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THE PHYSIO-CHEMICAL CHARACTERISTIC OF SAWA LAKE WATER IN SAMAWA CITY-IRAQ

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ABSTRACT

The physio-chemical characteristics and chemical composition of the Sawa lake water, well water, and Al-Atshan river water (branch of the Euphrates river) were studied by determination of the ionic composition of samples water. The hydrochemical composition indication the type of water in Sawa was Mg-chloride. Sawa water shows hydrochemical characteristics similar to Al-Atshan river rather than the well near by or sea water .Its water could be subject to mixing with fresh and groundwater or marine origin water. The water in the lake and those in Euphrates are similar in hydrochemical characters moreover than is a similarity between Sawa water and Euphrates river. It is based on to be terrestrial water exchangeable with the marine origin sediments. Sawa water is over saturated with calcite, dolomite, arogonit ,gypsum and anhydrite minerals

Key words: Sawa water, physio-chemical characteristic, saturation index (SI) of carbonate minerals.

Introduction

Sawa lake is an elongated closed basin with no tributary entry of surface water is not available to it, underground water fed through system of joints, cracks and fissures from the aquifer beneath, its water level and salinity have not changed and not last its water or dried up because of the evaporation and climatic conditions it seems to be in state of equilibrium with the pressure gradients within the aquifers that feed it with water (Jamil, 1977). Ionic composition is governed by runoff of soil and rock in drainage basin, atmospheric evaporation and precipitation. In open lakes (those with stream outflow) salinity is governed by chemistry of inflow .In closed lakes (no stream outflow) salinity is governed by evaporation and precipitation so lake becomes saline owing to these process and continued influx of solutes(Hem,1985). The origin of the lake was influenced by the tectonic activity of the area which proceeds by the leaching processes i.e a morphotectonic problem (Naqash *et al*. 1977).

One of the most interesting feature of Sawa lake represented by it's salt rim which is formed by chemical processes, this rims have a rough rugged surface and look like cauliflower in shape (Naqash *et al*., 1977; Jamil, 1977). It is believed that Sawa lake is of marine origin water due to mixing of Dammam formation water (meteoric and rich with $CaSO_4$) with Euphrates formation water (marine origin), its type of water cation – chloride water (Samaan1986).

The present study afferent to investigate the contrasts between the hydrogeochemical processes observed in study area and seek for better understanding of the factors that control on the geochemical processes and identify the origin of the salinity in the study area.

Material and methods:-

1)Site description

Sawa lake is located at Muthana governorate southern Iraq about 32 km west of Samawa city and bounded by 31°18´Late. N and 45° 00´Long. E from Samawa city (Fig.1) .It is a land locked leak of gypsum barrier that rises to over 6 m above the land and entry of surface water is not available to it .It is surrounded by a salt rim which is higher than the lake water by 2.8 m and sea water by 18.5 m (Naqash *et al*., 1977). The climate of study area is dry, hot summer and a cool winter with medium humidity. Geology and hydrochemistry of the lake were reported by Naqash *et al.* (1977), Jamil (1977). Sampling survey was performed in 2002 during January and February from Al-Atshan river, will which related to it to and Sawa lake water. Ten stations eight of them were collected from different sites in the lake (Fig 1) at two different depth. The tow rest samples were collected from the well water and Al-Atshan river water. using clean cool in ice box until return to the laboratory refrigerated at 4 °C.

2)Physical –chemical analyses

Field measurement of water were carried out for the parameters pH ,temperature (T °C) and EC (electrical conductivity), which were all measured by electrode (AWTW multi meter) chemical component, (Ca , Mg , Na , K , HCO_3 , Cl and SO_4) were analyzed in the laboratory using standard procedures in APHA (1989)sodium and potassium were determined by flame photometer (JENWAY PEP7).Calcium and magnesium were titrated with 0.01N Na_2EDTA. Chloride was determined volumetrically by titration with 0.01 N $AgNO_3$. Sulfate was determined by spectrophotometer(CEIL CE292) using turbidty method and bicarbonates were determind volumetrically by titration with 0.01N H_2SO_4.

