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OUTSTANDING UNIVERSAL VALUES OF THE SAWA LAKE AS A WORLD NATURAL HERITAGE

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ABSTRACT

This work has been accomplished through a dense field work on the Sawa Lake. The aim of this work is to highlight on characteristics that are consistent with outstanding universal values to be a new Iraqi site belongs to the World Natural Heritage. This study sorted many unique characteristics might ensure that Sawa Lake as a world natural heritage sites. This study shows that the lake had met four natural criteria of the outstanding universal values: (1) the seventh criterion which states to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance. (2) The eighth criterion which stated to be outstanding example representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features. (3) The ninth criterion which stated to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals. (4) The tenth criterion which state to contain most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Key words: Sawa Lake; Natural Heritage; outstanding values; chemical process

INTRODUCTION

The Sawa Lake is a one lake with specific characteristics among Iraqi lakes; it is located about 23 km to the west of Al-Samawah governorate, southern Iraq. It represents an impressive geological site for the Iraqi peoples, because it has unique properties at the local, regional and global levels. UNESCO has been constantly on the search for such sites in order to announcing a World Heritage sites. For this purpose, a specific criteria represents outstanding universal values of the natural and cultural world heritage has been developed to assess such those sites. The list of the World Heritage of UNESCO includes of 1931 monuments and sites that include the cultural and natural heritage of the world consisting of 802 cultural sites and 197 monuments and natural sites and 32 mixed and collectively called World Heritage sites are found in 163 countries (Zimmerli *et al*., 2010). It is interestingly to present specification that are matching the required criteria to be a world natural Heritage site. A ground water provides salt to the lake (Al-Rawi and Al-Hadithi, 1968) that has been formed due to the structural activity in the area (Al- Naqash *et al*., 1977). This study aims to provide convincing evidence of outstanding universal values that characterize Sawa Lake.

MATERIALS AND METHODS

Location, nature of Sawa Lake, geological exposures, and sediments sampling were done through field work during March 2012 to determine the effective sampling sites. Consequently, 20 sites were chosen.

Location and lake nature

The Sawa Lake is located between longitudes (44° 59 29 and 45° 01 46.61) and Latitudes (31° 17 42 and 31° 19 49.8), 23 km to the west of Al-Samawah town (Figure 1). There is no surface water inlet feeding the Sawa Lake and no outlet as well. The source of its water may be groundwater of the Euphrates and Dammam aquifers through system of joints, cracks and fissures (Al-Rawi, 1975). Despite the seasonal fluctuation in the water level, but has an equilibrium state between water feed up and evaporation (Jamil, 1977), so it doesn't dry up completely. It is a land-locked lake with maximum length of 4.74 km and maximum width of 1.77 km isolated by gypsum barrier with total path of 12.5 km surrounding the lake. The lake has an elongated shape with NW-SE trend parallel to the Abu-Jir Fault Zone.

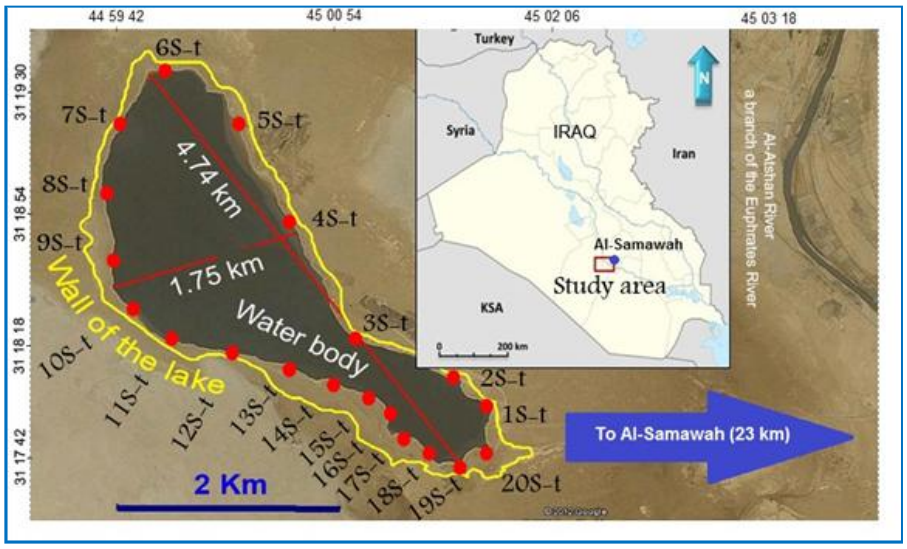

Figure 1: Location, sampling sites and shape of Sawa Lake.

