Determination of Uranium, Thorium and Potassium Concentrations in Different Clay Types by Spectral Gamma Ray Log, in Hawaz Formation in Well O6i-NC115, Murzuq basin, SW Libya

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Abstract

The paper discusses Uranium, Thorium and Potassium Concentrations in different clay types based on log data.

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formation in the well O6i-NC115 in Murzuq basin, SW of Libya. The study implemented a well log data of spectral gamma ray which has been performed throughout two hundred and six feet thick of Hawaz sandstone intervals.

The Spectral gamma ray data includes uranium, thorium and potassium that logged from 5447 ft. to 5653 ft. depth of the well. The analysis includes values of uranium (U) and thorium (Th) in ppm, where potassium (K) is recorded in percentage.

The values of potassium and thorium are plotted on (clay type diagram of Schlumberger). This shows different locations of data according to their content of potassium and thorium which reflect particular clay type. The analysis is being obtained from different types of sandstone beds in Hawaz formation namely H6, H7 and H8. These intervals contain distinctive type of clay content and in respect of this they have different values of uranium concentration. The H6 which has clay type Montmorillonite-Illite has lesser values of uranium concentration (average 1.48 ppm), whereas the intervals H7 and H8 have higher values of uranium (average 2.03 ppm and 2.04 respectively) which they cemented or interbedded by Montmorillonite clay.

This work contributes to understanding the uranium concentration in sandstone facies as well as the relation between clay type and concentration of uranium within Murzuq basin, SW Libya.

Keywords*: Spectral gamma ray, Uranium concentration, Montmorillonite, Illite, Hawaz formation, Murzuq basin.*

1 Introduction

The uses of spectral gamma ray (SGR) has been applied in many aspects in geology. It can be implemented in many applications related to understanding mineralogy of different rock types. One of these uses is to measures the uranium concentration in the rocks.

The SGR tool measures the naturally occurring radioactivity of the formation surrounding the tool and outputs the results as a gross gamma ray curve. By analyzing the energy levels of the incoming gamma rays, the tool provides the amount of potassium, uranium, and thorium contributing to the total gamma ray count. The results are used in clay volume calculations, clay type analysis (Table 1), and heavy mineral detection. This technic has been used in Hawaz Formation by [1] to understand the facies of the Hawaz Formation and study the contents and types of clay minerals which is compared the SGR whit SEM and core data**.**

Table (1): clay minerals classification based on Th/k (ppm/%) cross plot, [2]

No.	Th/k (ppm / %)	Minerals
1	< 0.6	Feldspar
2	0.6 – 1.5	Glauconitic
3	1.5 -2.0	Mica
4	2.0 – 3.5	Illite
5	> 3.5	Mixed layer clays
6	10 and above	Kaolinite & chlorite

2- Hawaz formation:

Hawaz formation consists of interbedded sandstone and shale beds. It includes fine to medium grained, coarsening upward, and well cemented, hard sandstone, with silt- stone, claystone and fine sandy interbeds. Hawaz Formation is very similar to the upper parts of the Hasawanah formation and the contact between the two units can be difficult to establish [3], Otherwise it is probably the lateral equivalent of the Achebyat formation [4].

Hawaz formation represented the onset of the major Paleozoic marine transgression in the area [5]. The depositional environment of the unit ranges from lower shoreface-offshore transition to upper shoreface. The depositional setting was characterized by a stable shelf with very gentle slope and extensive costal plane areas dissected by fluviotidal channels, minor facies changes are observed over long distances [6].

3- Study area :

Murzuq Basin is an intracratonic basin located in western part of Libya. It covers an area of over 350,000 km2, (Figure 1)... The study area is located within the basin between Longitude 11 50º -12 40º and latitude 26 10º- 27º, [7]**.**

4- Stratigraphic of Murzuq Basin:

A stratigraphic column for the Murzuq Basin is depicted in figure (2). The sedimentary deposits in the basin range from the Cambrian to the Quaternary in age, and can be subdivided into different sedimentary units [8-10]. The stratigraphic schemes established by these authors have been slightly modified in order to incorporate additional information derived from the surface and subsurface of the basin.

