Geology of Salt and Salt Bearing Formations in Iraq

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ABSTRACT

A general outline of Iraqi salt and salt bearing formations is given including their geological distribution, tectonic, sedimentological, geophysical and hydrogeological implications.

The two main salt bearing formations in Iraq include the Middle Miocene sediments in the NE parts reaching 45 meters in thickness and the Upper Jurassic salt bearing sediments in the SE parts reaching a maximum thickness of 350 meters. Out of the 33 known salt locations in Iraq, only ten are actually producing from playa lakes, brines and sea water sources, no rock salt is produced at the present.

Salt geology radiates into many problems of theoretical and applied geology. It is suggested that studying the sedimentary history of salt in the Iraqi basin may contribute to the understanding of the country's oil potential.

INTRODUCTION

Salt deposits are accumulating on every continent and are distributed in two great belts, one in either hemisphere, which lie approximately between the latitudes of 15° and 35° from the equator. Evaporite beds act as an excellent sealing agent to trap oil and the genetic affinity between them and oil is stressed by Borchert and Muir (1964). The importance of salt in Iraq has been emphasized by Sayyab (1970) who suggested that studying the sedimentary history of salt in the Iraqi basin from the Cambrian up to the present may contribute to the understanding of the country's oil potential.

In addition, Dunnington (1968) attributed the disharmonic structural habit of the beds of the NE part of Iraq to salt tectonics rather than to tectonic stresses resulting from crustal shortening.

SOURCES OF SALT IN IRAQ

The main sources of salt in Iraq at the present are playa lakes, brines and sea water. Although rock salt exists in Iraq, it is not exploited at the present time. Table I presents some data on the salt production in Iraq.

A location map (Fig. 1) shows 33 salt occurrences in Iraq it also outlines the three main physiographic provinces. The salt occurrences areas of playa lakes, brines, solar salt, rock salt and a salt dome. Of these, ten are actually producing and are discussed in some detail by Alsinawi and Sadallah (1971) as well as in this paper.

Jezira salt

Boara salt. Five salt springs are the source of the deposit, is 3 cm thick of 91–96% NaCl with an annual production of 4,000 tons in 1968, that can be raised to

TABLE I (*)

Salt Consumption in Iraq		Metric Tons	Year
A: Human Consumption		60,662	
Industrial Consumption		41,204	1970
Animal Consumption		13,916	
	Total	115,782	
Human Consumption		86,330	
Industrial Consumption		147,208	1980 (projected)
Animal Consumption		19,970	
	Total	253,508	
B: Human Salt Consumption in Iraq		**Tons**	**Year**
Hot Areas		48,639	1970
Cold Areas		12,023	
	Total	60,662	
Hot Areas		70,881	1980 (projected)
Cold Areas		15,449	
	Total	86,330	

(*) After Al-Rawi (1970).

