RESEARCH ARTICLE OPEN ACCESS

Effective SCA Stimulation Proved To Be the Key Economic To Maximize Profitability in the Grgaf Group Formation of the Sirte Basin, Libya

Emad Ibrahim Fandi[1], Badees Khalfa Gazal[2], Mohamed Ali Alrabib[3]
[1](Senior Technical Professional –Frac/Acid with Halliburton Companyin Libya)
[2](Reservoir Engineer with Hess Libya Exploration LMT)
[3](Geology Department, Faculty of Science, Zawia, Libya)

ABSTRACT
Implementing SCA treatment selection technique and design in Grgaf group formation to remove the excepted skin damage near well bore and improve well influx (productivity). The Grgaf Group Formation was responded positively to stimulation technique despite of the designed recommended volume 24 gal/ft.
An important part of SAC is the 'art' of diversion because in the treatment of a large interval and natural fracture that why it implemented on it. Therefore output results before treatment, the pressures were rise up, while the rates were dropped such as 800 psi at 0.615 and 1000 psi at 0.963 bpm. The initial injectivity test after treatment, the pressures were dropped and the rates were increased by ratio from 22 to 88% while the final injectivity after treatment, the rates were increased by ratio from 638 to 842.6 % in order to responsible for a major increase in productivity and amount of high –quality work Thus fractured quartzite that it supported to removed damage around wellbore.
The benefits of (SCA) is to accept very good feedback in design consideration and has made many improvement based on it and regards the acquisition of technical knowledge as one of the highest priorities profitability.
Keywords-Stimulation, Grgaf Formation, Profitability, Sirte Basin, Libya

I. INTRODUCTION

A vast amount of data is available for the Sirte Basin as a result of oil exploration activities extending over more than forty years. Thousands of wells have been drilled, gravity, magnetic and seismic data have been gathered, and as a result the basin is far better known than any other area in Libya, although it can fairly be claimed that the deep troughs are still imperfectly known. Studies on the subsidence history of the Sirt basin have been published by Gumati and Kanes, Gumati and Nairn, van der Meer and Cloetingh and Baird, et al. and the results of a gravity study of the Sirt Basin were presented by Suleiman, et al [1].The Sirte Basin covers an area of 600,000 km2 in central Libya and contains a basin-fill which reaches a thickness of 7500m. The nature of the faults which control the Sirt Basin grabens is important, particularly in respect of oil migration. Basement in the Sirte basin has been penetrated in a number of deep oil wells and in general comprises parisian accreted oceanic terrace north of latitude 27 °N.[2,3].

II. GEOLOGICAL SETTING

Libya is situated on the Mediterranean foreland of the African Shield, extending over several sedimentary basins. Several tectonic movements and events formed the present major structural and tectonic features, including Caledonian, HercynianOrogenies of Paleozoic time, and disturbances during Cretaceous to Middle Tertiary times (Conant and Goudarzi, 1967) [4]. These events have resulted in uplifting, subsidence, tilting, and faulting. Libya has been subdivided into major sedimentary basins is shown in Fig. 1[5].

The Sirte Basin province is considered to be a holotype of a continental rift (extensional) area and is referred to as part of the Tethyan rift system (Futyan and Jawzi, 1996; Guiraud and Bosworth, 1997) [6]. The structural weakness of the area is exemplified by alternating periods of uplift and subsidence originating in the late Precambrian age commencing with Pan African Orogeny that consolidated a number of proto-continental fragments into an early Gondwanaland (Kroner, 1993) [7]. Early Paleozoic history of the Sirte Basin reflects a relatively undisturbed Paleozoic cratonic sag basin (Ahibrandt, 2001) [8]. Rifting in the Early Cretaceous, peaked in the Late Cretaceous, and ended in the Early Tertiary time, resulting in the triple junction (Sirte, Tibesti, and Sarir arms as shown in Fig. 2 within the basins (Ambrose, 2000) [9]. However the Early Cretaceous rifting reflected east-west sinistral shear zones (strike-slip) that strongly controlled clastic deposition in the Sarir arm (Anketell, 1996) [10].