Geology

The geological exposures around Sawa Lake are presented in Figure 2. According to the reports of GEOSURV (1983), the lithostratigraphy in the study area from oldest to youngest was order as: Rus Formation (E. Eocene) which deposited in lagoon environment with thickness of about 82 m (Jassim and Goff, 2006) consisting of anhydrite, marl, and limestone, chalky limestone and dolomite (Buday, 1980). This formation does not crop out in the study area, but it has outcrops along the Saudi-Iraqi border, where called Jil Formation the equivalent of Rus Formation at outcrop where the anhydrite has been dissolved. Dammam Formation (E-L. Eocene) represents a shallow neritic environment overlaying the Rus Formation comprising of karstified limestone, dolomitic limestone, nodules chert with chalky and marly limestone. The study area represents a complex hydrogeological unit within different aquifers extend regionally with hydraulic connection (GEOSURV, 1983). On the top of the stratigraphic succession, the facies unconformably changes to oolitic-chalky limestone containing corals and shell coquinas; it is represented by the Euphrates Formation (E.

Miocene) with thickness of 30-50 m. The study area is covered by the Quaternary Sediments which consist of gypecrete, sabkha, and aeolian deposits (sand sheet and sand dune).

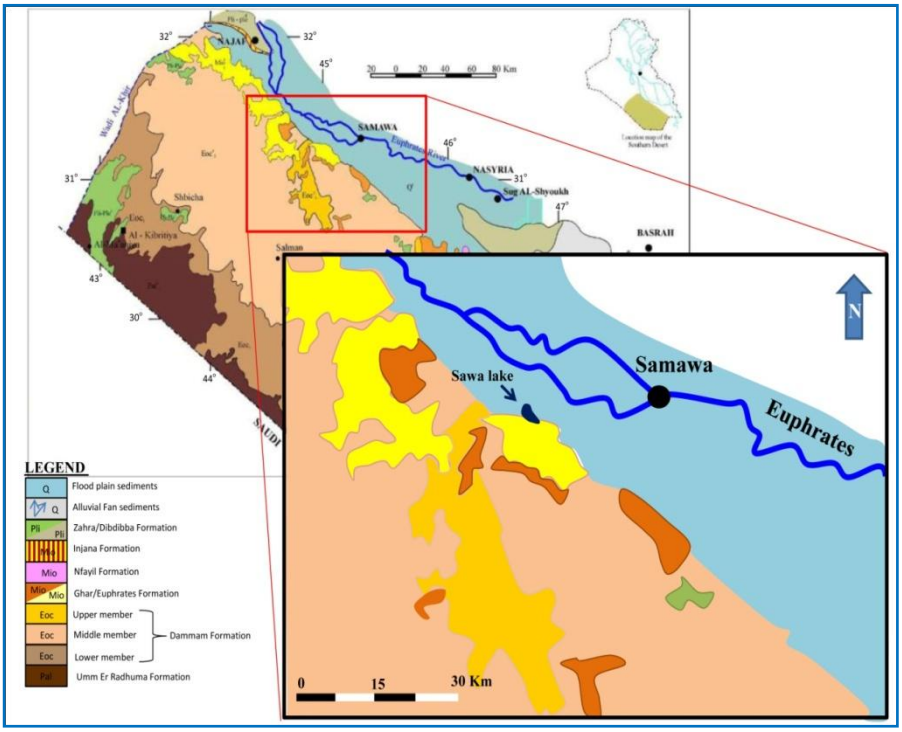

Figure 2: Geological map of the study area and the surrounding areas (After Sissakian, 2000)

Sampling, Analysis and measurements

Different locations along the shore line of Sawa Lake were chosen to be sampling sites. Consequently, a total of 20 sediment samples were collected from these sites (Figure 1). These samples are stored in plastic bags, then transferred to the laboratory for studying. Thin sections were prepared in the workshop of the Department of Geology, College of Science, University of Baghdad. Mineralogical study (polarized microscope, XRD technique and clay mineralogy) was done to determine the mineralogical components. Global Positioning System (GPS) was used to determine the water level in the Sawa Lake, adjacent area, and Euphrates River.

