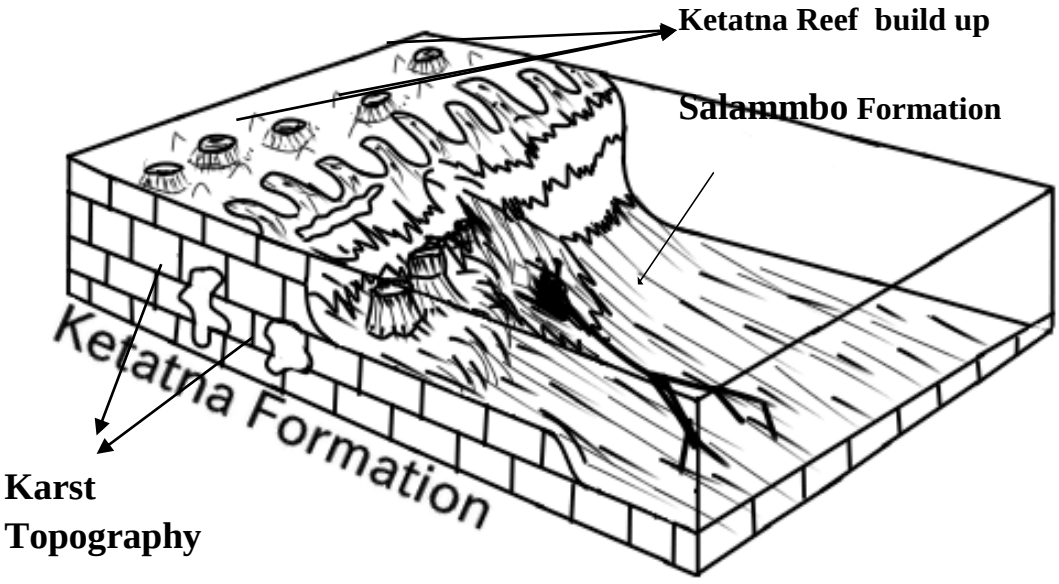
The Ketatna Formation is mainly composed of skeletal limestone characterised by Lepidocyclina and Miogypsinoides, and rich in diverse nanoflora assemblages allows a detailed biostratigraphy. The lower boundary coincides with the Oligo-Miocene transition section. The upper boundary is marked by the early Miocene hiatus and condensed facies section as equivalent to Salammbo Formation in H1-NC41. This unconformity is well recognised all over "A" structure area by Agip regional group.

Only few wells drilled in "A" structure and the lack of cores, the absence of log coverage over the interval of Ketatna section in well A3-NC41 and the poor quality of ditch samples recovered due to loss of circulation in A1-NC41 and A2-NC41 and the absence of ditch samples in A3-NC41 well prevents more certain interpretation. From the cuttings available from A1, A2 and A3-NC41 tentatively only five facies associations have been recognized by the regional group of Agip oil company laboratory as follows:

1. *Marl and shale locally silty, deposited in a distal environment (Salammbo Formation).*
2. *Fine to coarse grained packstone composed of skeletal debris of Echinodermata, Hydrozoa, Algae, and benthonic foraminifera with*

rare Planktonic foraminifera probably deposited on the build-up flanks in a fore reef-slope (Ketatna Formation).

3. *Dolomite and dolomitic shale locally silty, interbedded with skeletal pack-Grainstone probably deposited in a shallow internal lagoon (Ketatna Formation).*
4. *Boundstone-grainstone composed of Hydrozoa and other frame-build-up (Ketatna Fm.).*
5. *Packstone-Grainstone containing skeletal fragments coated by micrite rims, Crinoidea, Ostracoda, Algae, interaclasts and pellets and subordinated Hydrozoa and Molluscs fragments, interpreted as possible back-reef facies (Ketatna Fm.).*



Figure(5): Proposed environment of deposition module of Ketatna Formation and Karastification.

5. Karst Topography phenomena of Ketatna Formation

The karst Topography phenomena is suggested to have probably been of direct influence in increasing the porosity dramatically which reaches in some cases to cave sizes ranging from few meters to more than tens of metre in width possibly depends on duration of sub areal exposure and climate influence. Karst topography can be directly related to sub Arial exposure which is related to sea level changes, tectonic movements or combination of both sea level changes and tectonic movements evidenced by the unconformities and Hiatus within Ketatna sequence (Figure 5).

