Assessment of the Groundwater at Ali Al-Garbi area, Iraq using Geochemical modeling and Environmental isotopes

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Overview

- Background and motivation
- Aims
- Study area
- Methodology and material
- results
- Conclusion & Recommendations …

Introduction

- During the last few years, a critical scarcity of water has occurred in the Middle East due to population growth, economic development, energy need, and mismanagement of water.
- Iraq relies mainly on surface water (the Tigris and Euphrates) and its accumulation in reservoir dams.
- In the south of Iraq because of the emergence of drought conditions, the increased necessity of water for the purpose of food security, and lastly, the water policies of neighboring countries.

- Groundwater is the important source of water used for human utilization and for both industrial and agricultural activities in regions where surface water is scarce .

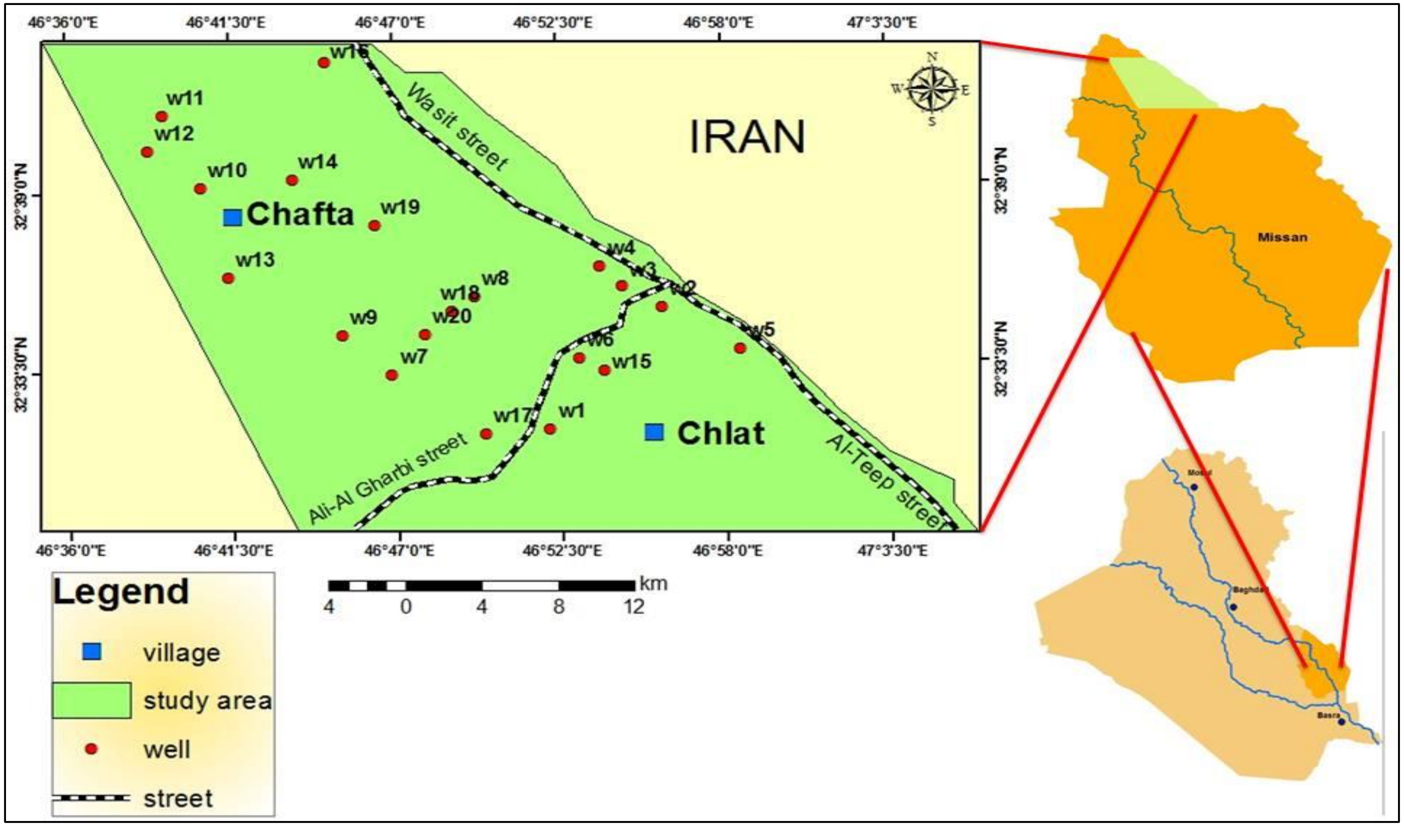
- Hydrogeochemical modeling is an important tool to study the evolution of groundwater in a specific aquifer leading to combination of a management plan for the total system.

