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Groundwater Assessment for Drinking and Irrigation proposes of Ar Rajmah Area, NE Libya

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الملخص

يهدف العمل الحالي إلى تقييم جودة المياه الجوفية لاستخدامات الشرب والري في منطقة الرجمة، شمال شرق ليبيا، أوضحت النتيجة أن المياه الجوفية للمنطقة هي عباره عن مياه عذبة صلبة وتتميز بنوع الكالسيوم- ماغنيسيوم- كلوريد، وذلك بسبب تجوية الصخور الكربونية التي تتحكم في كيمياء المياه. المياه الجوفية مفرطة التشبع بالهاليت والجبس والدولوميت والكالسيت. بشكل عام، المياه الجوفية في العينات المدروسة مناسبة لأغراض الشرب والري، ولكن يجب معالجة الزيادة الطفيفة في قيمة النترات.

الكلمات المفتاحية:

جيوكيمياء المياه ، جودة المياه الجوفية، استخدامات الشرب والري، منطقة الرجمة، بنغازي - ليبيا.

Abstract

The aim of the present work is to assess the groundwater quality for drinking and irrigation uses in Ar Rajmah area, NE Libya. The result revealed that the groundwater is hard to fresh water and characterized by Ca-Mg-Cl type, due to weathering of carbonate rocks that controlling water chemistry. The groundwater is supersaturated with halite, gypsum, dolomite and calcite. In general the groundwater in the studied samples is suitable for drinking and irrigation proposes, regardless of slight increase in (NO_3) value which should be treated.

Keywords: Hydrochemistry, Groundwater quality, Drinking and irrigation uses, Ar Rajmah area, Benghazi - Libya..

1. INTRODUCTION

Groundwater quality has become one of the most important aspects in our living environment and the chemistry of groundwater has a bearing on our health and livestock. Water is used for drinking, domestic, agricultural and industrial purposes. Ar Rajmah area is located east of Benghazi city (Fig. 1). This area is an agricultural area. Shaltami et al (2017) have conducted a geochemical evaluation of water in the Benghazi city, NE Libya. As far as the authors are aware, there is no detailed geochemical assessment of ground water quality for drinking and irrigation proposes in Ar Rajmah area[1]. The aims of the current work are to identify water chemistry type and the suitability of the ground water quality for drinking and irrigation proposes. However the published data on water quality in Ar Rajmah area so far are insufficient.

2. METHODOLOGY

Four samples were collected from four wells during September 2019 (one sample of each well). The ground water of this horizon is discharged from the carbonate aquifer (Benghazi Formation) of the Miocene age. This horizon is considered to be the most important horizon of the ground water in the suburb of Benghazi city.

These samples were analyzed using chemistry techniques as following:

- Major ions were measured by using a Flame photometer.
- Total dissolved solid (TDS) and alkalinity (Alk) were determined by gravimetric method and acid-base titration, respectively.
- The heavy metals were analyzed by using AAS Hitachi-5000.

The chemical analyzes were performed in Sirt Company laboratories.

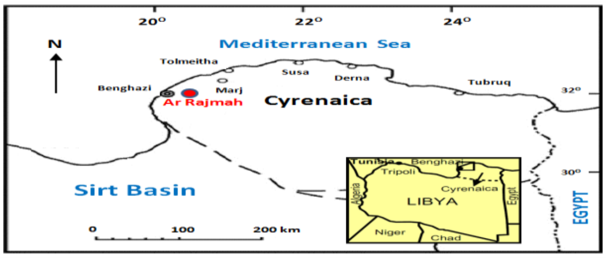

Figure 1: Location map of the study area

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3. RESULTS DISCUSSION

Table (1) presented the values of different parameters for the analyzed groundwater samples compared to [2] permissible limits.

Table 1: Comparison between the chemical data of the studied water and the permissible limits of[2] for drinking water (concentrations in mg/l, except for EC in µs/m).

Parameters	1	2	3	4	WHO 2018
pH	7.5	7.8	7.5	7.7	8
EC	1341	1261	1304	1280	-
ALK	160	151	157	153	-
TDS	885	833	860	850	500
Cl	26	24	27	26	250
SO^4	44	50	48	55	600
HCO^3	100	99	90	102	600
TH	340	307	330	8.7	500
Ca	77	64	65	70	200
Mg	35	35	41	40	150
Na	132	129	131	130	200
NO^3	10.1	8	8.4	7.5	10
K	28	22	26	23	100
Fe	0.2	0.1	0.2	0.1	0.3
Zn	2.99	2.02	2.15	2.3	3

3.1. Rock - Water interaction

Figure (2) displays the plot of Ca + Mg vs. HCO_3 + SO_4, to distinguish carbonate rock or silicate rock sources of ions. The studied water samples fall in the field of carbonate weathering which indicates the main source of ions. Also this interpretation is further supported by the plot of HCO_3 vs. Na (Fig. 3). However, dominance of evaporation and weathering of rocks in the water samples are prevalent in the plots Na/Na+Cl vs. Ca/Ca+SO_4 and Cl/Cl+HCO_3 vs. TDS (Figs.4 and 5).