Evidences from the cutting analysis indicates fair to good secondary porosity due to probably dissolution and replacement phenomena. Thus evidence can be used to support the presence of the Karst topography related to the three unconformities present in the Ketatna Formation. The Karst Topography phenomenon is probably associated with the three unconformities that was identified by geological analysis, but more likely restricted to the middle unconformity. An attempt was made to identify these internal seismic reflectors in the Ketatna sequence can possibly be related to the unconformities with the support of cutting descriptions from wells A1 and A2-NC41. Evidences of subaereal exposure present in both wells of A1-NC41 and A2-NC41 carbonates possibly dissolved the carbonates creating large voids filled later with residual of brown reddish marl and the presence of breccia, vugs, solution filling cavities, poorly preserved fossils, iron oxides, and recrystallization of packstone-grainstone which contains carbonate lithoclats and bioclasts as evidence of paleokarstification.

Observations from cutting samples can be summarised below:

1. *Breccia: the persons of Breccia of carbonate lithoclasts and marly matrix of subaereal exposure surface.*
2. *Solution filling cavities: the solution filling cavities of marl residual origin indicates a subaereal exposure surface.*
3. *Vugs: the persons of vugs can be an indicative of subareal exposure.*
4. *Recrystallization: recrystallization of packstone-grainstone with poorly preserved fossils and packstone with micrite-coate, altered fossil fragments recrystalized matrix and calcite cement is an indicative of subareal exposure. Also the persons of moldic porosity, iron oxide, altered material and coated pore walls and is an indication of subareal exposure.*

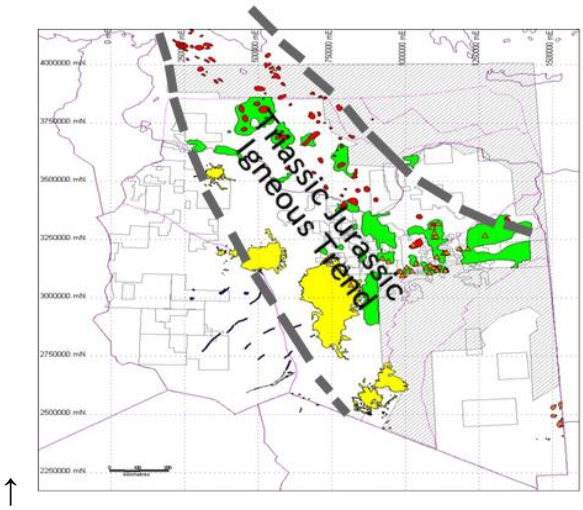


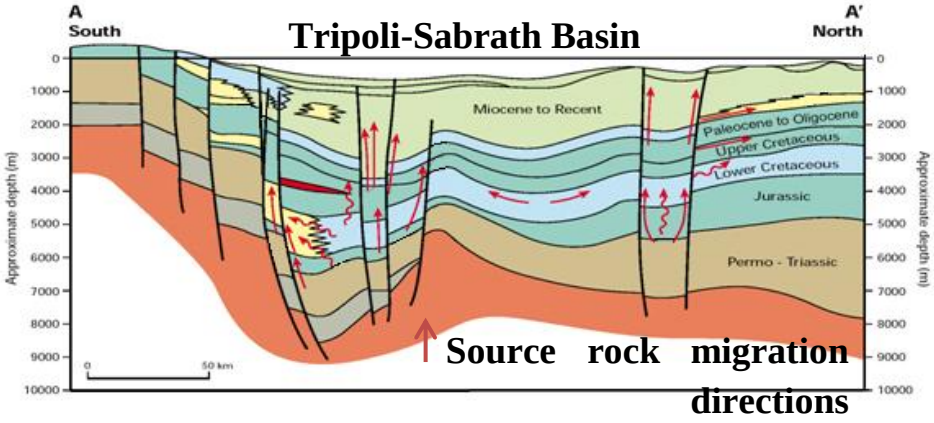
Figure (6): Traissic-Jurassic volcanic and igneous activity extends to the offshore of Tripoli-Sabratah Basin.