- During the last thirty tears, many geochemical models were established that predict ionic facies, thermodynamics, saturation indices, and mixing processing between water bodies.

Aims

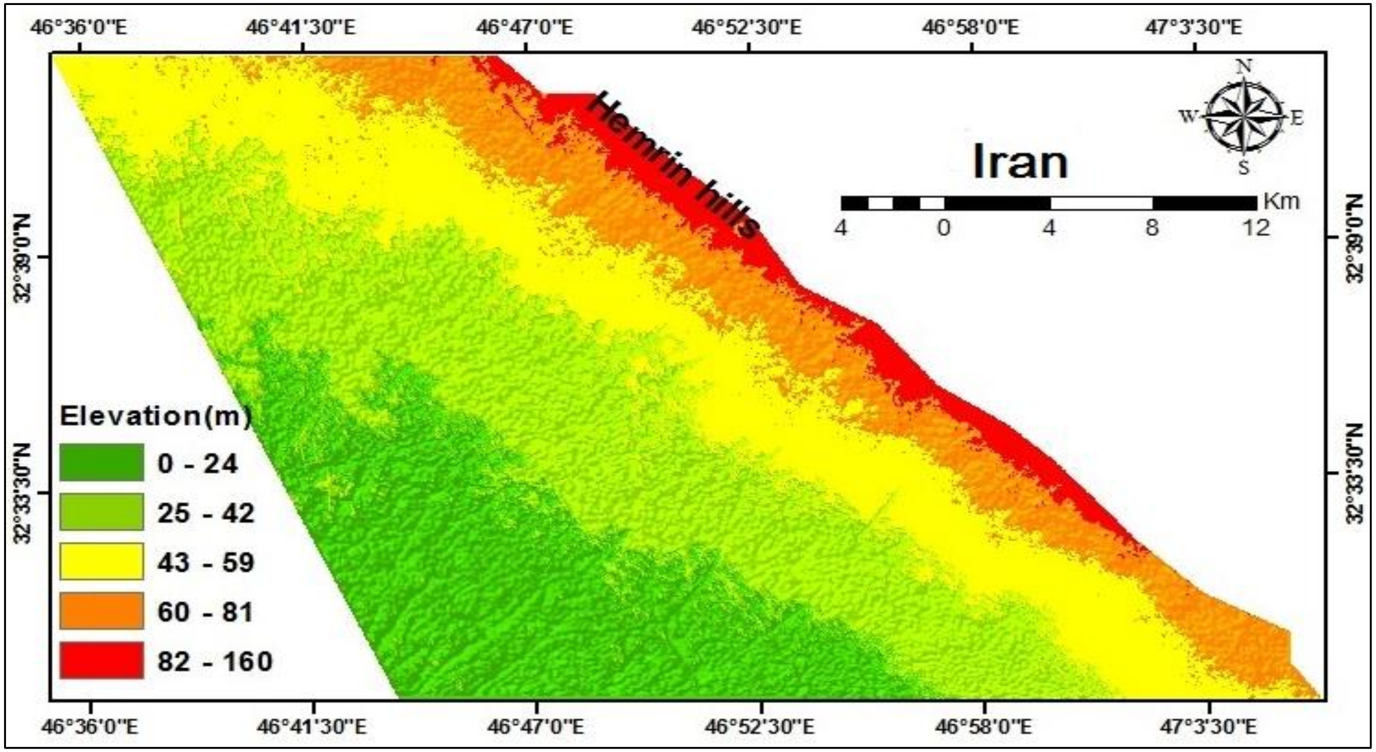
- The purpose of this study was to use environmental isotope techniques.
- And a geochemical modeling to make better studies and clear image for groundwater type in Quaternary aquifer.
- Draw of the Amarah Meteoric Water Line (A.M.W.L) using stable isotopic technique (18O & 2H) in rainwater samples and linking it with the Global Meteoric Water Line (G.M.W.L).