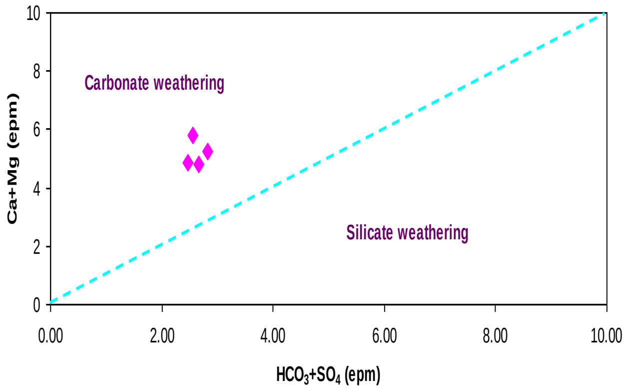

Figure 2: Plot of Ca + Mg vs. HCO_3 + SO_4 of the water samples (field after[3]).

fulfilled the inclusion criteria. A total of 994 root canals were evaluated for the quality of root canal fillings.

All radiographs were independently examined by two endodontists. The results of assessment were compared by the two assessors and a final agreement between the assessors was made. In case of disagreement, a third investigator was asked to interpret the radiographs and a final agreement was reached. The latter was the case in only three canals.

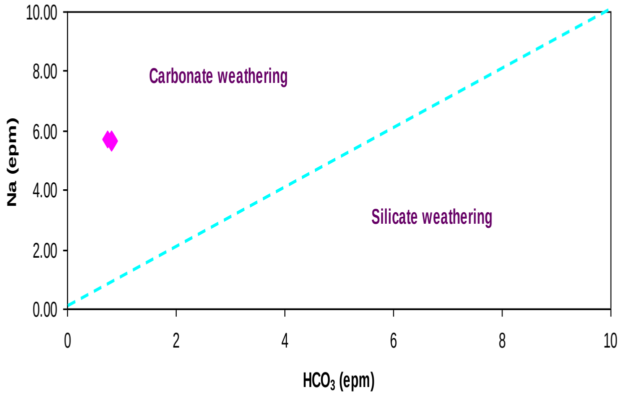

Figure 3: The plot of Na vs. HCO_3 of the water samples (field after[3]).

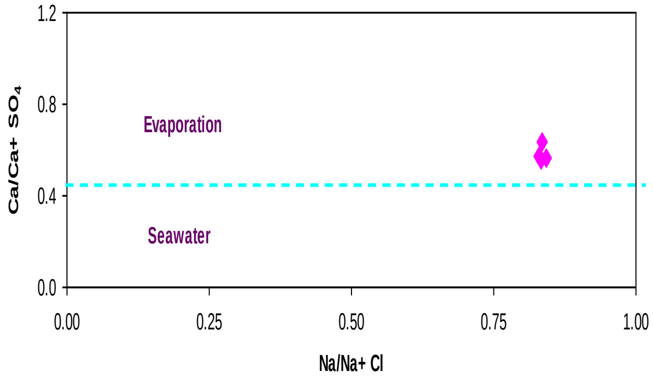

Figure 4: Molar Na/Na+Cl and Ca/Ca+SO_4 to differentiate water of different origin (field after[4]).

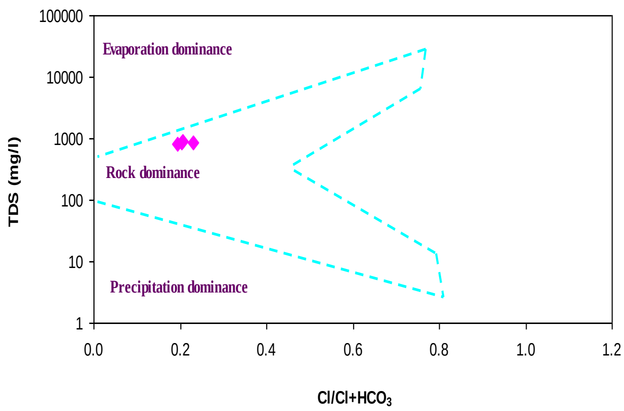

Figure 5: Dominance of rock precipitation and evaporation on Cl/Cl+HCO_3 vs. TDS of the studied water (field after[5]).