Theoretical background of the world heritage criteria selection

A total of 10 criteria of the world heritage selection; they called criteria of outstanding universal values. For any site to be included on the world heritage list, it must meet at least one of those criteria. Six of those criteria are relevant to the cultural heritage, while the remnant four criteria are specific for natural heritage. According to the UNSCO instructions, Badman *et al*. (2008) mentioned the ten selection criteria (the first six are cultural criteria, but the others are natural criteria). It is preferable to list the natural criteria rather than the cultural criteria as follows:

Outstanding universal values of the Sawa lake

1. The vii criteria: To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
2. The viii criteria: To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.
3. The ix criteria: To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.
4. The x criteria: To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

RESULTS AND DISCUSSION

Age description

Depending on the previous studies, ages of Rus, Dammam and Euphrates Formations were presented on geological time scale. The relative ages were illustrated in Figure 3. The age estimation of the Rus Formation was Early Eocene, meaning of about 56-48 Ma., while the Dammam Formation was younger and estimated as of Middle-Late Eocene (48-34 Ma.). The relative age of the Euphrates Formation was Early Miocene ranging between 23-16 Ma. The Euphrates Formation as well as quaternary sediments were hosted the depression of the Sawa Lake. Consequently, it was believed that age of this lake is younger than the Euphrates. Then, however, it is reasonable to say that the lake is formed after Middle Miocene. Basically, it must be formed after faulted area by the Abu-Jir Fault Zone (AJFZ). The faulting zone crosscuts the Dibdibba Formation in the adjacent areas and it is clear at Najaf and Karbala in the central Iraq. As the Dibdibba Formation belongs to the age of Pliocene-Pleistocene, so the age of Sawa Lake should be post of this age. Pliocene started before 5.3 Ma and ended before 10000 years which marked by Holocene. Accordingly, it is a logic to suggest that the age of the Sawa Lake corresponds to the beginning of the Holocene (10000 years) approximately.