Study area discretion



The study area is district that is called Ali Al-Gharbi and located in the northeastern of Missan province, the area of study about (760 km2).

Digital elevation's models of study area.



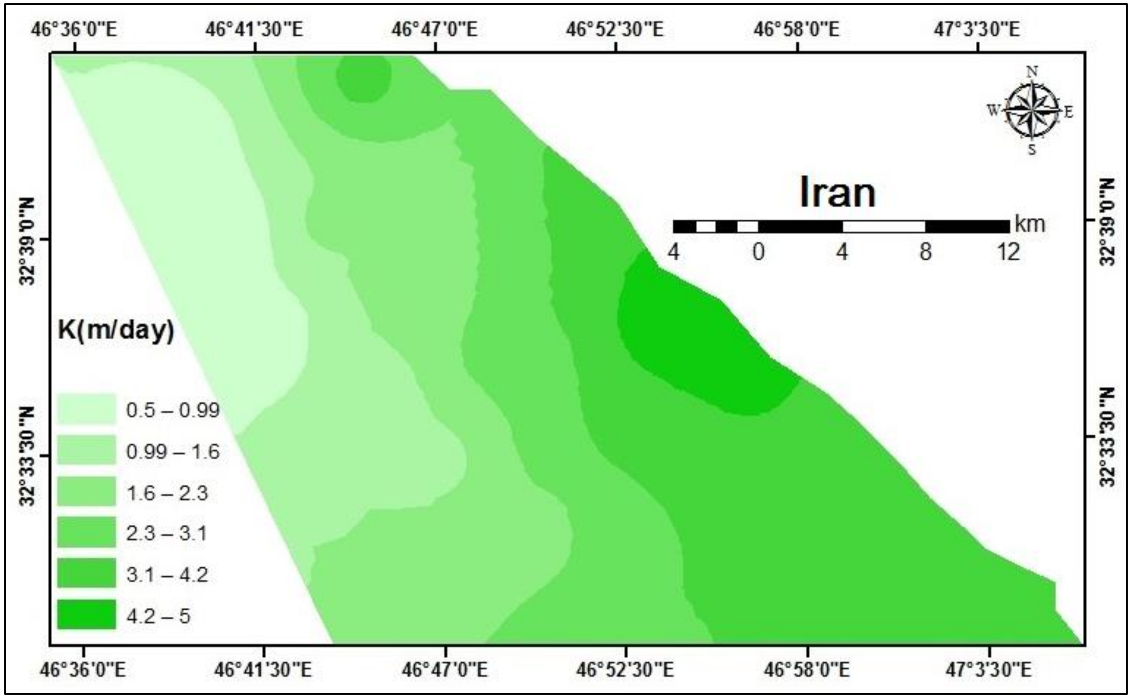
Hydrogeologic settings

- Aquifer system is(unconfined), deep aquifer (confined).

- The sediments of unconfined aquifer are sand (fine, medium) with little layer of silt and clay represents the main component of this unit and some of wells contain a gravel.