3.2. Quality of Drinking Water

All parameters of the analyzed ground water samples are below the permissible limit of[2] except (NO_3). According to TDS classification, the studied water samples are considered permissible for drinking (Table 3). The bivariate plot of TDS versus TH (Fig.6) shows the studied water samples found to be hard fresh water. [6] classified the salinization in groundwater into three types based on the Cl /HCO_3 vs. Cl (Fig.7). The studied water samples are unaffected by saline water. In addition the low concentration of Cl value indicates no impact of seawater intrusion in Ar Rajmah area. The plot of EC vs. Cl, indicates that the studied water samples falling in the normal water field (Fig.8).

Table 3: Classification of groundwater based on TDS[7]

TDS (mg/l)	Water type
< 500	Desirable for drinking water
500 - 1000	Permissible for drinking
< 3000	Useful for irrigation
>3000	Unfit for drinking and irrigation

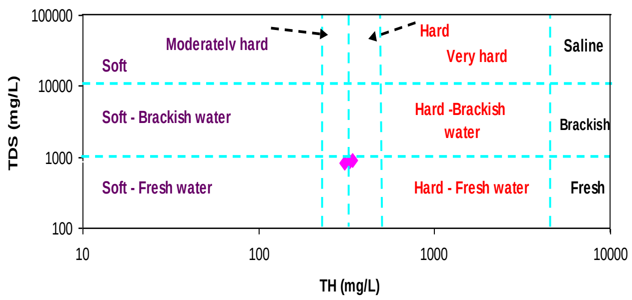

Figure 6: Plot of total dissolved solids (TDS) versus total hardness (TH) of the studied water (fields after[8]).

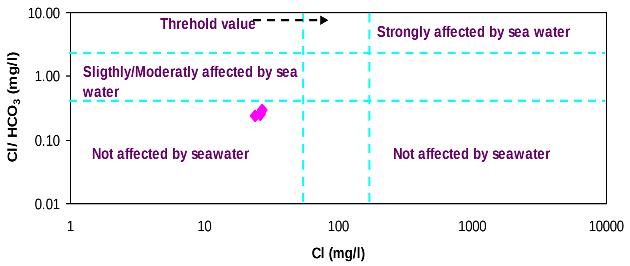

Figure 7: Molar ratio Cl vs. Cl/HCO_3 in the water samples (fields after[6]).

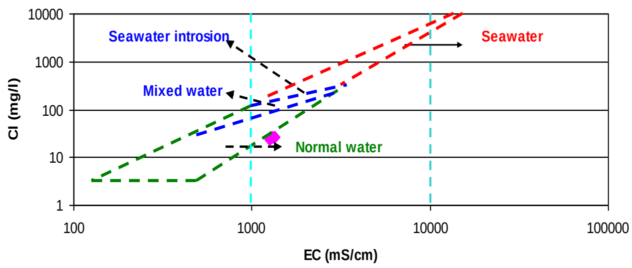

Figure 8: Molar ratio EC vs. Cl in the water samples (fields after[6]).

3.3. Hydrochemistry Classification

According to Schoeller diagram (Fig. 9), the dominant cation order of ion contents in the ground water samples are Na>Ca>Mg>K and anion order is HCO3+CO3>SO_4>Cl. The Stiff diagram analysis signifies dominance of Na-HCO_3+CO_3. The water facies type in the Piper diagram is represented by Ca-Mg- Cl type (Fig.10). Therefore, (Fig.11) reveals the studied samples fall in field of natural water.

The saturation index (SI) can be calculated as:

Log SI halite = log a_{Na} + log a_{Cl} + log Ks halite

Log SI gypsum = log a_{Ca} + log a_{SO4} + log Ks gypsum

Log SI calcite = log a_{Ca} + log a_{HCO3} + log Ks calcite

Log SI dolomite = log a_{Ca} + log a_{Mg} + log a_{HCO3} + log Ks dolomite

The water samples are above zero, which indicating super-saturation with, dolomite, calcite, gypsum and halite.

There was a statistically significant difference between length of root canal fillings and tooth groups [P<0.001] (Table 2) and also length of root canal fillings and number of roots (Table 3) [P<0.001].