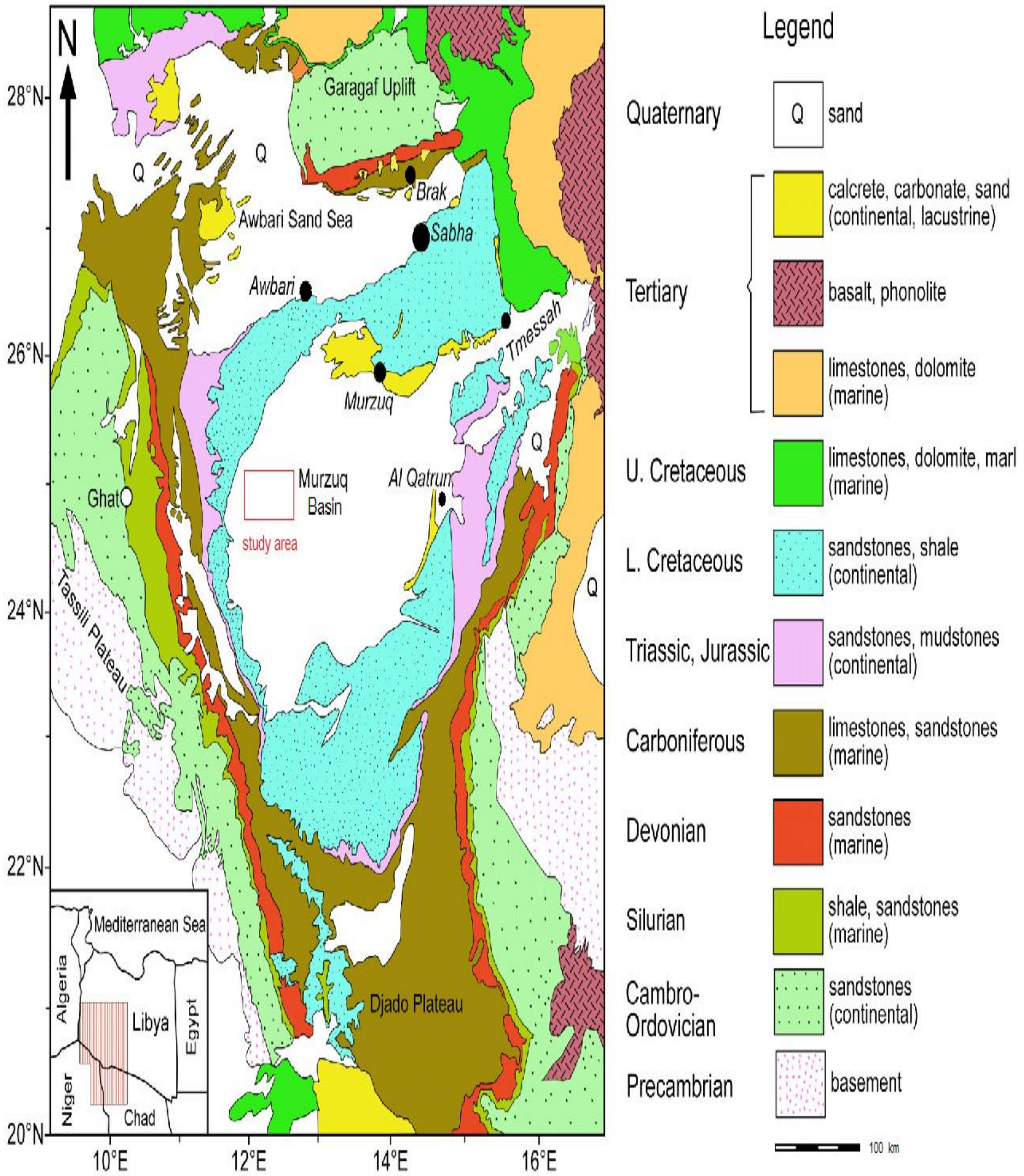


Figure (1): Geological map of the Murzuq Basin showing the main Precambrian and Paleozoic Outcrops Modified after [11].

