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FF 1

HYDROGEOLOGY OF THE TRIASSIC AQUIFERS IN EASTERN GEFARA PLAIN (N.W.LIBYA)

by

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INTRODUCTION

The study area covers the eastern part of the Gefara plain in NW Libya (Fig.1). The Gefara plain is a flat area of a triangular shape, bounded on the south by Nafusa mountain and on the north by the Mediterranean sea. The ground elevation at the foot of the mountain is around 300 m and gently sloping towards the coast. The plain is dissected by a number of wadis with considerable runoff during the winter season. The Gefara plain plays a major role in the Libyan economy as it contains almost half of the country's population and produces most of the national agricultural output.

The average annual rainfall in the Gefara ranges from 100 to 350 mm and occurs mainly from October to March.

GEOLOGY

The Gefara plain is transversed by 3 major faults in the east-west direction along with a number of smaller faults in the NW-SE and NE-SW direction (Fig.1). Displacement of more than 100 m are normally observed.

Table 1 shows the general stratigraphy of the Mesozoic and Cenozoic formations in the study area.

The Triassic formations which are of interest in this study are the Azizia and Abu Shaybah. The Azizia formation of Middle-Upper Triassic (ladinian-carnian), is made of dolomitic limestone with chert and sandstone intercalations. It outcrops over large areas south of the Azizia fault. North of the fault, it dips deeply towards the Mediterranean to a depth of about 900 m near the coast. The thickness of the Azizia formation varies from few meters to over 500 m.