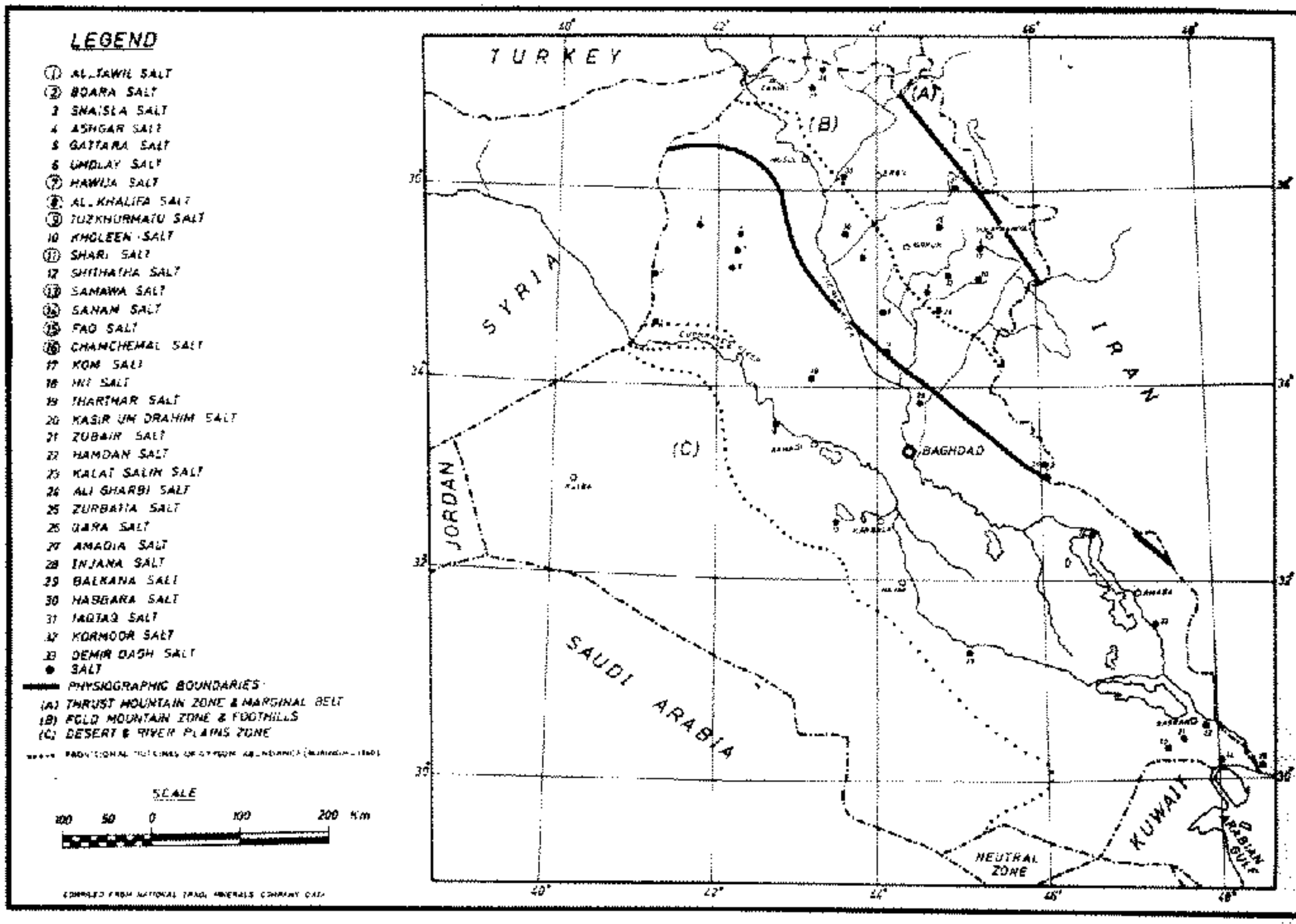

Figure 1. Physiographic map of Iraq, with salt locations (After Alsinawi and Saadallah 1971).

30,000 tons in 1980. The salt reserve is estimated at 1,040,000 cubic meters (Loc. No. 2 in Fig. 1).

Al-Taweel salt. The deposit is located 50 kilometers south of Boara. The salt springs in the valley are the source and produce a layer of salt 2–8 cm thick. Salt reserves are estimated at 1,380,000 cubic meters (No. 1 in Fig. 1).

East Tigris salt

Al-Khalifa salt. The deposit is a salt spring of continuously flowing which stems from the Lower Fars Formation. Salt is collected from a 2 km long and 50 meter wide evaporation pond. It produces 600 tons annually, production is expected to reach 15,000 tons in 1980 (No. 8, Fig. 1).

Chemchamal salt. A salt well that needs pumping in the summer but which flows in winter is the main source. The salt brine is directed to evaporation ponds (No. 16, Fig. 1).

Hawija salt. Salt is collected from an area 2 kms long and one km wide where the salt flows from Jabal Hamrin. The site produces 1,000 tons annually, and this quantity is projected to reach 10,000 tons in the year 1980. The salt has a high content of Na_2SO_4 (No. 7, Fig. 1).

Shari Lake salt. The deposit is in a depression of 20 km long and 4 kms wide which receives salt from salt springs located in Jabal Hamrin. The lake has a salt crust only one cm thick. The salt has high Na_2SO_4 content and chemical analysis suggested a genetic similarity between this salt and that of Hawija and Al-Khalifa (Al-Rawi 1970). The salt annual production is 4,000 tons and is projected to reach 9,000 tons in the year 1980 (No. 7, Fig. 1).

Tuz Khurmato salt. The salt covers an area of 8 square kilometers. Salt wells are pumped and the brine is distributed to evaporation ditches. It is believed that the source of the salt is of Lower Fars Formation where suspected hidden fault reaches the oil reservior of Balkana structure, as suggested from the oil contamination of the brine. Annual production reaches 1,200 tons and production is projected to reach 2,000 tons in the year 1980. The salt has a high NaCl content and shows no genetic relationship with Jabal Hamrin salt (No. 9, Fig. 1).

Southern salt

Samawa salt. The salt covers a 3 km long and a 1.5 km wide depression. Scores of salt springs which are believed to fall along a subsurface fault are the salt source. Salt is found alternating with clay in four main layers each with an average thickness of 8 cm, 9 cm, 11 cm and 12 cm respectively. Salt is produced from dug wells in the upper salt layer at one meter depth where brine is accumulated in a high water table. The salt then is collected after evaporation. The annual salt production is 25,000 tons. This figure is estimated to reach 80,000 tons in the year 1980. The salt reserve is estimated at 4,300,000 tons (No. 13, Fig. 1).