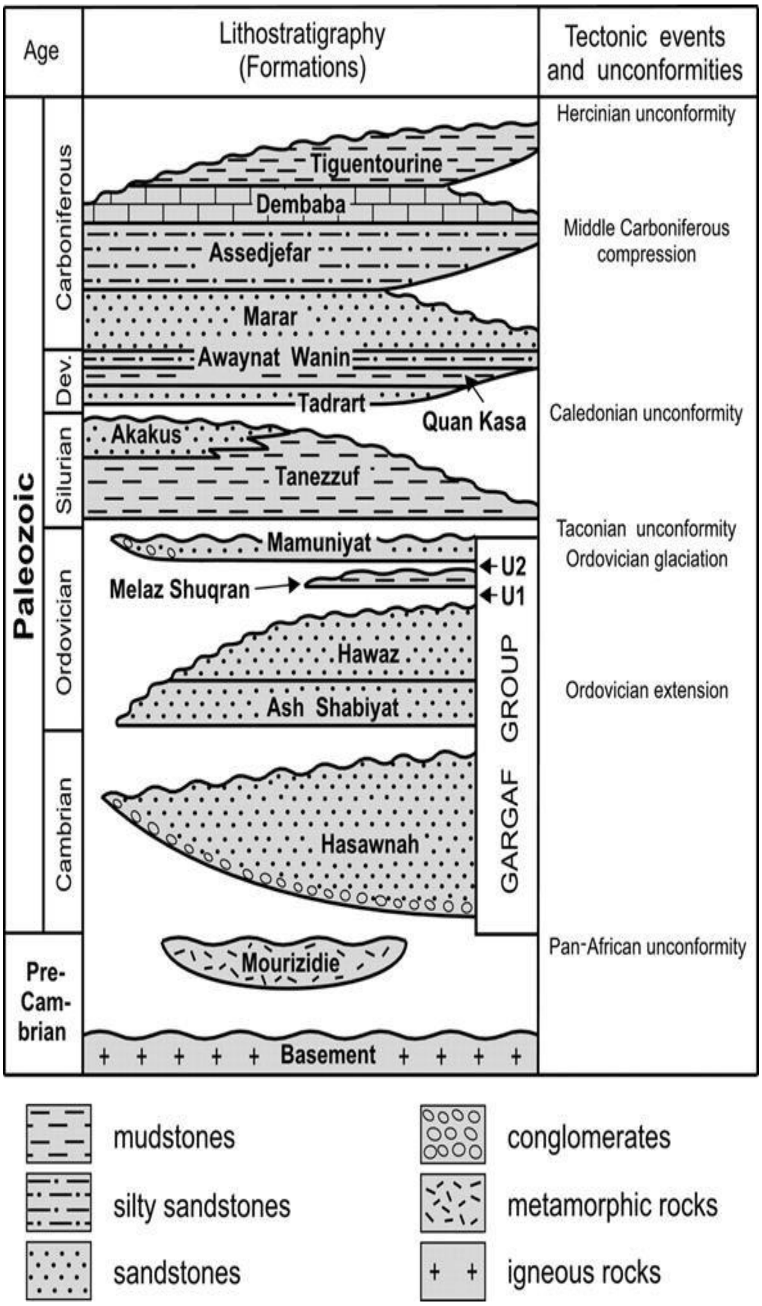


Figure (2): A stratigraphic column of the Murzuq Basin (Compiled from [12-14].

5- Previous studies

Many geological studies have been carried out by many authors on Murzuq basin in general and a few sedimentlogical and sequence stratigraphic studies have been carried out for Hawaz formation compared with upper Ordovician Mamuniyat formation although both formation represent the main reservoir rocks in Murzuq basin.

[15] had been studied the late Silurian Tanzzuft formation in the Murzuq Basin by using the gamma-ray spectrometry in surface exposures. Also [16] study the Silurian source rock distribution of Murzuq and Al Kufrah basins based on Gamma-Ray Spectrometry in surface exposures.