Hydrogeologic settings

- The value of hydraulic conductivity for quaternary deposits between (0.5 – 5.3) m/day, (Fig. 3). These values are less than other deposits,

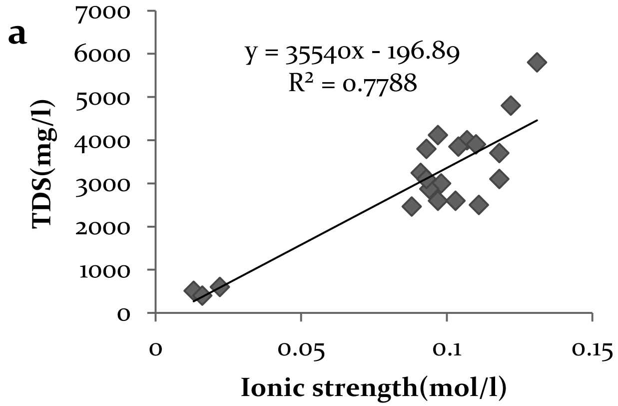


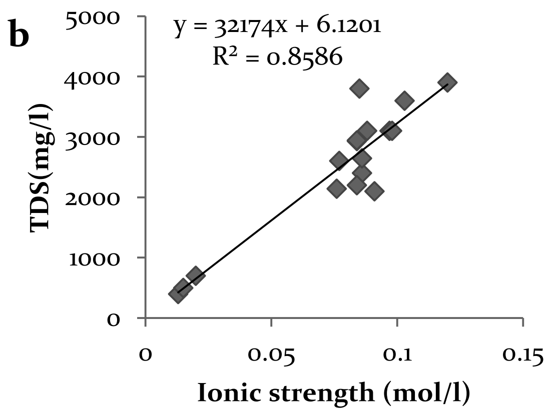
Methodology

Hydrogeochemical modeling

- Mass transfer along flow paths and geochemical reactions that control on water were modeled for (20) wells during two period of study area by NETPATH code.
- Saturation index (S.I)
- (2H, 18O and T) , (10) groundwater samples and
- (6) samples for rainwater. All samples were analyzed in (Iraq).

Results: Hydrogeochemical results





TDS & ionic strength relationship for in the study area, a (dry period), b...?

Table. Ionic strength & Log PCO_2 for two period.

Well No.	Dry period				Wet period			
	EC	TDS	I. strength	Log PCO_2	EC	TDS	Ionic strength	Log PCO_2
	(μs/cm)	(mg/l)			(μs/cm)	(mg/l)		
w1	7660	4000	0.107	-1.233	4240	3800	0.085	-1.557
w2	792	510	0.013	-1.542	787	400	0.013	-2.133
w3	808	600	0.022	-1.48	1020	700	0.02	-2.033
w4	3383	2600	0.097	-1.588	2870	2400	0.086	-1.92
w5	619	400	0.016	-1.586	610	500	0.015	-2.477
w6	3200	2500	0.111	-1.512	2730	2100	0.091	-1.002
w7	6340	5800	0.131	-1.18	4450	3900	0.12	-1.499
w8	5270	4800	0.122	-1.644	3800	3100	0.097	-1.692
w9	5140	3850	0.104	-1.197	-	-	-	-
w10	4340	3100	0.118	-1.3	-	-	-	-
w11	4900	3800	0.093	-1.339	-	-	-	-
w12	4467	3900	0.11	-1.523	3900	3100	0.098	-1.873
w13	5790	3700	0.118	-1.367	4450	3600	0.103	-1.764
w14	5130	4120	0.097	-1.453	4160	3100	0.088	-1.852
w15	4443	2466	0.088	-1.861	3900	2140	0.076	-2.351
w16	3383	2600	0.103	-1.387	2600	2200	0.084	-2.076
w17	5620	3242	0.091	-1.55	4938	2930	0.084	-2.317
w18	4170	3000	0.098	-1.207	3550	2646	0.086	-1.703
w19	4740	2871	0.094	-1.304	3740	2600	0.077	-1.726
w20	5850	3100	0.093	-1.266	4150	2940	0.084	-1.694

Saturation index (S.I)

- The saturation indices of carbonate phases of groundwater in the study area are oversaturated during the wet period Main recommendations (what needs to be made next?)