Fao salt. Sea water is collected by scores of channels and flows into storage and evaporation ponds. The annual production is 7,000 tons, and production is projected to reach 80,000 tons in the year 1980. (No. 15, Fig. 1).

Sanam Salt Dome. It is believed by Al-Naqib (1970) that Jabal Sanam, located 55 kms south of Basrah, at an elevation of meters, is formed by salt piercement and attained its present form during the late Tertiary. The National Iraqi Minerals Company is planning to investigate the site by subsurface geophysical methods to estimate the reserve (No. 14, Fig. 1).

A gypsum map of Iraq is also incorporated in Fig. 1 which shows the occurrences of primary gypsum, secondary gypsum and primary gypsum mixed with limestone and gypsiferous alluvium (after Buringh 1960). It is evident that the gypsum occurrences in Iraq coincide with the salt occurrences outlined in the same figure. The correlation between the soil and the underlying evaporite formation and their agricultural implication is evident.

SALT BEARING FORMATIONS IN IRAQ

The salt bearing formations in Iraq can be roughly grouped under bedded salt deposits formed in closed basins in the northern part during the Middle Miocene and piercing salt bodies in the southern part of Iraq during the Upper Jurassic. The sedimentological history of salt beds in southern Iraq differ from the north, it seems that the role of salt in the south is more pronounced where salt constituted the nuclei around which important structures have grown (Sayyab 1970).

A map (Fig. 2) shows salt locations in Iraq and superimposed on these is the area of salt deposits according to Stanley (1969). Isopachs of the Lower Fars, called the Mobile Group by Dunnington (1969) are shown in NE Iraq extending from Iran, and fall mainly in the folded physiographic province (B) of Iraq (Alsinawi and Saadallah 1971).

The Lower Fars Formation of the Middle Miocene is the thickest and most extensive salt deposit reaching about 45 meters in thickness in the Kirkuk structure. The main bulk of Jabal Hamrin North is made up of Lower Fars sediments with a maximum thickness of 440 meters exposed over the Fadhul dome. From Jabal Hamrin South, the Lower Fars exposures are confined to the smaller crestal areas of Injana and Khashim Al Ahmar domes. This variation in the Lower Fars thickness is believed to be due mostly to salt tectonics (Al-Naqib 1960).

The salt ranges in thickness from 350 meters at Nahr Umar to 180 meters in Zubair and 90 meters in Rumaila (Stanley 1969, Owen and Nasr 1958). The Gotnia Anhydrite Formation of the Upper Jurassic age represents the closing evaporite phase and is considered an effective cap rock of Najmah Limestone Formation. In Figure 2, the isopach of the Upper Jurassic outlines the extent of evaporites in southern Iraq. In the extreme south of Iraq, the Gotnia Anhydrite Formation thickness enormously and contains considerable rock salt; it is not known however in the subsurface section north and northwest of Jabal Makhul (Razak and Tomas 1971). The Cambrian salt that exists in Iran is not believed to be present in Iraq (Stanley 1969).

SALT TECTONICS IN IRAQ

Evaporites because of their exceedingly incompetent character flow more readily than any other consolidated sediment due to stress applications or water introduced or produced by geothermal heating (Borchert and Muir 1964). These effects are seen in Iraq where O'Brien (1955) after Dunnington (1968) divided the rock units of NE Iraq on the basis of tectonic behavior into an upper Incompetent (passive) group (comprising the upper units of the Lower Fars Formation) the Upper Fars, the Upper and Lower Bakhtiari Formations; the middle mobile group (embracing the saliferous Lower Fars Formation) and the lower competent group which include the massive Asmari Limestone Formation (or its equivalent Euphrates and Jeribe Limestone Formations equivalent) and all the underlying units down to the top of the Cambrian salt. The NE flanks of the strongly developed Miocene-Pliocene anticlines in NE Iraq show the typical disharmonic habit due to gliding adjustments of the synclinal fill and due to gravitational changes caused by isostatic recovery of the foot hills folds of the Zagros thrust. The initial smaller thickness of the salt beds in Iraq compared to those of Iran, is considered immaterial provided that there was sufficient for tectonic lubrication (Dunnington, 1968).