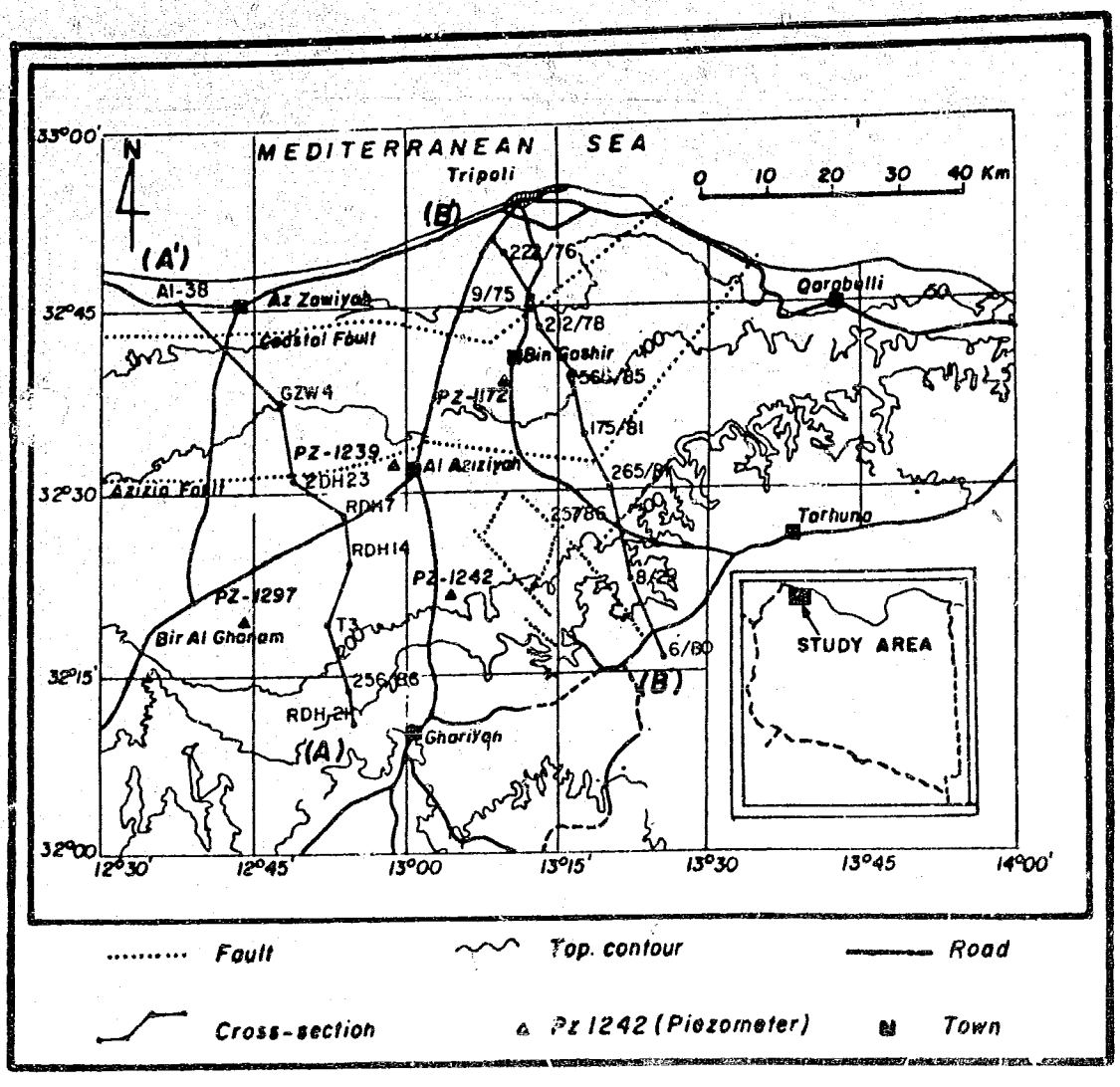

Fig.1 - Location map of the Gefara plain

The Abu Shaybah formation of Upper Triassic (carnian) overlies the Azizia and outcrops only in small areas at the foot of Nafusa mountains. It consists of alternating sandstone and clay beds with minor calcareous intercalations. The thickness of the Abu Shaybah ranges from 25 to 350 m.

In the southern part, it is overlain unconformally by the Sidi-asSid formation of Upper Cretaceous, while in the central and northern parts it is overlain by Tertiary and Quaternary sediments.

Fig. 2 shows two geological cross-sections constructed on the basis of gathered data from exploratory and production water wells.