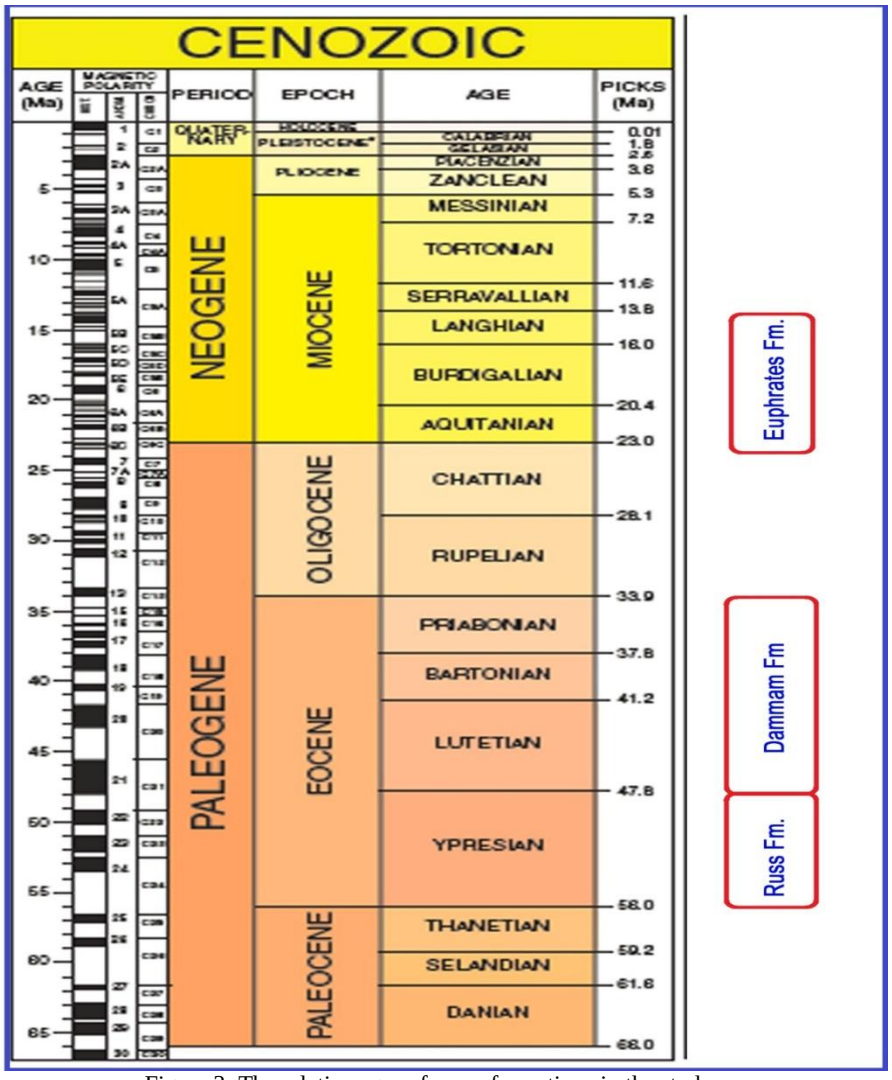

Figure 3: The relative ages of some formations in the study area.

Mineralogy

The evaporate lithofacies is the main mineralogical facies (Awadh and Muslim, 2014) in the lake, where it is represented by gypsum that forms an amount varies between 67.5% and 97.5% with average of 87% from the total lake sediment (Table 1). The water body in the Sawa Lake is considered as a super-saturation solution that mainly contains calcium and sulfates. A direct precipitation from water was the chemical process acting in the lake. It precipitates throughout the lake area, but the chemical precipitation rate at costal line of the lake being more than at deeper areas near the lake center due to the shallow water. Chemical crystallization happened directly depending on the ion concentration and temperature. The common feature of gypsum in the lake is identified as a concentric circles forming a massive balls similar to the Cauliflower flower. The XRD well identified and showed that gypsum is

the main mineral (Figure 4). Gypsum masses sometime contain algae and black spots that are attributed to the organic matter. Because of the high solubility of halite, so it stays dissolved in solution. Consequently, a very little amount of halite (0.3% -2.7% with 3% in average) was detected. Quartz probably has been transported by wind from Quaternary sediments and/or dust storms. The quantity of quartz is restricted between 0.0 -15%, and reaches 4.5% in average. Total clay minerals in the sediments of Sawa Lake ranges between 1.5-19% with average of 5.5%.

Table 1: Mineralogical composition (%) of the Sawa Lake sediments.

Sample number	Gypsum	Halite	Quartz	Clay minerals
	%			
3S-t	97.3	1.2	0.0	1.5
5S-t	77.8	15	0.0	1.0
9S-t	97.5	1.5	0.0	1.0
14S-t	95.3	2.7	0.0	1.5
19S-t	96.5	1.5	0.0	2.0
7S-t	91.7	0.3	4.0	4.0
10S-t	67.5	2.4	11.0	19.0
12S-t	77.1	1.9	11.0	10.0
14S-t	72.3	2.7	15.0	10.0
Range	67.5-97.5	0.3-2.7	0.0-15	1.5-19
Average	87.0	3.0	4.5	5.5

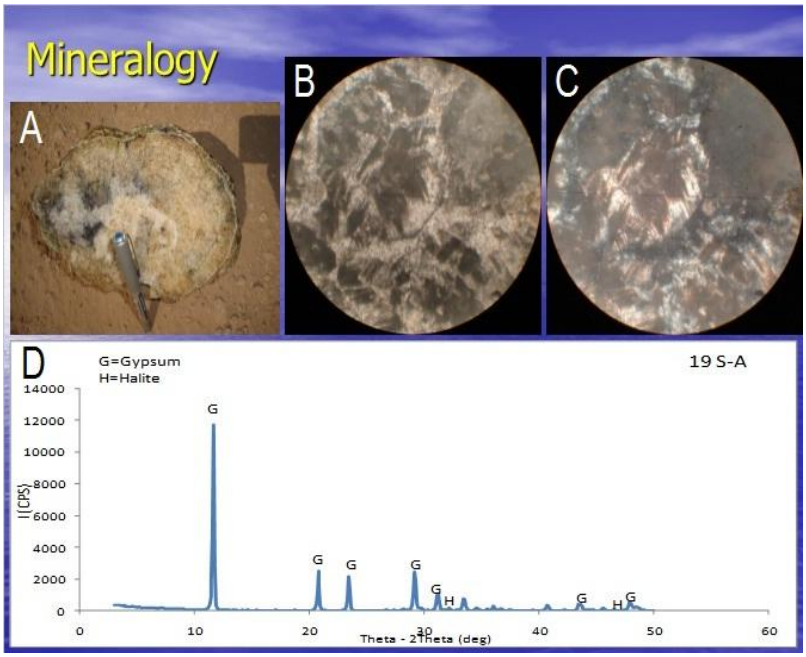

Figure 4: A: Cross section of gypsum mass show the internal structure as concentric circles; sample no. 11S-t; B and C: microphotographs under polarized microscope; D represents XRD diffractogram.