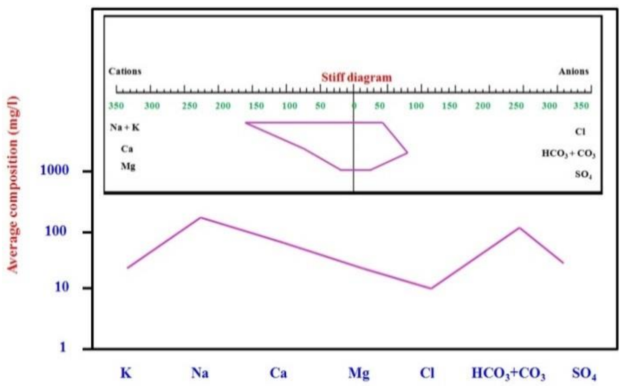

Figure 9: Schoeller diagram showing average composition in mg/l of the studied water samples. Stiff diagram is shown in inset[9].

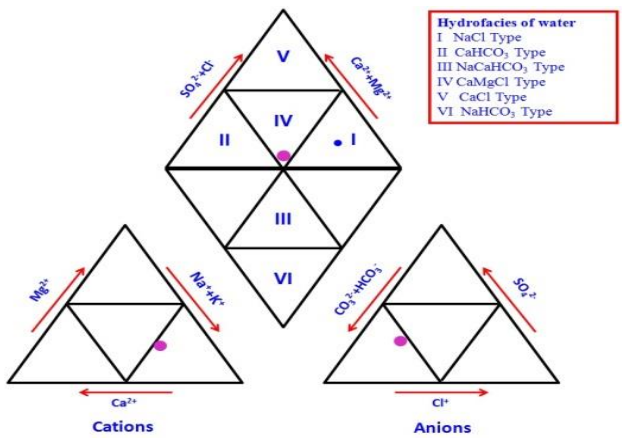

Figure 10: Piper diagram of water chemistry in the study area (fields after[10]).

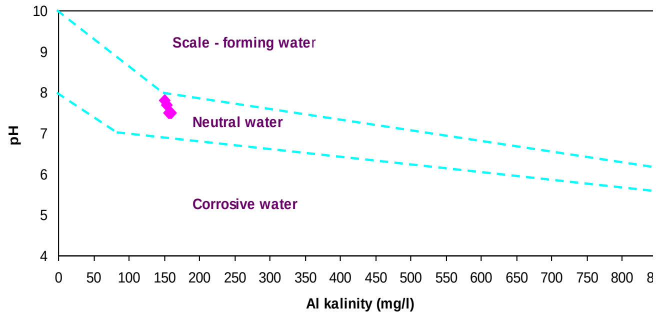

Figure 11: Plot of alkalinity vs. pH showing the hardness of the studied water (fields after[11]).

3.4. Irrigation Water Quality

The bivariate plot of EC versus sodium percent (Na %) suggests that the water samples of Ar Rajmah area are fair for irrigation (Fig.12). This assumption is also supported by the irrigation parameters such as pH (7.5, in average), sodium adsorption ratio (SAR = 25.8, in average), magnesium adsorption ratio (MAR = difference between the number of the roots and density of the root canal fillings [P=0.02].

5.4, in average), residual sodium carbonate (RSC= -0.8, in average) and Kelley's ratio (KR = 7, in average) indicating that the ground water samples of Ar Rajmah area are suitable for irrigation. The irrigation parameters are computed as follows:

Na% = (Na * 100) / (Ca+ Mg + Na + K)
SAR = Na / √ (Ca+ Mg)/2
RSC = (HCO^{-3} + CO_3^{2-}) – (Ca + Mg)
MAR = [Mg / (Mg + Ca)] 100
KR = Na / (Ca + Mg)
(All concentrations are expressed in meq/l)

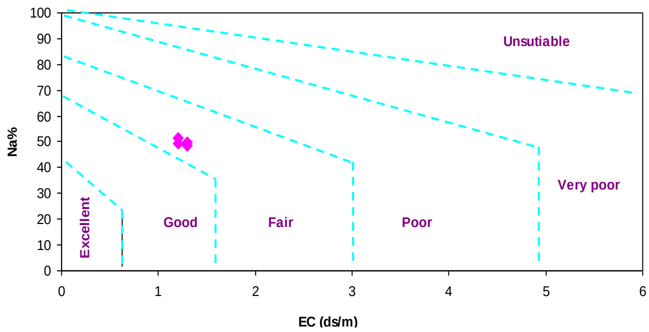

Figure 12: Plot of EC vs. Na% showing the classification of irrigation water (fields after[12]).

4. CONCLUSIONS

The groundwater samples of the study area are classified as normal water not affected by sea water intrusion. The dominated hydrochemical facies are (Na- Mg- Cl type) this is because of the water is affected by carbonate weathering.
There is a marginal contamination by NO_3 in this case the water should be treated for drinking water. The groundwater of Ar Rajmah area is suitable for irrigation.

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