- The most of Sulfate minerals (S.I) are undersaturated for two period

- S.I. for hematite and goethite are high value which shows that the solutions are oversaturation for both periods because of amount of water recharge.

- Halite (NaCl) are found in many current evaporative deposits.

Well No.	Mineral phases								
	Calcite	Aragonite	Dolomite	Siderite	Gypsum	Anhydrite	Hematite	Goethite	Halite
Dry period									
w1	-0.44	-0.58	-1.08	-1.29	0.14	-0.07	5.29	1.42	-5.07
w2	-1.68	-1.83	-4.02	-2.08	-1.08	-1.29	4.03	0.87	-6.80
w3	-1.29	-1.43	-3.00	-1.61	-0.73	-0.93	5.07	1.24	-6.97
w4	-0.50	-0.64	-0.93	-1.50	0.04	-0.16	6.09	1.75	-5.32
w5	-1.72	-1.86	-3.34	-2.09	-1.07	-1.28	4.31	0.86	-6.92
w6	-0.42	-0.56	-0.90	-1.71	0.16	-0.04	5.53	1.40	-5.14
w7	-0.56	-0.70	-0.96	-1.47	0.07	-0.13	4.93	1.17	-4.61
w8	-0.41	-0.55	-0.99	-1.62	0.12	-0.09	6.06	1.81	-4.58
w9	-0.35	-0.49	-0.65	-1.32	0.05	-0.15	5.36	1.46	-5.02
w10	-0.31	-0.45	-0.38	-1.28	0.00	-0.21	5.85	1.70	-4.82
w11	-0.19	-0.33	-0.68	-1.34	0.20	0.00	5.81	1.68	-5.52
w12	-0.01	-0.15	0.06	-0.90	0.02	-0.18	7.45	2.50	-5.09
w13	-0.28	-0.42	-0.61	-1.10	0.08	-0.13	6.34	1.95	-4.69
w14	-0.38	-0.52	-0.56	-1.35	-0.14	-0.34	6.21	1.88	-4.86
w15	-1.00	-1.14	-2.33	-1.79	0.02	-0.18	5.85	1.63	-4.94
w16	-0.69	-0.83	-1.25	-1.69	0.02	-0.17	5.01	1.14	-5.19
w17	-0.98	-1.12	-2.29	-1.66	-0.06	-0.26	5.40	1.33	-4.76
w18	-0.29	-0.43	-0.74	-1.60	0.02	-0.18	4.92	1.17	-4.94
w19	-0.19	-0.33	-0.55	-1.40	0.02	-0.19	5.62	1.59	-5.07
w20	-0.20	-0.35	-0.29	-1.14	-0.12	-0.33	6.06	1.81	-5.25
Wet period									
w1	-0.24	-0.38	-0.99	-1.33	0.01	-0.21	6.24	2.02	-5.08
w2	-1.02	-1.16	-2.70	-1.82	-1.07	-1.29	6.88	2.36	-6.93
w3	-0.52	-0.66	-1.42	-1.53	-0.88	-1.11	7.08	2.68	-6.97
w4	-0.11	-0.25	-0.14	-1.15	-0.05	-0.27	7.94	2.89	-5.39
w5	-1.20	-1.34	-2.37	-1.34	-1.11	-1.33	8.51	3.32	-6.98
w6	-1.10	-1.25	-2.66	-2.33	0.08	-0.15	1.14	-0.10	-5.14
w7	-0.37	-0.51	-0.64	-1.35	0.06	-0.16	5.90	1.98	-4.73
w8	-0.36	-0.51	-0.94	-1.20	-0.04	-0.27	6.62	2.51	-4.73
w12	0.19	0.04	0.21	-0.76	0.03	-0.20	8.35	3.39	-5.13
w13	-0.03	-0.18	-0.16	-0.84	0.00	-0.23	7.78	3.09	-4.80
w14	-0.18	-0.33	-0.16	-0.78	-0.22	-0.45	8.40	3.27	-4.90
w15	-0.73	-0.87	-1.77	-1.42	-0.06	-0.29	7.81	3.05	-5.11
w16	-0.21	-0.36	-0.47	-1.06	-0.03	-0.26	8.05	3.24	-5.41
w17	-0.41	-0.55	-1.19	-1.06	-0.09	-0.32	8.88	3.51	-4.83
w18	0.04	-0.11	-0.05	-1.18	-0.10	-0.32	7.25	2.62	-5.00