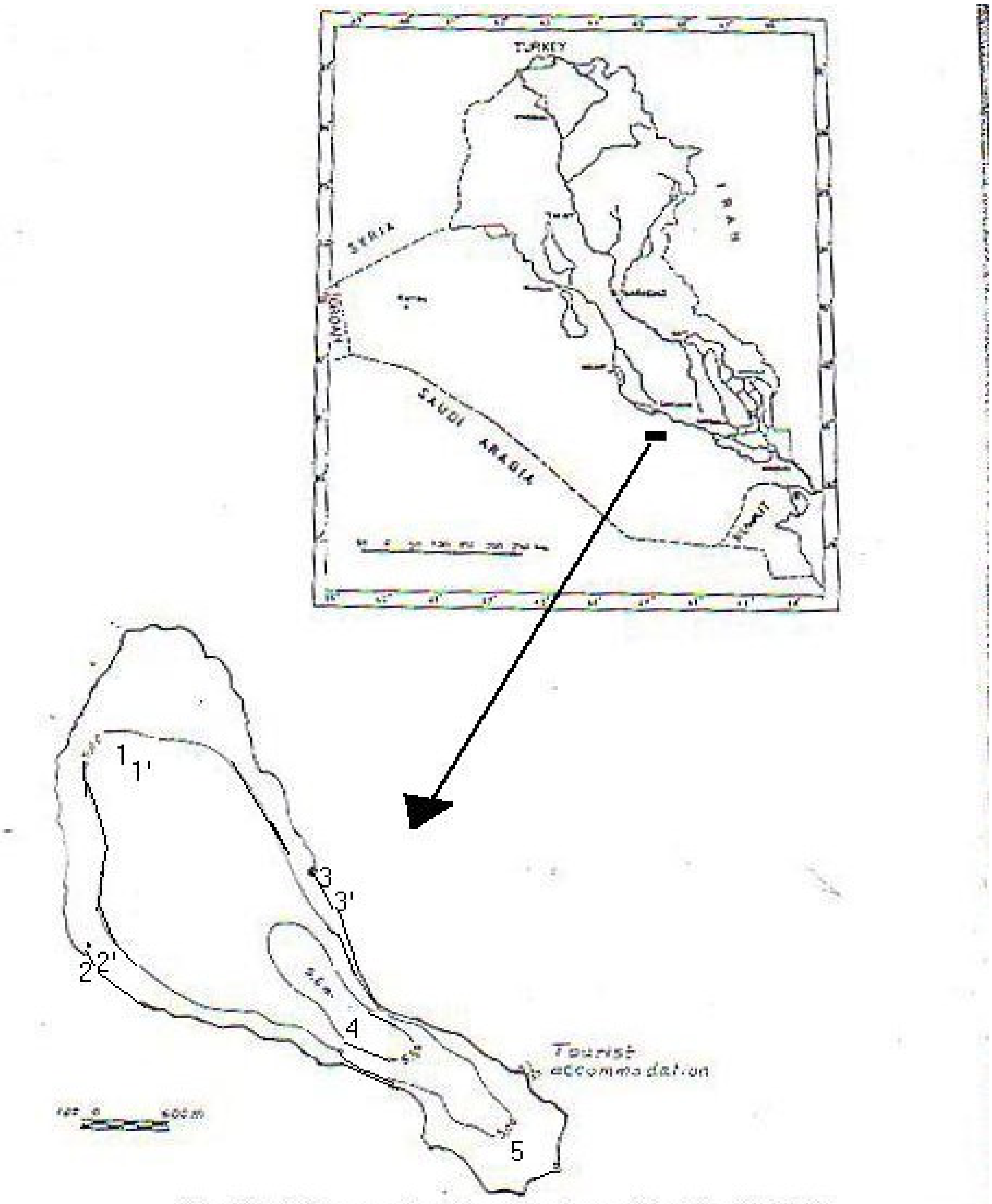

Fig. 1. Study area showing sampling sities (Jamil, 1977)