[17] have been studied petrography and facies of the Al-Mahruqah formation in the Murzuq basin, SW Libya. He classified the facies by study the concentration of uranium, thorium and ratio of potassium of the samples.

6- Material and Methods

Spectral Gamma Ray (SGR) logging technique is commonly used in the industry for determining clay minerals content in rocks. SGR tool measures individual fractions of radioactive elements Uranium, Thorium and Potassium and also their ratios as function of depth and split into contributions from each of the major radio-isotopic sources.

The spectral gamma ray tool uses the same sensor as the total gamma ray tool.

The output from the sensor is fed into a multi-channel analyser that calculates the amount of radiation coming from the energies associated with each of the major peaks. This is done by measuring the gamma ray count rate for 3 energy windows centred around the energies 1.46 MeV for potassium-40, 1.76 MeV for the uranium-radium series, and 2.61 MeV for the thorium series (Figure 3). These readings represent the gamma ray radioactivity from each of these sources. Their sum should be the same as the total gamma ray value measured by the total gamma ray tool, and is coded SGR if measured with a spectral gamma ray tool. Any combination of the three components can be summed and analysed. However, the most important is the sum of the potassium-40 and thorium radiation, which is called the computed gamma ray response (CGR).

The clay types within the Hawaz reservoir were determined using an interpretative model for spectral gamma ray mineral identification (thorium/potassium cross-plot).

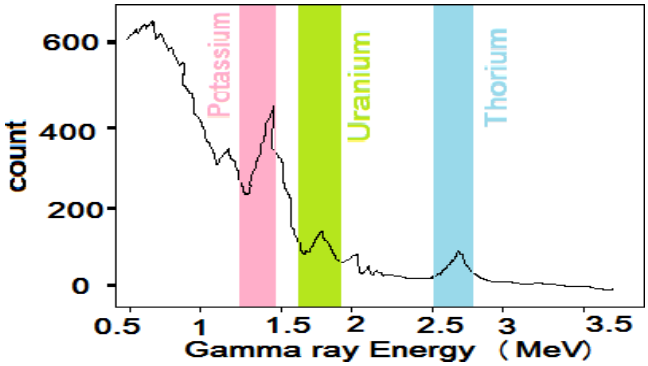


Figure (3): Standard natural gamma ray spectra Potassium, Thorium and Uranium components (after [18]).

7- Results And Discussion

The spectral gamma ray data (SGR) included uranium, potassium and thorium were used to distinguish different clay types within Hawaz sandstone formation in the well O6i-NC115. The logged interval includes three beds of Hawaz namely H6, H7 and H8. The H6 interval plots in the Montmorillonite and Illite fields on Thorium vs. Potassium diagram of [18], (Figure 4A), whilst the H7, and the H8 intervals fall in the Montmorillonite field on the diagram (Figures 4B and 4C).

The clay in these intervals either thin beds included in the main sand bed or can be as cement bonds the sand grains with each other.

These three intervals which have slightly differences in clay content noticed to have different values of uranium concentration counted by spectral gamma ray log. (Figure 3).

The interval (H6) from 5447 ft to 5530 ft with thickness of 83 ft has an average uranium value of 1.48 ppm with minimum reading of 0.11 ppm at depth of 5513.5 ft and maximum reading of 3.53 ppm at depth of 5455.5 ft. (Table 2 and Figure 5).

In the interval (H7) from 5530 ft to 5575 ft with thickness of 45 ft the average of uranium value of 2.03 ppm with minimum reading of 1.28 ppm at depth of 5565.5 ft and maximum reading of 6.65 ppm at depth of 5572.5 ft. (Table 2 and Figure 5). The interval (H8) from 5575 ft to 5653 ft with thickness of 78 ft has an average uranium value of 2.04 ppm with minimum reading of 0.18 ppm at depth of 5606 ft and maxi- mum reading of 9.42 ppm at depth of 5653 ft. (Table 2 and Figure 5).