III. LITHOLOGY

Originally proposed the name Gargaf Group to include a thick sandstone sequence in the JabalGargaf area of the Fezzan. This sequence was subdivided into four formations (from bottom to top), Hassaouna Formation, Haouaz Formation, MelezChograne Formation and Memouniat Formation. The type section was designated from igneous basement on JabalGargaf (JabalHassaouna: 28° 15' N; 14° 00' E) to the Silurian (Gothlandian) outcrops at AouinetQuenine (28° 20' N; 12° 55' E) and Bir al Gasr (27° 30' N; 12° 55' E).

Fig. 1: Geographical location map shows sedimentary basins (after Clifford, 1986) [5].

In the Dahra- Hofra area and other portions of the western Sirt Basin, this thick sequence of quartz sandstones and quartzites has been assigned to the newly defined Hofra Formation. The Hofra Formation is included in the Gargaf Group, but its relationship to the surface formationsof this group is uncertain Gargaf Group Formation comprises primarily a sequence of relatively clean quartz sandstones with minor amounts of shale, siltstone, and conglomerates. The sandstones are normally white to light gray in color, firmly cemented with silica, very often to the point of becoming orthoquartzites. Quartz overgrowths are common.

The shales and siltstones occur throughout in thin beds and laminae and are gray to brown-gray and green rarely red in color, micaceous to very micaceous, varying from blocky to fissile, and sometimes soft, waxy and lustrous. The dominant colors are white to light gray. However, varicolored sandstones or orthoquartzites do exist in the sequence.

These are red, often hematitic, and yellow and green and the Gargaf Group derives its name from JabalGargaf where the lower portion of its type section is located [11].

The classification of Grgaf Group Formation from fractured and brecciated Cambro-Ordovician aged Gargaf quartzite located at the crest of a NNE-SSW trending horst [12].

IV. TREATMENT TIMING

Well stimulations may be carried out immediately after the initial drilling/completion programme has been finalised e.g. to correct formation permeability impairment caused by the drilling mud.The stimulation candidate may be identified as a result of routine, field production surveillance e.g. the well is identified as producing less than the surrounding wells with comparable reservoir quality or reservoir permeability thickness (kh).

V. MATERIAL AND METHODS

The Chemistry of a sandstone completion Acid (SCA) treatment with additives and diversion success for treatment the Grgaf Group Formation, how the impairment, formation clays and inter-granular cements are removed and partially replaced by secondary reaction products. However, there is an overall increase in porosity and permeability, leading to stimulation. By applying chemical knowledge to stimulate petroleum wells, we can increase the rate of oil & gas production. A pre-flush is pumped to flush out any undesirable minerals/fluids in the Grgaf Formation. This is followed by the SCA itself; followed to push the spent SCA back into the formation and away from the near-wellbore region to push any potential damage as far away from the well as is practical.

A. Pickling Treatment

Lots of theory on this issue from side the volume, concentration, and cost that it implemented 200 gal of 15% HCL in order to prevent potential iron sludging (tubing) problems by removing loss iron.

B. Sandstone Completion Acid (SCA)

Provides maximum dissolving power without secondary precipitation, prevents aluminum precipitation, and is the fluid of choice when mineralogy is unknown. This fluid is compatible with a majority of formations and will probably be used for acidizing most sandstone formations. The exceptions include formations high in feldspars, particularly at temperatures below 200 ºF and formations containing HCl sensitive minerals [13].

C. Primary Advantages of SCA

Contains high HCl-HF ratio to provide compatibility with most formation mineralogist. Exceptions include formations high in feldspars, particularly at temperatures below 200°F and formations containing "HCl-sensitive" minerals. Contains ALCHEK to prevent secondary precipitation of aluminum. This is particularly important when the mineralogy is unknown or the formation contains high carbonate streaks or more than 5% carbonates[13].

D. Data Acquisition

InSite for Stimulation is RealTime Stimulation Data Acquisition System based on the InSite Core and InSite for Stimulation software products. For the Production Enhancement, InSite for Stimulation is the primary data acquisition module used in the workflow process. This workflow process is aligned with steps of the HMS (Halliburton Management System), which documents the processes that are involved. The workflow at this level is more detailed than the HMS processes, so more steps and processes are necessary than at the higher level view of HMS [14].