The accuracy of a water analysis was checked by carrying out a cation –anion balance. The sums of cations and anions were expressed in mill equivalents per liter(meq/l) (Mather,1997).

$$\frac{\sum \text{cations} - \sum \text{anions}}{\sum \text{cations} + \sum \text{anions}} * 100 \quad \% \text{ is within } \pm 5$$

3) Salinity origin tracing

In order to identify the origin of the salinity in the study area, the following ionic relationships were employed. These comprise Mg/Ca this ratio may be useful in differentiate between studying water from limestone and that from dolomite (Hem, 1985), Cl/HCO3 ratio and, the Cationic Exchange Value [CEV ={Cl-(Na+K)}/Cl}] (Pulido-Bosh et al 1999).

The determination of the equilibrium between water and the different solid phases was carried out via calculating the saturation index (SI=log IAP/K_t), using NETPATH code (plummer *et al.*, 1994), with respect to calcite, dolomite, gypsum, aragonite and anhydrite. Where SI the saturation index, IAP the ion activity product and K_t the equilibrium constant of the sample at given temperature. Davies (1962) equation was used in this program to determine the coefficient of activity described by Lindsay (1979).

$$\log \gamma_i = -A Z_i \left(\frac{\mu^{½}}{1-\mu^{½}} \_0.3\mu \right)$$

where A = .509 for water of 25 C

z_i= the valence of ion

γ_i= activity coefficient

μ= ionic strength based on concentration expressed in mole/l (Mi). it is defined as $\mu=1/2\sum MiZi^2$

Result and Discussion

Physical –chemical characteristics

The conductivity value was generally ranged from 18.50-18.85 dS/m in Sawa lake station, 4.85 dS/m in river and 9.72 dS/m in the well (Table 1). In these two leter stations the content of the main ions was lower than that reported in the Sawa lake stations.

Mg constitutes the dominant cation in Sawa lake water (203.84 -269.81 meq/l), whereas, potassium is the lowest at all (6.41-4.27 meq/l).

The dominancy of Mg has been recorded in many saline water in Iraq (Maulood, 1989). Specially in the middle of Euphrates river the water of this river it is vary hard (Al-Marsomi *et al.*, in press). Generally in the

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available water sample much more sodium than potassium which is attributed to the selective removal of potassium from solution by clay minerals (Davis & Dewest,1966).

Further more, the local variation in sodium and potassium concentrations may reflect the effect of a complex of factor via mixing with brines or surface water, evapotranspiration and possibly local recharge (Al-Marsoumi & Al-Mosaeed,1999).

On the other hand, chloride represents the main anion in the examined water, while, bicarbonates has the lowest value of concentration (8.36-10.98 meq/l) in Sawa water due to; its relative charge, the minimum exhausting of the anion by plants and, its high mobility (Al-Marsoumi, personal communication).

Water origin

Based on Pulido-Bosh *et al.*(1999) the Mg/Ca value in Sawa lake water and the well water was found to be less than 5 (T able 2). According to the interpretation of this index, the water in the study zone appears to be of terrytiral origin.

The hydro geochemical index Cl/HCO_3 ranged from 19.56 to 31.13 in Sawa lake water, whereas, the value of this index inland water is between 0.1 to 5 and for sea water from 20 to 50 (Pulido-Bosh *et al.*, 1999) .Thus, the value of Sawa water and well water might be reflect the effect of sea water, nevertheless, other processes (diagenesis) could give the same result in addition to the Interaction between ground water and marine origin sediments of the area (fossil water) (Pulido-Bosh *et al.*, 1999). It is suggested that the Sawa water are survive mixing between fresh and ground.