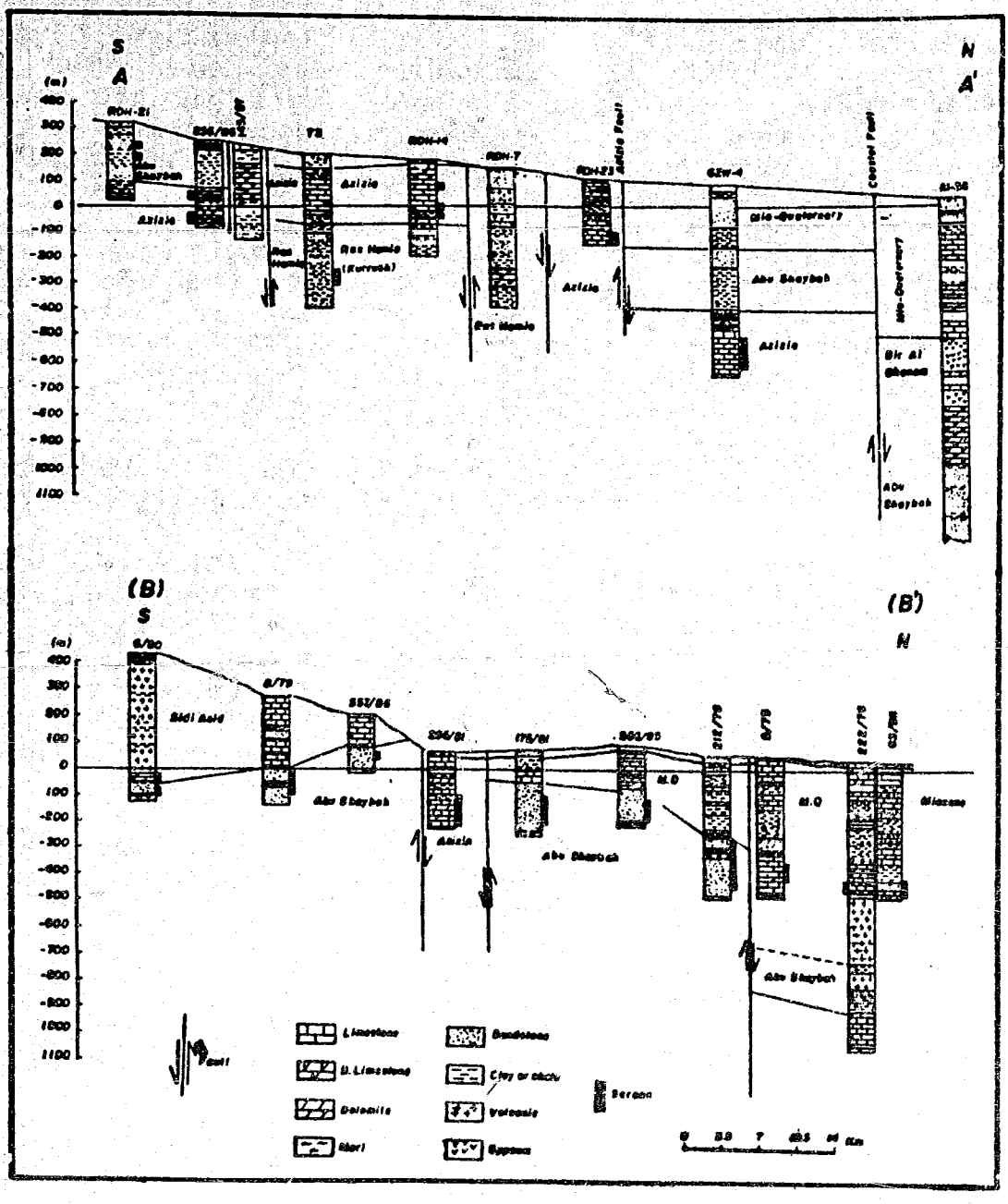

Fig. 2 - Geological cross-sections

HYDROGEOLOGY

North of Azizia fault, the Abu Shaybah aquifer is confined with an average transmissivity of 430 m^2/day and a storage coefficient in the order of 10^{-4}. South of the fault,

however, the aquifer is unconfined with low transmissivity due to reduced thickness and dominating clay beds. TDS of Abu Shaybah water ranges from about 1000mg/l in the south to 2000mg/l in the north. Higher salinities in excess of 2000mg/l are observed near the coast with remarkably high sulfates and iron content.

The Azizia aquifer on the other hand is of varying hydraulic properties. It is exploited in the south central part of the Gefara plain, i.e., south of the Azizia fault. Here, transmissivity ranges from 1700 to 4300m²/day, and storativity from 0.01 to 0.05 with TDS normally less than 2000mg/l.

North of the Azizia fault, the aquifer becomes less important due to higher depth, increasing salinity and reduced hydraulic properties.

All over the study area, the Azizia aquifer is underlain by Ras Hamina (Kurrush) aquifer. The latter is of little importance due to poor hydraulic properties and high salinity.

Both Azizia and Abu Shaybah aquifers are receiving current recharge either directly at exposed areas or indirectly by vertical and lateral flows.

Table 2 gives examples of chemical analyses of the Triassic aquifer waters, while Fig.3 shows water level decline in few representative observation wells in the study area.

Table 1 - Stratigraphic divisions.