Water level

The water level in the lake is one of the manifestations of the lake, which gives something of aesthetic and strangeness. Strangeness reflected the fact that the water level in the lake is higher than the adjacent land around the lake by 1-4 meters (Figure 5). Add to that, the water level of the lake is also higher than the water level of the Euphrates River by 5-7 meters which flow near the lake to the east side and the Shat Al-Arab and Arabian Gulf by 17-20 m. This means a possibility and ease of emptying the lake and drain its water to the low land. Such a proposal is discussed for the purpose of highlighting the strange manifestations in the lake, but does not recommend for that, so to prevent the natural environment.

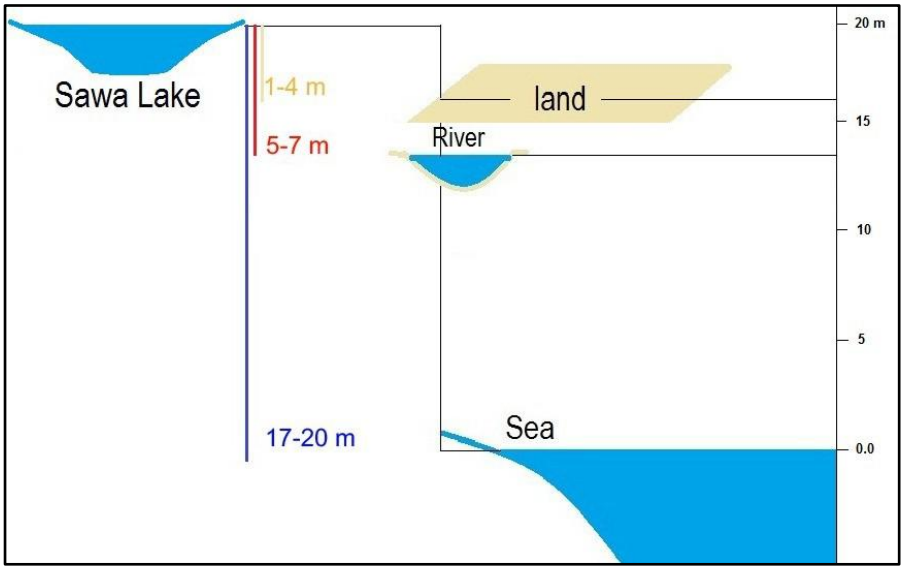

Figure 5: Water level comparison among Sawa Lake, adjacent land, river and sea waters.

Origin of Sawa lake depression

Structural factors along with chemical action together created Sawa Lake. The structural factor is specifically represented by AJFZ extended in direction of NW-SE crosscutting the Samawa lineament extended SW-NE. A weak zone has been created as a respond to the faults intersection. The fault planes formed secondary permeability, allowing deep-water ascension upwards. The rise of water from confine aquifer from site beneath the lake accelerates the speed of water movement, which eventually causes expedite the dissolution rate, especially for layers of gypsum and anhydrite belong to the Russ Formation. The dissolution processes caused eventually a depression that has been formed due to cavities, interconnected fractures and expanding karst in the Russ Formation. A collapse occurred as a response to the gravitational force for the unstable masses. Deep groundwater ascends upwards and mixes with water to less depth; then it reaches the surface filling the depression with water forming the lake body.