As is well known the deformation of evaporites favors the development of various types of secondary oil traps. Evaporites and salt domes also provide an important indication of the possible occurrence of oil in a district (Borchert and Muir, 1964). Sayyab and Valek (1968) in reviewing the general properties of the gravity map in Iraq, point out that salt tectonics may be responsible for

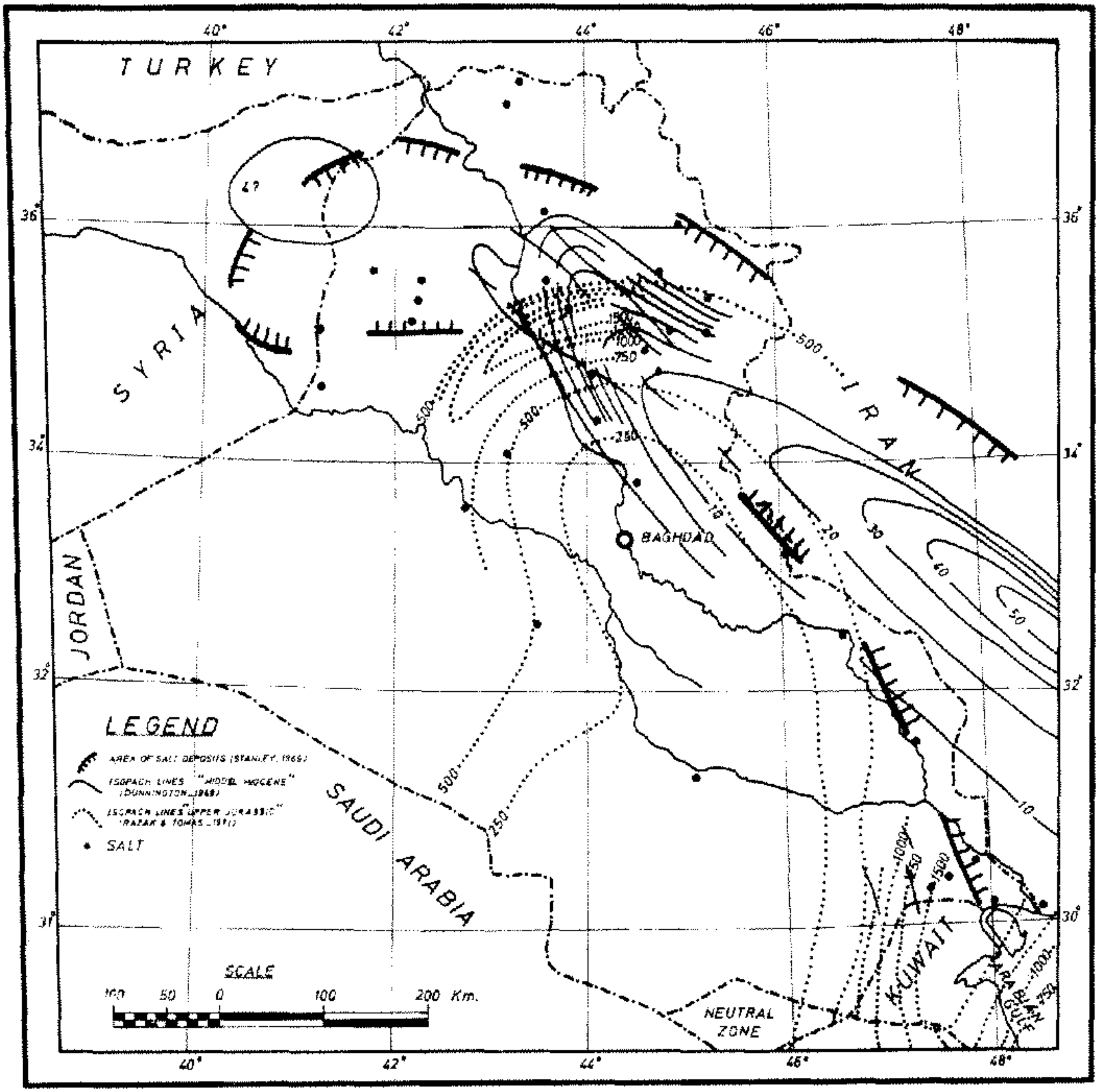

Figure 2. Map of Iraq showing the L. Miocene and U. Jurassic isopachs compared to salt locations (After Alsinawi and Saadallah 1971).

some of the local abnormalities in the gravitational field. This is more exemplified in southern Iraq, where the negative residual anomalies are due to anticlines formed by few hundred meter thick salt beds that formed the diaperic folds with salty cores.

CONCLUSION

It is evident from the general survey that a detailed field study is greatly needed in Iraq before a more comprehensive picture can be developed. The Samawa salt area is especially suitable for geophysical investigation as is Jabal Sanam.

From economic standpoint the authors believe that the exploitation of the present evaporative salt localities should be carried to the maximum before any attempt is made to exploit the rock salt reserve. However the delineation of the salt beds at the present time has its sedimentological and tectonic implications in the process of arriving at a better picture of the geology of Iraq.

A further challenge confronts hydrogeologists in their search for ground water especially in developing methods for detecting different salt bed distribution from water salinity analysis. This problem is coupled with that of relating mineralized springs and their association with hidden subsurface tectonic trends in Iraq.

A thorough subsurface investigation with the help of well logs, seismic and gravity data would definitely result in a much better picture.

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