6. Petroleum System and Play elements of Tripoli-Sabratha Basin

Sabratah Basin is expected to contain a thick Paleozoic sedimentary section ranging in age from Cambrian to Permian reaching a thickness of possibly 8,000 ft. Potential sandstone reservoirs could be expected in the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian and Triassic. Potential Permian reef plays on the southern margin of Sabratah Basin, north of the Djeffara Fault have been described in Tunisia and M'Rabet. On the Eastern Platform of Tunisia, biostromal limestones, of about 6,000 ft. thick interbedded with shales and sandstones have been described from outcrop geological studies. Bioherms, 100 ft. and 130 ft. thick were also described. The bioherms are built up by encrusting algae and sponges. They are generally dolomitised and affected by karstification. Initial porosities could be high, in the order of 30-35%, but these may have been reduced by early cementation. In outcrops, porosities of 0.5 to 4.7% have been measured but these have been affected by late diagenesis. Fracturing may enhance the porosity. In well KJD, average porosities of is about 11.5% in the well dolomitized limestones ('near-reef facies'). Seismic and well data have shown a number of build-ups. There are no hydrocarbon occurrences within these carbonates. First exploration in areas having Permian reef anomalies as primary objectives was conducted between 1975-1980.

Kerogen is Type II. Peak expulsion occurs during the Late Miocene, proceeding to gas generation during the Pliocene. Bu en Niran-Les Abreghs comprises shale, marls and argillaceous limestone. Data on source quality are lacking due to depth of burial. Peak oil expulsion

occurs during the Oligocene, gas generation during the Miocene. Harshah Formation predominantly shale Harshah Fm. Carbonate 60 - 80 % possible seal problem.



Figure(7): Modified Regional cross-section after Agip regional group (1985) oriented North South of Tripoli-Sabratah Basin.

The reservoir is limited to the southern part of the basin, where the Triassic occurs at shallow depths. North of the Djeffara Fault, the Triassic is deep (below 17,000 – 20,000 ft) and the reservoir quality is probably poor. Both the TAG-I and TAG-S are fluvial to shallow marine and shelf clastic reservoirs deposited in a platform setting. The upper interval TAG-S is more distal sandstone and thus probably deposited in a shallow marine to outer shelf setting. Triassic sandstones are reservoirs in the El Borma Field (northern west margin of Ghadames Basin), where sandstones thickness around 50 ft. porosities are 18% on average and permeability around 200 mD.

The Triassic clastic interval is also capable of production on the northwest at Hassi Keskessa and in well D-23 and F-90 Fields in

northern Ghadames Basin. No production or shows have been recorded in the Sebrata Basin beyond the Silurian sub-crop. However, hydrocarbon charge from younger or older source rocks cannot be discounted. The seal of Triassic sandstones is provided possibly by intraformational shales, separating many individual sandstone layers and by overlying shales and Upper Triassic halites.

The Middle and Upper Eocene alternating limestones and shales of the Tellil Group comprise a regressive sequence of nummulitic and molluscan wackestones, packstones, shales and anhydrites. The sequenceof Middle and Upper Eocene grades northwards into pelagic shale of the Ghalil Group in Tripoli-Serata Basin. The best reservoir quality may be found in the limestone of the Dahman Formation which attains a maximum thickness of 200' at well K1-137, thinning out northwards and southwards.

Oligocene to Miocene section includes Ketatna Formation (Dirbal) and Ras Abdjalil Formations or Fortuna Formation of Libya. These are marginal marine to shallow marine sandstones and shales, which have a widespread development across the Libyan and Tunisian sectors they overlie the Nummulites Limestone Marker Bed, which is easily picked on wire line logs. They represent a widespread non-marine to open shallow marine platform deposit. The lower part of the Oligocene-Miocene comprises shales and the upper part comprises channelised massive and often cross-bedded sandstones with continental fossils. Sedimentary features indicate transport from southwest to northeast. Towards the northwest, the sequence becomes glauconitic and therefore most

probably marine. This reservoir is prospective in Libya, with noncommercial hydrocarbons recorded in well G1-NC41.

The Lower Oligocene may also be developed in carbonate facies (Ketatna and Ain Gobi Formations). These are carbonate shelf and reef limestone. Build-ups have been noted on seismic data at this level. A single oil discovery has been made in Libya in the Oligocene carbonates, at well J1-137.

7. Summary and Conclusion

Ketatna Formation of Oligocene to Early Miocene in age is composed of mainly of carbonate sequence. The section designated to Dirbal Formation by Stratigraphic Nomenclature of the Northwestern offshore of Libya Hammuda et al as proposed type section 1985. Seismically Ketatna Formation carbonates shelf might show reef limestone build-ups also well data indicate a number of build-ups in the Ketatna level.