The unique characteristics of the lake

It has a superlative natural phenomena of exceptional natural beauty and aesthetic importance. It is a land locked lake in Iraq with no inlet and outlet flow. It doesn't have a clear geometrical shape, but it tends to be pear-like shape with maximum length 4.74 km and

maximum width 1.77 km. Gypsum barrier with total path of 12.5 km surrounds and isolates lake from the adjacent land. Lake is free of mechanical sediments. It feeds by groundwater at different levels via fractures, fissures and joints. The water level in the lake depends regionally on the recharged area, doesn't locally (Awadh and Muslim, 2014). The height of the wall surrounding the lake is about 6 m. The mechanism of the wall construction is closely linked to the process of evaporation of saturated solution with the slow simultaneous feeding from the bottom. The process of building the gypsum wall begins by directly precipitation of gypsum from solution and crystallization on the bottom. It considered as an outstanding natural features and landscapes. Crystallization is active in the shallow sites that represent the boundary of the lake. Gypsum grows with time and rises upward to be higher than the water level; hence capillary process absorbs water upward to the surface of crystallized gypsum nuclei then evaporate under high temperature forming strange shapes of gypsum masses resembling cauliflower (Awadh and Muslim, 2014). Lake derives water from groundwater reservoir sets that are located underneath. Its level fluctuates between summer and winter by 1 to 3 meters approximately. It feeds by groundwater at different levels via fractures, fissures and joints. The water level in the lake is higher than the level of the adjacent land, the Atshan and Euphrates Rivers, where it elevates of about 17 to 20 m above the sea level. To prevent water spillage and overflow, lake has ability to build up a water-hosting barrier formed mainly from gypsum around the water body. The barrier of gypsum which represents the wall of the lake contains caves formed by the dissolution processes. In case of unbalanced masses, caves get collapse causing increase the area of the lake. The mechanism of the wall construction is closely related to geochemical processes which considered as significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features which is a one of the outstanding universal values. The process of building the gypsum wall begins by directly precipitation of gypsum from solution and crystallization on the bottom (Awadh and Muslim, 2014). This process is active in the shallow sites that represent the boundary of the lake. Gypsum grows with time and rises upward to be higher than the water level; hence capillary process absorbs water upward to the surface of crystallized gypsum nuclei then evaporate under high temperature forming strange shapes of gypsum masses resembling cauliflower. The chemical sediments along the coast represent a natural sculpture exhibition. It is beautiful sculptures extend around the lake, especially the southern and eastern coasts which faced the wind. This criteria is of universal outstanding value. The aquatic environment characterized by saline water with average TDS 33500 mg/L, it represents a restricted marine environment in the desert. A similarity to the case of sea water encourages us to call it the Sea of Iraq. In general, mechanical processes is very restricted, except that fine particles derived either from the geological formations or from atmosphere (Hassan, 2007), whilst, chemical processes are active and predominant. Fish and algae are the most importance aquatic organism (Awadh and Muslim, 2014). Fish characterized by soft appearance, small size, they do not exceed 10 cm, and eyes that quickly disappear after the death may be attributed to the water pressure. It classified as *Aphanius dispar* species belongs to genus *Aphanius*, Cyprinodontidatae Family, Cyprinodontiformes Order, Actinoptrygii Class, Chordata Phylum of Animalia Kingdom. This species of fish is unknown in the Iraqi aquatic environments. This study proposes that the fish eggs were transported from the Red Sea or Mediterranean Sea via groundwater, and therefore fish origin is of Sea environment. Consequently, Sawa Lake contains significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species. Fossils of *Pomatiopsis Tryon* which is *Gastropoda* genus lives in brackish water from Oligocene to Recent also was found at the lake bottom. From geological point of view, Sawa Lake recorded a part of the earth history through the continuing chemical dissolution, which are dissolving gypsum and anhydrite from the Russ Formation from depth transporting it to

the water body on the surface; and then using it spontaneously for building its wall under equilibrium state ion concentration, evaporation and precipitation.

CONCLUSIONS

Despite the Sawa lake has a unique characteristics, it also meets the outstanding universal values. This study diagnosed four natural criteria (VII, VIII, IX and X) of outstanding universal values, that help in the selection of the Sawa Lake as an Iraqi sites belongs to the World Natural Heritage. The descriptions of these criteria are summarized below:

1. The Sawa Lake is characterized by natural beauty, in terms of the diversity of appearances, as it has a natural wall of exceptional importance due to containing a lot of geometric shapes such as picturesque blocks of gypsum, along with a lot of small caves that have different beautiful shapes. The gypsum wall embraces the very serene water gives the lake a natural beauty. Natural sculptures formed by geological processes are beautiful and help to bring visitors and tourists. Consequently, the coast of the Sawa lake looks like as a natural landform gallery along with the spectacular view of lake. Hence, Sawa Lake meets the 7th criterion (VII) that requires the availability of superlative natural phenomena of exceptional natural beauty and aesthetic importance.
2. Sawa Lake is an outstanding example representing major stages of earth's history, including significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features. Therefore, it meets the 8th criteria (VIII): It can be considered as an outstanding natural features and landscapes. A self-construction of the gupsuferouse natural barrier that is synchronously building up prevents water overflow formed by dissolution and precipitation processes. These geological processes are considered as geochemical processes (dissolution and precipitation) represents natural mechanisms rarely occur in the world. In case of unbalanced masses, the unstable masses of wall got collapsed causing increase the surface area of the lake. The mechanism of the wall construction is closely related to geochemical processes which considered as a significant on-going geological process in the development of landforms, or significant geomorphic or physiographic features which is a one of the outstanding universal values.
3. The biological activity of algae plays an important role in development the terrestrial and coastal ecosystem. The algae contribute to build gypsferouse barrier after death becomes they have a body-like sponge of high capacity to absorb water. The algae action along with capillary action represents a dynamic balance of the ecological elements. They raise water through the gypsum masses that were precipitated under the effect of ion concentration and atmospheric temperature. This mechanism causes growth of massive gypsum in the shallow water near the lake coast. The harmonic action of algae with the environment participates in a new terrestrial ecosystem. For this reason, the example that representing significant on-going ecological and biological processes in the development of terrestrial, coastal ecosystems and communities of plants and animals is available in Sawa lake.
4. The most importance aquatic organism are fish and algae. Fish belongs to *Aphanius dispar* species, genus *Aphanius*, Cyprinodontidatae Family, Cyprinodontiformes Order, Actinoptrygii Class, Chordata Phylum of Animalia Kingdom is of marine environment and unknown in the Iraqi aquatic environments. Sawa Lake provides a significant natural habitat for in-situ conservation of this type of fish. Fossils of *Pomatiopsis Tryon* which is *Gastropoda* genus lives in brackish water from Oligocene to Recent also was found at the lake bottom. The 10th criteria (X), Sawa Lake provides an outstanding example of the most important and significant natural habitats for in-situ conservation of biological

diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

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المعايير العالمية الاستثنائية لبحيرة ساوة بوصفها تراث طبيعي عالمي

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الخلاصة

تم إنجاز هذا العمل من خلال عمل حقلي كثيف أجري على بحيرة ساوة. الهدف من هذا العمل هو تسليط الضوء على خصائص البحيرة التي تتفق مع المعايير العالمية الاستثنائية لتكون موقعا عراقيا جديدا ينتمي إلى التراث الطبيعي العالمي. فرزت هذه الدراسة العديد من الخصائص الفريدة التي تضمن أن بحيرة ساوة هي موقع تراث طبيعي عالمي. لقد بينت هذه الدراسة ان البحيرة قد لبت أربعة معايير طبيعية من المعايير العالمية الأستثنائية: (1) المعيار السابع الذي ينص على "إأن يحتوي على ظواهر طبيعية خلابة أو مناطق ذات جمال طبيعي استثنائي وأهمية جمالية". (2) المعيار الثامن الذي ينص على "أن تكون مثالا بارزا يمثل المراحل الرئيسية من تاريخ الأرض، بما في ذلك سجل الحياة، وذا أهمية للعمليات الجيولوجية المستمرة في تطوير التضاريس، أو ملامح شكل الأرض". (3) والمعيار التاسع الذي ينص على "أن تكون أمثلة بارزة تمثل أهمية العمليات االبيئية والأحيائية في رقي وتطور الانظمة القارية والمياه العذبة والساحلية والبحرية والمجتمعات النباتية والحيوانية. (4) المعيار العاشر وينص "أن يحتوي على المواطن الطبيعية ذات الأهمية العالمية للحفظ الموقعي للتنوع الأحيائي، بما في ذلك القيمة العالمية الاستثنائية لتلك الأنواع المهددة بالانقراض من وجهة نظر العلم أو الحفظ.

الكلمات الدالة: بحيرة ساوة، التراث الطبيعي، المعايير الاستثنائية، العمليات الكيميائية.