E. Halliburton Pumping Unit& Fluid Transport trailers

Pump unit is capable of blending on pumping to the wellhead with maximum pressure and maximum rate. Since the control and data measurement is essential to Acidizing operation otherwise Halliburton Fluid transport Trailer each 6200 gal that it used in the job of sandstone Acid treatment with additives and diverter [15].

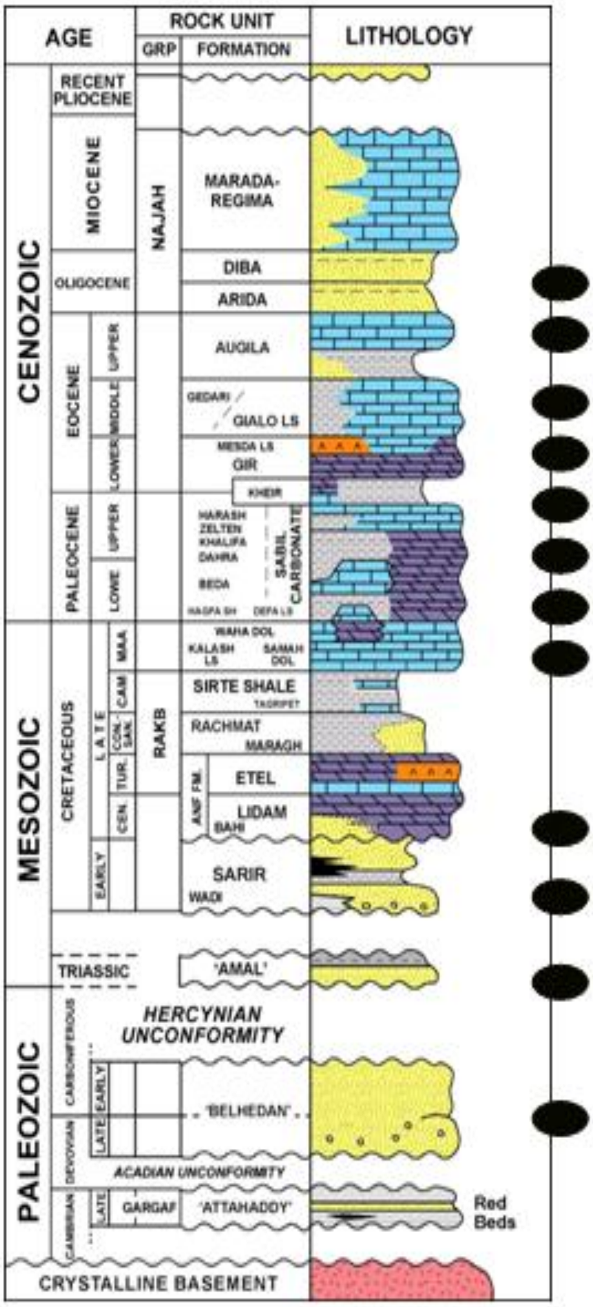


Fig. 2: Stratigraphic section in central sirte basin (Sirte and Tibesti arms Ahibrandt, 2001) [8].

F. Total treatment volume

The treatment actually pumped consisted of:

- 7392 gal of Treated Water
- 200 gal of 15% HCL Acid Pickling.
- 2000 gal of 15% HCL Acid with 5% Clay Fix – (Pre- Flush).
- 6000 gal of SCA System – (Main Treatment).
- 2000 gal of 15% HCL Acid with 5% Clay Fix – (Over- Flush).
- 3000 gal of Diverter Guidon System.

VI. EXECUTIVE SUMMARY

During injectivity test before SCA treatment by pumped brine, the pressure was unstable while the rate was seems likely stable. The results as following below as shown in table 1and Fig3, 4.

Injectivity Test Before SCA Treatment		
	Drive Side Pressure (psi)	Combined Pump Rate (bpm)
Flag # 1	750	0.628
Flag # 2	1000	0.963
Flag # 3	800	0.615

Table 1. Injectivity test before SCA treatment.