The CEV for water from the study area given from 0.64 to 0.75 in Sawa water this values close to zero, the CEV for sea water range from +1.2 to + 1.3 whereas low-salt inland water give values of close to zero, either positive or negative (Pulido-Bosh *et al.*, 1999). The increasing in Sawa water salinity was accompanied by a slow rise in ionic exchange, which indicates a cationic exchange that increases the hardness of this water (Pulido-Bosh *et al.,* 1999). These results are in agreement with Sulen's classification(1946), the Sawa water is found to be Mg-chloride (according to A <1), it is of marine origin water in partly close basin whereas the well water is found to be Ca-chloride (A>1), it is marine water in close basing (Table, 2)

To compared this result with data in Fig. (2), show that hydrochemical characteristic of Sawa lake water and those in Euphrates are similar in

(Table 2.): hydrochmical indice Mg/Ca Cl/HCO3, CEV in water samples fromsawa lake, well and river near it.and A={rCl-r(Na+K)}/rMg (Sulin's,1946)

Station No.	Debth(m)	Mg/Ca	Cl/HCO_3	CEV	A*
1	0.3	2.8	19.56	0.64	0.79
1	2.5	2.61	23.27	0.73	0.96
2	0.3	3.24	25.02	0.7	0.9
2	2.7	2.93	24.52	0.69	0.89
3	0.3	2.71	29.42	0.69	0.98
3	2.7	3	28.03	0.75	0.97
4	0.3	2.36	28.03	0.75	1.05
5	0.3	3.38	31.13	0.72	0.92
well	0.3	0.43	13.13	0.81	2.72
river	0.3	1.69	10.28	0.44	0.89

hydrochemical characters. It is seemed to be inland water exchangeable with the marine origin sediments. Chemistry of Sawa lake and Al-Atshan river rather than well related to it or sea water. It worth to be mentionable, that Jamil (1977) observed that the Euphrates aquifer feed the lake with water from a system of joints cracks and fissures.

Saturation index

In order to investigate the thermodynamic control on the water composition, equilibrium speciation calculation were made using NETPATH code development (plummer *et al.*,1994) these calculations provide saturation index (SI) of minerals that may be react in the system .In this program if SI greater than zero the solution is over saturated with the specific mineral, and then, the precipitation is possible, when SI is less than zero,the solution under saturated with this mineral and dissolution continues, and if SI is equal to zero, the mineral could be dissolving or precipitating.

In Sawa lakewater the sample is over saturated with calcite, aragonite, dolomite, gypsum and anhydrite. Well and river water are over saturation with calcite, aragonite and dolomite but they are under saturated with gypsum and anhydrite (Fig. 3). Precipitation of these minerals effected by