Period	Epoch	Age	Formation	Lithology	Thickness (m)
Quaternary	Holocene		Eolian, Fluvial Sabkha Sed	Sand, Silt Clay	5 - 50
	Pleistocene		Gargaresh Gefara Qasr al Haj	Calcarenite Sand, Silt Gravel	
	Plio - Qual		Volcanic rocks	Basalt flows	25 - 250
Cretaceous Tertiary	Upper Middle Lower		Undifferentiated	Sandstone Limestone Calcarenite Clay	10 - 400
Cretaceous	Upper	Cenomanian	Sidi as Sid	Marl, dolomite Limestone	60 - 350
Jurassic	Middle	Bathonian	Bir al Ghanam	Gypsum Anhydrite, Limestone	45 - 750
Triassic	Upper	Rhaetian			
		Carnian	Abu Shaybah	Sandstone Clay	25 - 350
			Azizia	Limestone Dolomite	25 - 550
	Middle	Ladinian	Kurrush	Clay Sandstone	350 - [illegible]

Table 2 - Water quality.

Well No	Aquifer	(Mg./l) TDS	Ca	Mg	Na	K	HCO_3	SO_4	Cl
431/87	Azizia	1593	204	75	188	9	273	582	280
146/87	"	1959	158	97	360	67	607	484	475
220/86	"	2039	224	107	260	-	413	537	469
263/81	"	1800	241	111	190	20	215	272	336
36/85	"	1734	148	109	260	12	456	381	443
6/78	"	1780	255	95	296	14	486	471	379
6/78	Abu Shaybah	1060	102	82	145	5	415	268	188
66/85	"	1862	216	98	248	10	543	525	326
337/86	"	1416	208	115	246	11	543	567	334
16/86	"	1877	180	130	220	3	359	505	624
60/80	"	2905	276	101	450	44	445	820	852
221/76	"	1328	142	74	174	33	391	387	293
172/78	"	1258	148	68	156	7	175	326	302
PWH-8	"	1938	209	90	281	7	259	755	810
1830-3-552	Ras Hamia	3330	163	68	862	112	206	835	1027
145/87	"	2354	213	169	840	210	186	527	853

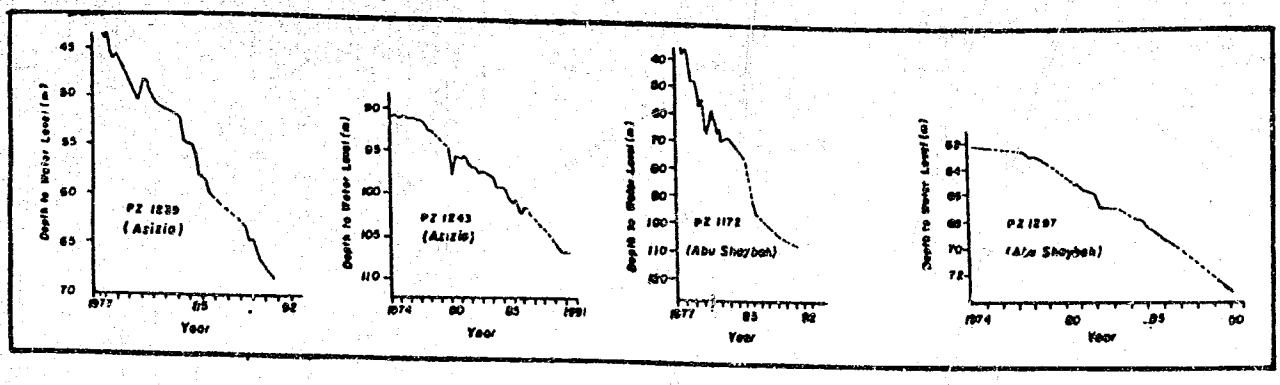

Fig. 3 - Water level decline

EFFECT OF DISCONTINUITY ON AQUIFER EXPLOITATION

The Triassic aquifers in the Gefara plain, are discontinuous as a result of the numerous faulting in the area. Changes in the hydraulic properties as well as in the salinity are commonly encountered at relatively short distances on both sides of faults and in particular near the Azizia fault. Location of production wells may become a difficult task due to sudden vertical displacements in excess of 100 m, leading to low yield or dry boreholes.

In absence of detailed geological and structural maps along with geophysical surveys, a proper understanding of the behaviour of both aquifers will continue to be a difficult problem facing hydrogeologists.

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