Therefor the clay type Montmorillonite Illite have less uranium concentration (average = 1.48 ppm) while the Montmorillonite clay has higher values of uranium contents (average = 2.035 ppm) in the studied Hawaz sandstone formation in the concession NC115 Murzuq basin.

Table (2): Clay types of Hawaz intervals and average of the uranium concentration in ppm in the well O6i-NC115

Depth (ft)	Interval	Clay type	GR (ave.)	Thor (ave.)	Uran (ave.)	Pota (ave.)
5447 - 5530	H6	Montmorillonite-Illite	44.43	6.10	1.48	1.50
5530 - 5575	H7	Montmorillonite	53.41	7.91	2.03	1.65
5575- 5653	H8	Montmorillonite-Illite Traces of mica	51.01	7.83	2.04	1.58

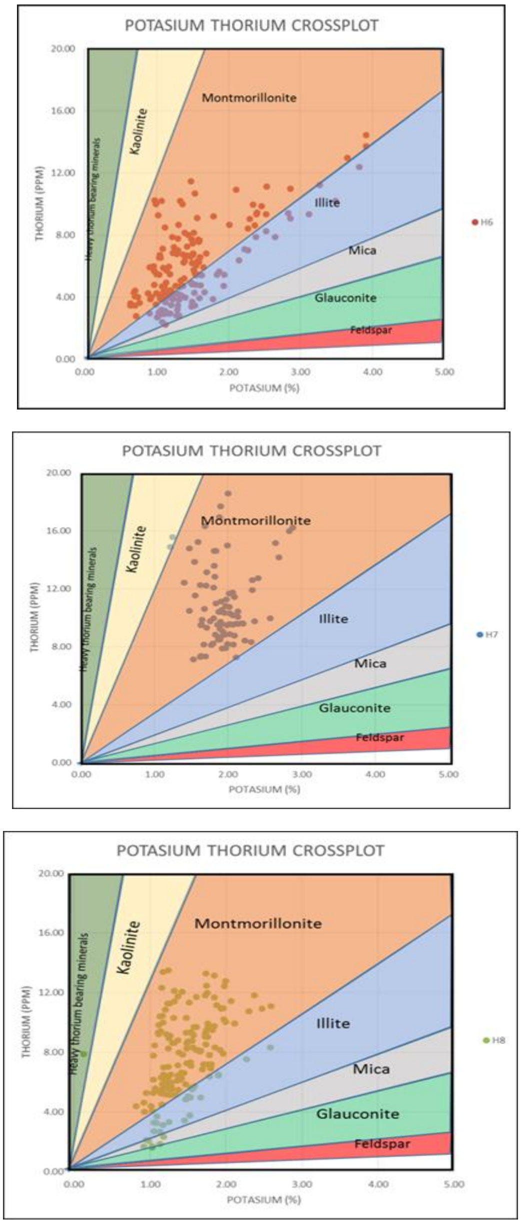
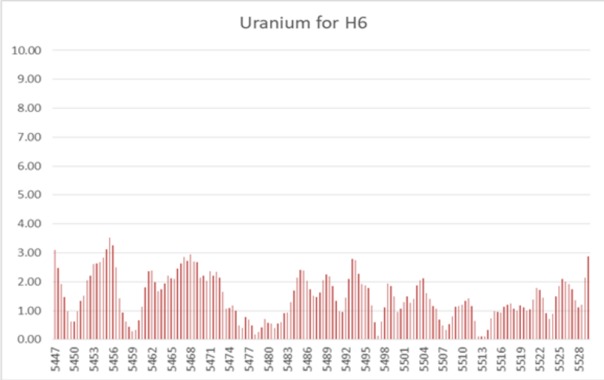
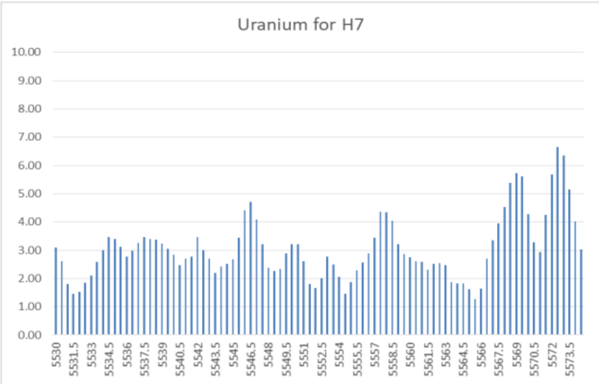


Figure (4,A): Locations of the different type of the clay from Hawaz FM on Thorium vs Potassium Clay Type Cross-plot of [19].