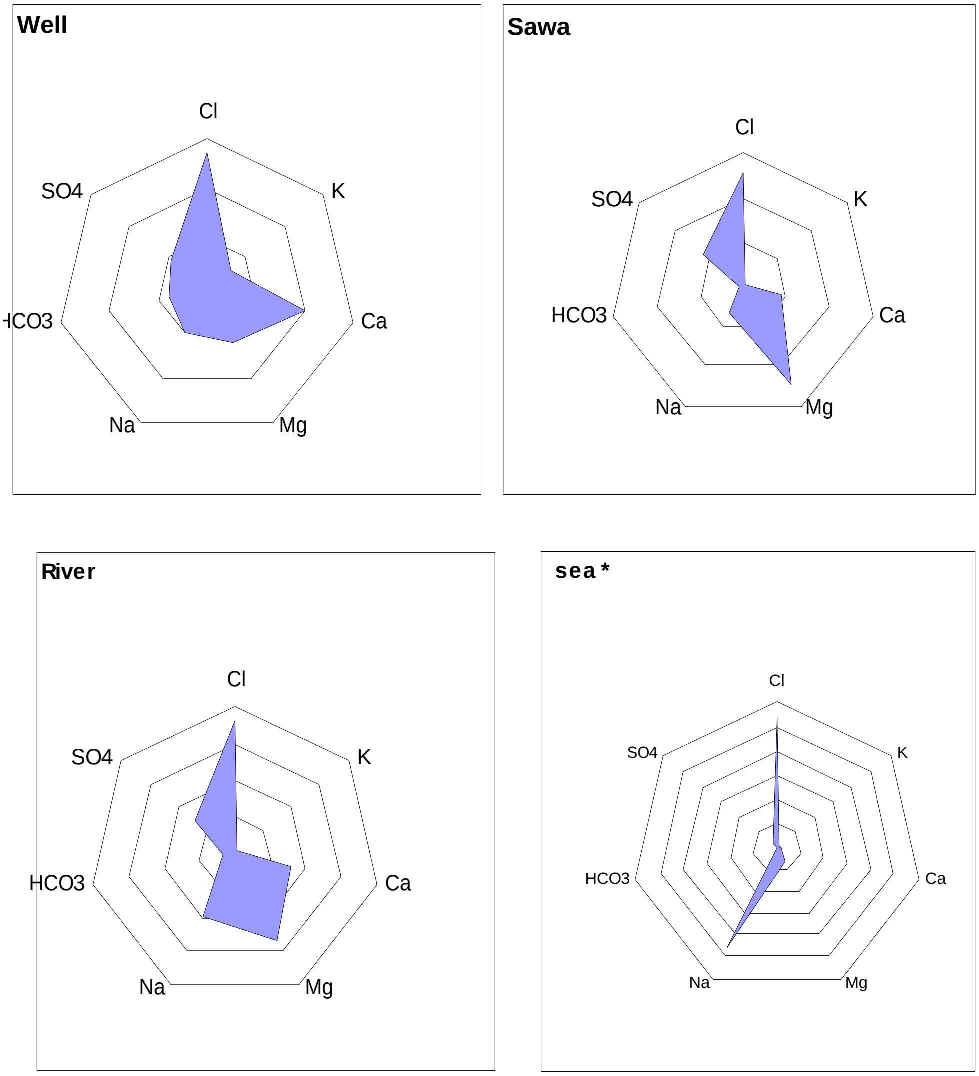

Fig. 2 :A hydrochemical characteristic in Sawa lake, well,river water * and the sea Al-Mussawy (1989)

concentration of Ca (calcite, aragonite, anhydrite), Mg (dolomite), SO_4 (gypsum, anhydrite) and by ionic strength, CO_2 pressure and temperature (Fig. 3). So Sawa lake has high concentration of all these ions in normal CO_2 pressure (Table, 1). These result agree with many previous studies (Broecker *et al*., (2001); De Leeuw, (2002); Al-Kazaeh, (2005) which stated that the sea or river water or groundwater versaturated by the ions of minerals calcite, dolomite aragonite. Ti appears that the saturation state of the groundwater is more sensitive indicator of water–rock interactions than the composition. Broecker *et al*., 2001 and Al-Kazaeh, 2005 suggested that the river water or groundwater which are in contact with calcite mineral become over saturat with calcite or pure calcite.

Decrease in Mg/Ca ratio does not effected in this mineral perspiration (Table 3) even in well or river water. Losta *et al*. (2003) also found same result the suggest that Mg concentration or its ion activity will not effected in calcite and dolomite precipitation or crystalline due to decrease of Mg/Ca ratio. Naqash *et al*. (1977) reveals that Mg/Ca ratio in the lake water is about 1.6 which is favor able for the precipitation of calcite in Lacustrine environment.

Gypsum precipitation was found to be strongly effected by the level of salinity, it's over saturation in Sawa water but under saturated in well and river water, this result agrees with Sheikholeslami & ong (2003) they found that $CaSO_4$ precipitations is effected by different salinity level in mixed salt and by sulfate concentration, they found that the degree of super saturation decreases due to the increasing of the ionic strength of solution and as the sulfate concentration increased the precipitation that occurred.