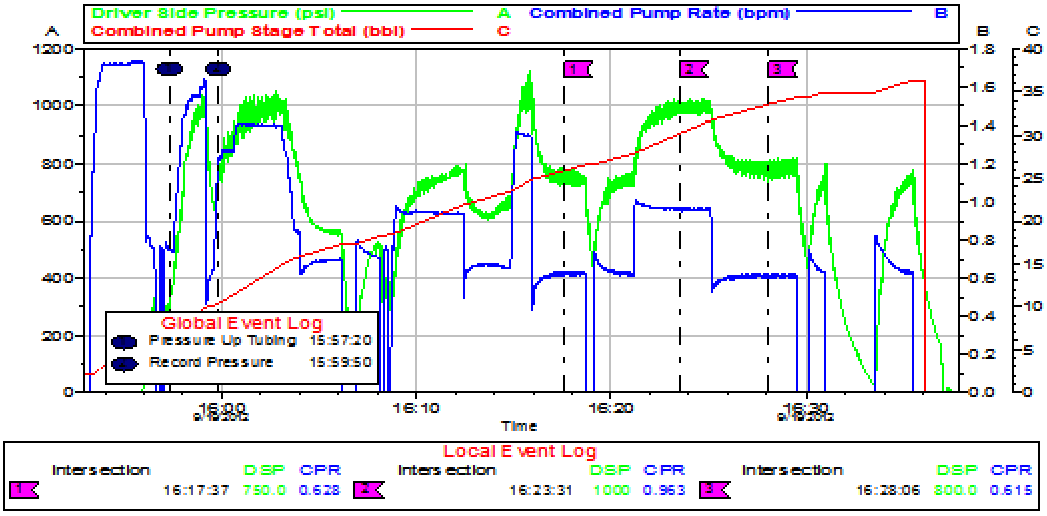


Fig. 3: Injectivity test before SCA Treatment for Grgaf Group Formation

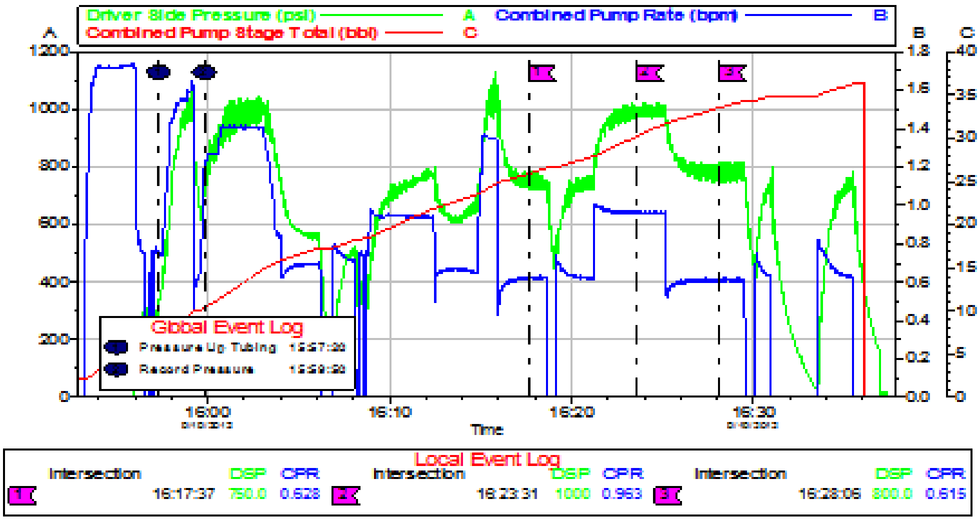


Fig. 4: Job Summary before SCA Treatment

Table 2. : Summary injectivity test after SCA treatment

Initial Injectivity Test After SCA Treatment		
Drive Side Pressure (psi)		Combined Pump Rate (bpm)
Flag # 1	1000	1.18
Flag # 2	750	1.18
Flag # 4	800	1.14
Final Injectivity Test After SCA Treatment		
Drive Side Pressure (psi)		Combined Pump Rate (bpm)
Flag # 12	800	5.8
Flag # 13	750	5.01
Flag # 15	1000	7.2

Initially, the well was loaded with SCA with additives, 15% HCL with ClayFix and diversion at rate of 2- 3.5 bpm. Once the was loaded and started squeeze into the Grgaf group formation in, the pressures were dropped, unstable and the rates were increase is given in table.2 so that the Grgaf Group Formation (Tick Sandstone) is open and responsible to SCA treatment.