(A)



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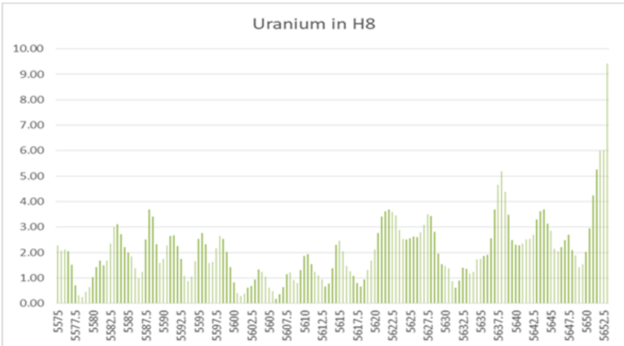

(C)

Figure (4,B): the histogram of uranium concentration in ppm (a) interval H6, (b) interval H7and (c) interval H8

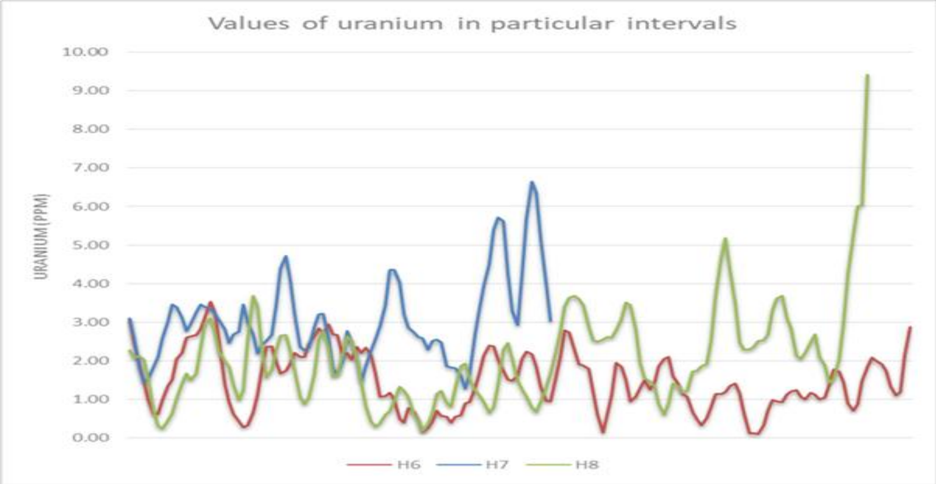

Figure (5): The uranium concentration in ppm verses depth for H6, H7, and H8 intervals in the well O6i-NC115.

8- Conclusion

Distinctive types of sandstone beds with different type of clay content have different values of uranium concentration within Hawaz sandstone in the well O6i-NC115. The interval which has clay type Montmorillonite-Illite has lesser value of uranium con- centration (average 1.48 ppm), whereas the intervals have higher values of uranium (average 2.035 ppm) those cemented or interbedded by Montmorillonite clay.

9- References

[1] Ghnia S ,Mohamed O. Musa, Osama A. Aldomany, Abdalhakim M. Saad, Sanad A. 2016,Clay Types and Reservoir Quality of the Hawaz Succession, Murzuq Basin, SW Libya, ICCPGE 2016, Almergeb University ,Alkhumes Libya, ICCPGE 2016, 1, 25 – 30.

[2] J Klaja, L Dudek. (2016), Geological interpretation of spectral gamma ray (SGR) logging in selected boreholes, Oil and Gas Institute – National Research Institute.