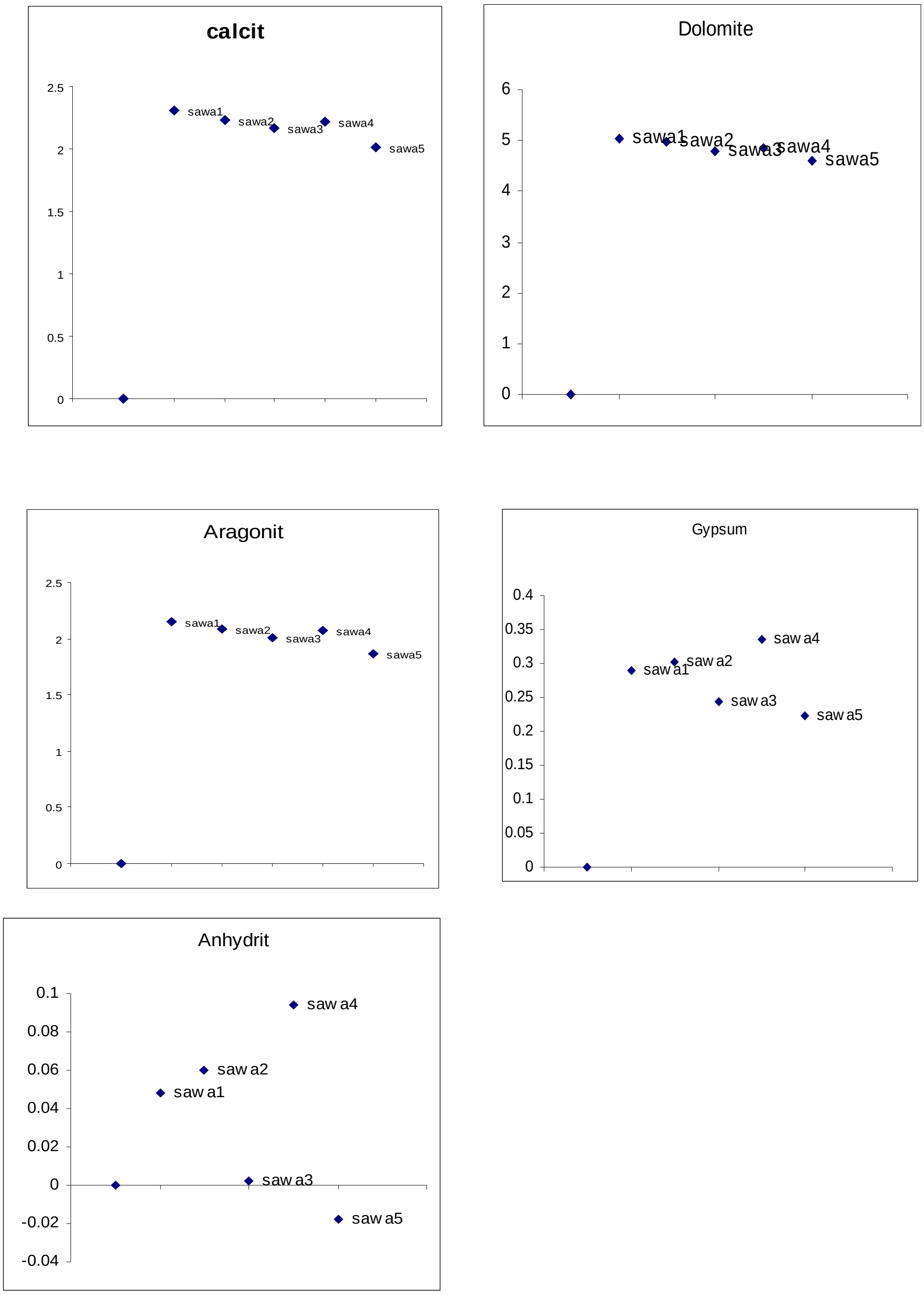

Fig. 3. Distribution of saturation index for calcite, Dolomite, water Aragonit, Anhydrit and Gypsum Anhydrite for selected water samples from the Sawa lake, well and river