Finally, during displacement stage after pumped the chemical, the pressures began to be dropped when compared with the first output results at the beginning of the squeezed and the rates were increased. As results it got from the treatment to the stimulation for expected economic life in order of their profitability as shown in Fig.5 to Fig. 7.

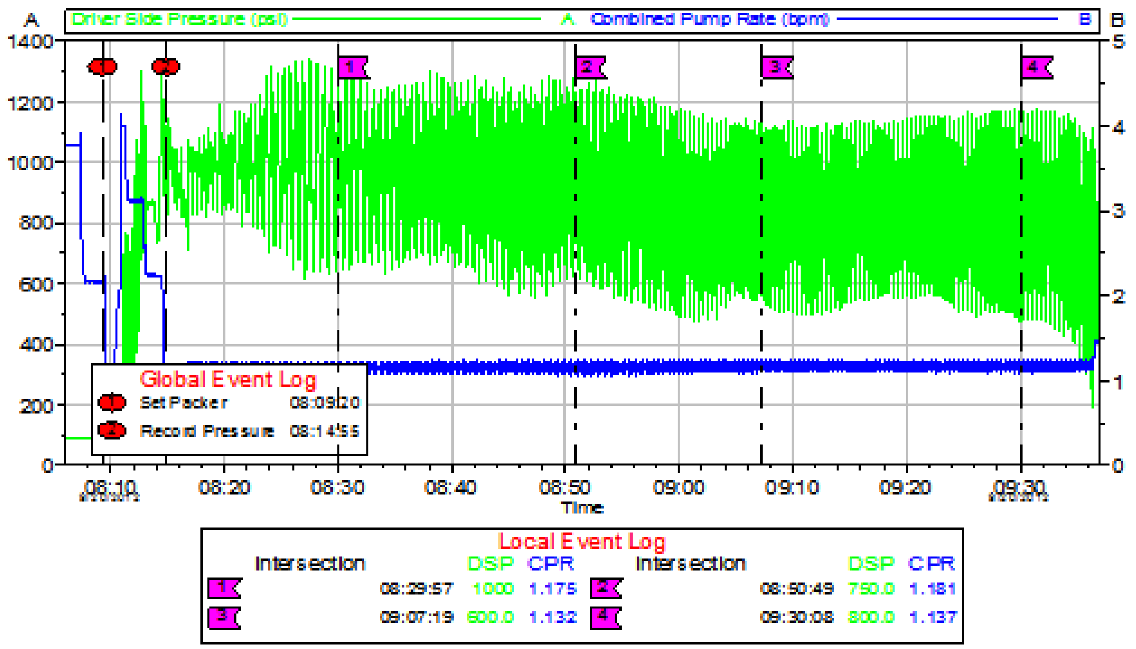
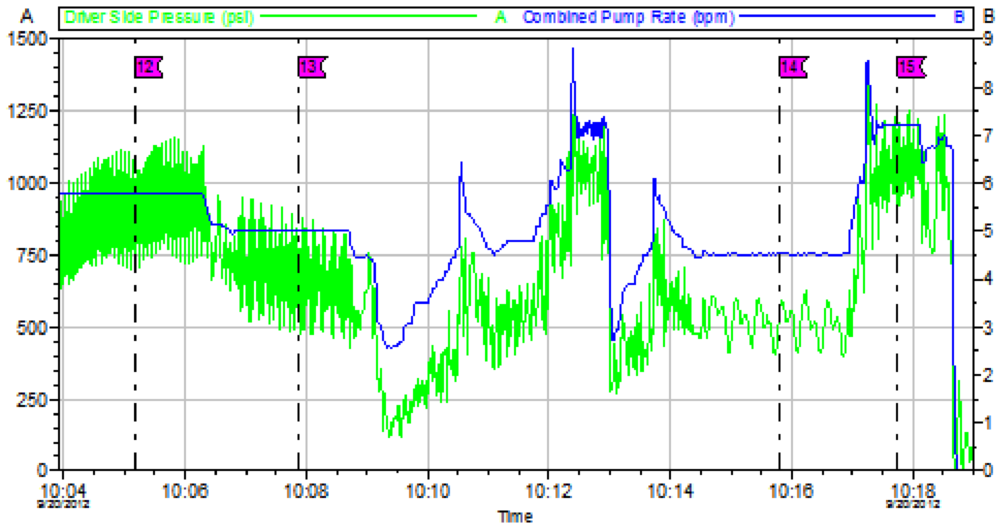