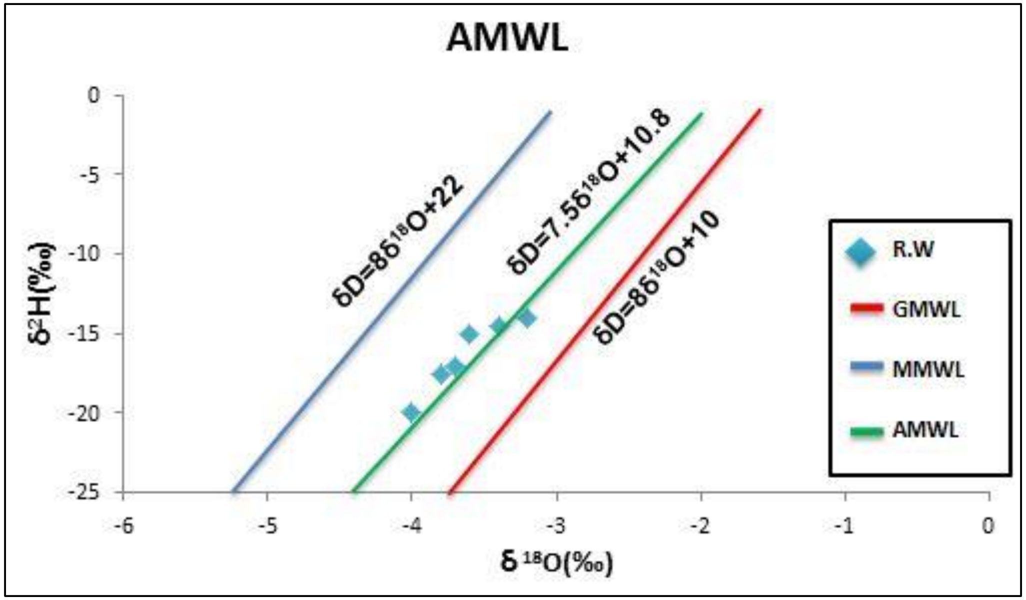
Mineral phases for each flow path. (mmol / kg H2O)

Mineral phases	Calcite	Dolomite	Halite	Sylvite	Gypsum	Hematite
Flow path No						
F1(dry)	5.13	-2.44	10.05	0.10	2.66	0.00
F1(wet)	-22.33	12.20	51.80	0.50	31.01	0.01
F2(dry)	-20.91	10.11	8.17	-0.26	9.31	0.00
F2(wet)	-17.97	8.69	5.33	-0.16	11.87	0.00
F3(dry)	-1.34	0.54	3.53	-0.01	1.13	0.00
F3(wet)	-2.70	1.30	8.63	0.14	4.12	0.00
F4(dry)	3.16	-1.90	-1.63	-0.07	-3.04	0.00
F4(wet)	3.05	-1.80	-1.26	-0.06	-2.79	0.00

Generally, there is change in the calculated mass transfers of selected minerals, and we can be seen as a "characteristic reaction" that dominates the field.