[3] Aziz, A. 2000. Stratigraphy and hydrocarbon potential of the Lower Paleozoic succession of License NC-115, Murzuq Basin, S.W Libya. In: M.A. Sola and D. Worsley (Eds), Geological Exploration in Murzuq Basin, Elsevier Science, Amsterdam, pp. 349-368.

[4] Davidson, L., Beswethherick, S.,Craig, J. Eales, M., Fisher, A., Himmali, A., Jho, J., Mejrab,B. and Smart, J. (2000) The structure, stratigraphy and petroleum geology of the Murzuq Basin, southwest Libya. In: Geological Exploration in the Murzuq Basin (Eds. M.A. Sola and D. Worsley), Elsevier, Amsterdam, 295-320.

[5] Echikh K. & M.A. Sola, 2000. Geology and hydroc:1rbon occurrences in the Murzuq Basin, SW Libya, In: M. A Sola and D. Worsley (Eds), Geological Exploration in Murzuq Basin, Elsevier Science, AmsterdatT,, p. 175-222. Massa & Collomb, 1960).

[6] Ghnia S , Luning S ,& Martin M., 2008 ; Genetic Stratigraphy of Cambro - Ordovician strata in Alkufrah and Murzuq basins, Geology of East Libya, 2008 Vol 1, P 311-336.

[7] Repsol Oil Company, Exploration Department, Geology Segment, (Internal geological re- ports, Unpublished).

[8] Mamgain, V. D. 1980. The pre-Mesozoic (Precambrian to Paleozoic) Stratigraphy of Libya- A reappraisal. Department of geological researcl1es and mining. Bulletin No. 14.

[9] Billini, E., Massa, D., 1980. A stratigraphic contribution to the Paleozoic of the southern basins of Libya. In: Salem, M.J. & Busrewil, M.T. (Eds.) The Geology of Libya I. Academic Press, London, 3-56.

[10] Abugares, Y.I. and Ramaekers, P. (1993) Short notes and guidebook on the Palaezoic geology of the Ghat area, SW Libya. Field trip, October 14-17, 1993. Earth Science Society of Libya, Interprint Ltd., Malta, 84 pp.

[11] El Chair, M.M. (1984) Zur Hydrogelogy, Hydrochemie und Isotopenzusammensetzung der Grundwässer des Murzuq-Beckens, Fezzan/Libyen. Unpublished Dissertation Naturwissenschaften Fakultät Universität, Tübingen, Germany, 214 pp.

[12] Klitzsch, E. 1963. Geology of the North east flank of the Murzuq basin (Djebel Ben Ghnema Dor el Gussa area), Rev. de I 'nsf. Franc. Eu Petrole Vol. 18 No.10/11, pp.97-118.

[13] Klitzsch, E., Ziegert, H., 2000. Short Notes and Guidebook on the Geology of the Dor el Gussa – Jabal Bin Ghanimah Area. In: Sedimentary Basins of Libya, Second Symposium, Geology of Northwest Libya. Gutenberg Press, Malta, pp.1–52.

[14] Ramos, E., Marzo, M., de Gibert, J.M., Tawengi, K.S., Khoja, A.A., Bolatti, N.D., 2006. Stratigraphy and sedimentology of the Middle Ordovician Hawaz Formation (Murzuq Basin, Libya). AAPG Bulletin 90, 1309–1336.

[15] Nuri Fello and Others, 2006 Silurian Tanzzuft formation in the Murzuq Basin by using the gamma-ray spectrometry in surface exposures.

[16] Sebastian Luning and Nuri Fello, 2008, Silurian source rock Distribution of Murzuq and Al Kufrah Basins Based on Gamma-Ray Spectrometry in Surface Exposur.

[17] M. Abdullah, 2010. Petrography and Facies of the Al- Mahruqah Formation in the Murzuq Basin, SW Libya. (Der Universität Hamburg 2010), (MSc. Thesis, published).

[18] Schlumberger: Interpretation charts. Schlumberger New York 1985.

[19] Schlumberger; Log interpretation charts, 2009, pp. 310.