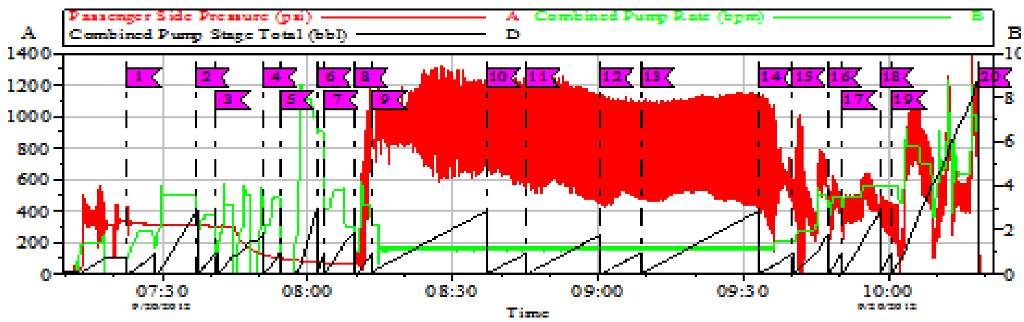
Fig. 5: Initial Injectivity Test after SCA Treatment



Local Event Log

Intersection		DSP	CPR	Intersection		DSP	CPR
12	10:05:11	800.0	5.797	13	10:07:52	750.0	5.005
14	10:15:48	550.0	4.523	15	10:17:45	1000	7.204

Fig. 6: Final Injectivity Test after SCA Treatment



Local Event Log

1	Pre-Flush 9.5 bbl	07:22:42	2	SCA 28.5 bbl	07:36:52
3	Over Flush 9.5 bbl	07:41:04	4	Diverter 17.8 bbl	07:50:52
5	Per-Flush 9.5 bbl	07:54:12	6	SCA 28.5 bbl	08:02:05
7	Over-Flush 9.5 bbl	08:03:30	8	Diverter 17.8 bbl	08:09:37
9	Pre-Flush 9.5 bbl	08:13:28	10	SCA 28.5 bbl	08:36:56
11	Over-Flush	08:45:11	12	Diverter 17.8 bbl	09:00:25
13	Pre-Flush 9.5 bbl	09:08:49	14	SCA 28.5 bbl	09:33:09
15	Over-Flush 9.5 bbl	09:40:10	16	Diverter 17.8 bbl	09:47:31
17	Pre-Flush 9.5 bbl	09:50:30	18	SCA 28.5 bbl	09:58:12
19	Over-Flush 9.5 bbl	10:00:49	20	Displacement Of Water 87 bbl	10:18:42

Fig.7 : Job Summary Stages with Local Event Log

VII. CONCLUSION

Sandstone completion Acid (SCA) aims to increase the Productivity Index (PI) by reducing the Skin (S) through dissolving formation damage components and rock in the near wellbore region. Acid Design techniques Considerations includes formation types, reservoir temperature, interval and additives that the injection rates be decreased in order to prevent fines being dislodged. Many factors govern the spending rate of stimulation such as pressure, temperature, flow velocity acid concentration, reaction products, acid type and formation composition (Physical and chemical).