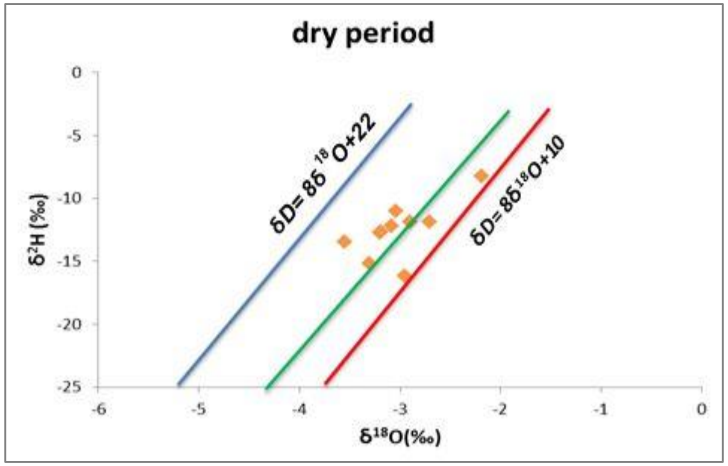
Isotope results

- Amarah meteoric water line (AMWL) which fits with the relation below a regression line coefficient
- $R^2 = 0.94$
- $\delta D = 7.51\ \delta^{18}O + 10.82$

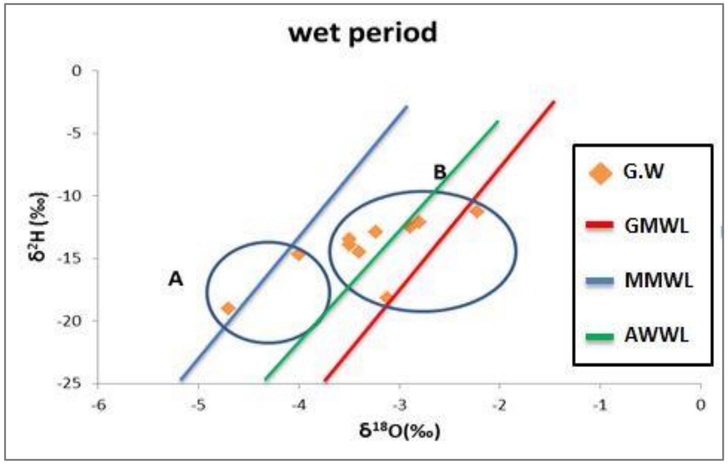


LMWL for Missan (Ali Al-Gharbi) during the observation periods December 2015 and January, February 2016.

- The variation in stable isotopes signature of water in study area is caused mainly by natural evaporation, change of stable isotopes content in rain water and mixing.



- The distribution of the samples of groundwater in the study area is located between the GMWL and MMWL, which that the evaporation is not an influential factor this indicates that groundwater in this study, where recharge water comes from the precipitation.



Conclusion & Recommendations

- Major minerals such as calcite, dolomite, gypsum and sylvite showed significant spatial and temporal changes and no significant change in other minerals.
- The situation in wet period showed a significant difference compared to December dry period.
- The processes both of dissolution and precipitation of carbonate minerals often influence in the control of chemical composition changes.
- The applied models are the dominant geochemical process of d-dolomitization involving dolomite, gypsum and halite dissolution and calcite precipitation of groundwater in study area.

- According to stable isotope data δ18O and δD, most wells of groundwater are of meteoric origin and exposed to evaporation, also presence hydraulic connection between to water type
- The variation in the isotopic composition in all points indicate that groundwater is affected by different degree of evaporation.
- Amara meteoric water line (AMWL) are near to GMWL and away from MMWL, this indicates climate of study area is affected by Arab Gulf climate.

Recommendation

- Establishing observation station to monitor groundwater fluctuation and conducting periodic chemical analyze, especially in the hydraulic connection area between aquifers.
- Conduct periodic or seasonal measurements of isotopes and make a chronological record of them to employ it in the future studies

Thank you for your attention