In general there are no major hydrocarbon discoveries within these carbonates section. The data at the level of Ketatna Formation of the Oligocene carbonates, suggest the environment of deposition is marginal marine to shallow marine carbonate and shales, which expected to be widespread developed across the Libyan and Tunisia offshore areas. Ketatna Formation is generally composed of carbonate/sahale/dolomitie and silt, fine to coarse grained packstone composed of skeletal debris of Echinodermata. Hydrozoa, Algae, benthonic foraminifera with rare Planktonic foraminifera probably deposited on build-up flanks of fore reef-slope skeletal pack-Grainstone

probably deposited in a shallow internal lagoon. Aeffected by karstification with initial porosities in the order of 30-35% porosity reduced in places by early cementation and secondary digenesis, evidenced by breccia fragments of Gastropoda shells of bioclasstic and lagoonal carbonates indicative of subaereal exposure surface. Solution filling cavities, Vugs, recrystallization, altered fossil fragments moldic porosity, iron oxide, altered material and coated pore walls also has been observed by Agip regional group.

The Ketatna Formation is restricted to the area and the surrounding of "A" structure formed by shallow water carbonates. Compressional stresses associated with folding and block faulting with nearly east - west trends has been noticed by Agip regional group. Potential reservoir in offshore of Mahdia area is provided by mature Albian Fahdene shales and limestone as primary potential source rock in the area. The Ketatna Formation is distributed in the subsurface of the top structures of southern offshore areas of Tripoli-Sabratah encountered mainly by drilled exploration wells for deeper potential reservoirs targets such as Metloui group and Abiod Formation.

Kerogen is Type II. Source rock is thought to be main contributor to Lower Eocene Play. Peak expulsion in deepest areas occurs during the Pliocene rapidly proceeding to gas generation in the Pleistocene. The Ain Tobi-Garian Formation, which is equivalent to Mouelha-Bahloul Mbr., comprises laminated argillaceous limestone.

8. References

1. *Anketell, J. M. (1996), Structural history of the Sirt Basin and its relationship to Sabratah Basin and Cyrenaican Platform, Northern Libya. In: The Geology of Sirt Basin (eds M.J Salem and M. T. Busrewil, A. M. Misallati and M. A. Sola). Earth Science Society of Libya, III, 57-88.*
2. *Agip oil company (1980), Regional internal report Agip Nami Milan Italy.*
3. *Agip . S . P . L . A . J . ,(1981), NC41 ,sedimentology , petrography and diagenesis of the Metlaoui Formation , February m , vol 2 , pp52 .*
4. *A. E. M. Nairn, W. H. Kanes, F. G. Stehli (1977). The Ocean Basins and Margins, vol. 4B The Western Mediterranean, plenum, pp 503.*
5. *Ali Chine, Khemais Ben Hassine, (1994), Proceedings of The 4th Tunisian Petroleum Exploration Conference.*
6. *Bailey H.W., Dungworth G. Hardy M., Scull D., Vughan R.D., (1989), A Fresh Approach to the Metlaoui.*
7. *F. T. Barr, A. A. Weegar, (1972), Stratigraphic Nomenlature of the Sirte Basin, Libya.*
8. *Gray, C. (1971), Structure and origin of the Gharyan domes. In: Sym. Geol. Libya. (ed. C. Gary). Fac. Sci., Univ. Libya, Tripoli, 307-319.*
9. *Mansour, A., (1980), Panel Diagram of Western Libya Offshore, Intern Report, Aquitaine, Libya.*
10. *O. S. Hammuda, A. M. Sbeta, A. J. Mouzughi, B. A. Eliagoubi, (1985), Stratigraphic Nomenclature of the Northwestern Offshore of Libya.*
11. *Sbeta, A. M., (1983), Results of the Offshore Eocene Studies, Internal Report, N.O.C., Libya.*

12. *Sbeta, A. M., (1984), Sedimentology of the Eocene rocks of offshore – Northwestern Libya, Internal Report, N.O.C., Libya.*
13. *Seddiq H, Bhaduri A (2006) The petroleum geology of Libya, a synthesis. In: Schlumberger reservoir optimization conference book, pp 20–44*
14. *The structural history of The Mediterranean, (1976). symposium international : Split, Yougoslavie, 25-29 octobre 1976 / publie sous la direction de B. Biju-Duval et L. Montadert.*
15. *Taktak F, Bouazziz S and Tlig S. (2012), Depositional and tectonic constraints for hydrocarbon targets of the Lutetian–Langhian sequences from the Gulf of Gabes — Tunisia, Journal of Petroleum Science and Engineering.*
16. *Taktak F. (2017) , Sedimentary and Tectonic Control of the Eocene/ Lower Miocene Hydrocarbon Systems of the Gulf of Gabes Basin-Ggb in Tunisia, Journal Material Science.*