A chemical treatment injected radially from the wellbore beyond the critical matrix at a pressure below the frac pressure to remove or bypass formation damage.

Selecting the correct treatment is often not a simple matter. The following information should be considered in the selection of a well treatment.

- Type of formation and mineral composition of the formation.
- Type time available for chemical treatment.
- Treating fluid compatibility with contaminants present and reservoir fluid.
- Type and amount of damage.

VIII. ACKNOWLEDGMENT

This research was supported byHalliburton-Libya team (Production Enhancement), Hess-Libya team and my deep appreciated to them to reach to goal.

IX. ABBREVIATIONS

SCA:	Sandstone Completion Acid
HF:	Hydrofluoric Acid
HCL:	Hydrochloric Acid
mD:	Milli Darcy
Kh:	Permeability Thickness
HMS:	Halliburton Management System
PI:	Productivity Index
Ft:	Feet
PSI:	Pounds Per Square Inch
Gal:	Gallon
S:	Skin
bbl/min:	Barrel per Minute

REFERENCES

[1] Gumati and Kanes, 1985, p. 39-52. Gumati and Nairn , 1991, p. 93-102. van der Meer and Cloetingh, 1996, p. 211-230. Baird, et al. 1996, p. 3-56. Suleiman, et al. 1991, p. 2461-2468.

[2] Harding, 1984, p. 333-362. Baird, et al. 1996, p. 3-56. Gras and Thusu, 1998, p. 322. Wennekers, et al. 1996, figure 22. Listric faults: Baird, et al. 1996, p. 36-38.

[3] Vail, 1991, p. 2262. Klitzsch, 1971, p. 256-257. Haruj al Aswad: Klitzsch, 1971.

[4] Conant L. C., and Goudarzi, G. H. (1967). Stratigraphic and tectonic framework of Libya. American Association of Petroleum Geology Bullet. Vol. 51, P. 719-730.

[5] Clifford, A. C. (1986). African oil-past, present, and future, Am. Ass. Petrol, Geol., Mem., 40, P. 339-372.

[6] Futyan, A., and Jawzi, A.H., 1996. the hydrocarbon habitat of the oil and gas fields of North Africa with emphasis on the Sirte Bsin: in Salem, M.J., El-Hawat, A.S., and Sbeta, A.M., eds., The geology of Sirte Basin: Amsterdam Elsevier, v. II. P. 287-308.

[7] Kroner, A. 1993. The Pan-African belt of northeastern and eastern Africa, Msdagascar, southern India, Sri Lanka and east Antarctica; Terrane amalgamation during formation of the Gondwana Supercontinent in Thorwiehe, U., and Schandelmeier, H., eds., Geoscientific research in Northeast Africa: Rotterdam Netherlands, A, A. Balkema, p.3-9.

[8] Ahibrandt, T. S., 2001. The Sirte Basin Province of Libya-Sirte-Zelten, Total Petrolume system, U.S. Geological Survey bulletin 2202-F. P. 1-33.

[9] Ambrose, G., 2000. The geology and hydrocarbon habitat of the Sarir Sandstone, SE Sirte Basin, Libya. Journal of Petroleum Geology, v. 23. P.165-192.

[10] Anketell, J. M. 1996. *Structural history of the Sirte Basin and its relationships to the Sabratah Basin and Cyrenaican Platform*, Northern Libya, in Salem, M.J., El-Hawat, A.S., and Sbeta, A.M., eds., the geology of Sirte Basin: Amsterdam Elsevier, v. III. P. 57-88.

[11] Burollet, P.F., 1960, "*LexiqueStratigraphique International, vol. IV: Afrique. Part IV: Libya*". Cong. Geol. Internat. - Commission de Strat., Rech. Sci., pp. 1- 62, 2 maps, Paris.

[12] HESS Libya Exploration team Overview 2012.

[13] Halliburton Company, Sandstone Stimulation Processes--Sandstone 2000 Acidizing System Updated on Sept. 2008.

[14] Halliburton Company, INSITE for Pumping Services, ISF V7.4.1, 2000-2012.

[15] Halliburton Company Acidizing Services - Libya Operations, 2008.