(Table 3): hydrochemical indice Mg/Ca, Cl/HCO3 and CEV in water samples from Sawa lake, well and river near it

Dwbth	Mg/ Ca	Cl/ HCO_3	CEV	Calcite	Aragonit	Dolomite	Gypsum	Anhydrit
1	0.3	2.8	19.57	2.30	2.15	5.05	0.29	0.05
1	2.5	2.61	23.27					
2	0.3	3.24	25.03	2.30	2.15	5.05	0.29	0.05
2	2.7	2.93	24.52					
3	0.3	2.71	29.42	2.16	2.01	4.79	0.24	0.00
3	2.7	3	28.03					
4	0.3	2.36	28.03	2.22	2.07	4.85	0.34	0.09
5	0.3	3.38	31.13	2.02	1.87	4.60	0.22	-0.02
Well	0.3	0.43	13.13	1.96	1.81	3.55	-0.25	-0.50
river	0.3	1.69	10.29	1.32	1.17	2.87	-0.32	-0.57

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التركيب الفيزوكيميائي لمياه بحيرة ساوه في مدينة السماوه في العراق

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الخلاصة

درست الخصائص الفيزوكيميائية لمياه بحيرة ساوه والبئر المجاورة لها ومياه نهر العطشان (احد فروع نهر الفرات) من خلال التركيب الأيوني لعينات المياه. كان التركيب الكيميائي لمياه البحيرة من نوع Mg-chloride. أظهرت مياه البحيرة تركيبا هيدروكيميائيا يشابه التركيب الهيدروكيميائي لنهر العطشان أكثر من البئر المجاور لها أو لمياه البحر. يمكن أن تكون مياه البحيرة تحت تأثير عملية الخلط بين المياه العذبة والمياه الجوفية، وليس ثمة شك من إن مياه نهر الفرات تتداخل مع المياه الجوفية التي تجهز البحيرة، كما أنها مياه أرضية تتداخل مع الرواسب البحرية الأصل. كانت مياه البحيرة مشبعة بمعادن الكلسايت والدولومايت والاروكونايت والجبسايت والانهايدريت.

Table1:Concentration of chloride, sulphate, bicarbonate,Na,Mg,Ca,K(meq/l),pH, temperature(T:C) and electrical conductivity (EC:mS/cm) in water samples from Sawa lake ,well ,and ri

Station No.	Debth(m)	T. C°	PH	EC	Cl	SO_4	HCO_3	Na	Mg	Ca	K	correctness
1	0.3	15.2	8.90	18.70	195.64	133.48	10.00	65.63	209.85	74.85	4.27	2.23
1	2.5	14.7	8.90	18.70	255.48	115.15	10.98	69.70	234.52	89.82	0.51	1.67
2	0.3	15.2	8.70	18.85	250.22	107.39	10.00	69.02	203.84	62.87	4.88	-3.81
2	2.7	14.7	8.90	18.85	245.19	128.07	10.00	69.70	251.80	85.83	5.11	3.67
3	0.3	15.0	8.80	18.80	260.38	104.69	8.85	74.43	247.85	91.32	6.14	5.77
3	2.7	14.8	8.90	18.80	280.27	112.71	10.00	65.63	251.88	83.83	5.73	0.51
4	0.3	15.0	8.70	18.69	280.27	112.71	10.00	65.63	263.81	111.78	5.32	5.13
5	0.3	15.1	8.70	18.50	260.24	117.13	8.36	66.99	269.81	79.84	5.93	4.56
well	0.3	14.0	8.30	9.72	105.00	15.84	8.00	19.62	29.94	69.86	0.41	-3.62
river	0.3	15.1	8.00	4.85	71.99	28.73	7.00	39.24	53.96	31.94	0.92	7.84