



## STATUS STUDY OF ABU SHAYBAH AQUIFER IN THE MIDDLE PART OF THE JIFARAH PLAIN, LIBYA

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### ABSTRACT

*The study area is part of the Jefarah Plain located in the north western part of Libya. It is one of the most important agricultural areas in Libya. This is because of the properties and quality of its soil and the location of experienced people in agriculture. A considerable growth of population due to agricultural and industrial activities in the area causing high water demand which depend mainly on the groundwater resources.*

*The water resource mostly from Abu Shaybah Aquifer in the study area, this aquifer is very important in the area and it is still under exploitation by wells supply water for agriculture and domestic, its depth varies from 300 to 700m with a thickness of 35 to 300 m. The production wells penetrating this aquifer are pumped with a ranging rate of 30 to 130 m<sup>3</sup>/h. Depth to water level varies from 10 to 145m depending on the topography of the area. The transmissivity of the aquifer ranges from 200 to 2850 m<sup>2</sup>/day The water quality is good where the total dissolved solids does not exceed 2000mg/l.*

### **INTRODUCTION:**

The study area is located within Jefarah plain in the north The water resources for agriculture, domestic and industry is groundwater bumped -western part of Libya. The plain is bordered from the north by the Mediterranean sea, on the south and the east by Jabal Nafusah escarpment, and on the west by the Tunisian Border (figure 1). The area is located between longitude 13° 00' , 13° 30' East and latitude 32° 30' , 32° 55' North .The important cities and towns in the study area are Bin Ghashir, Sidi Al Said and Sawani.

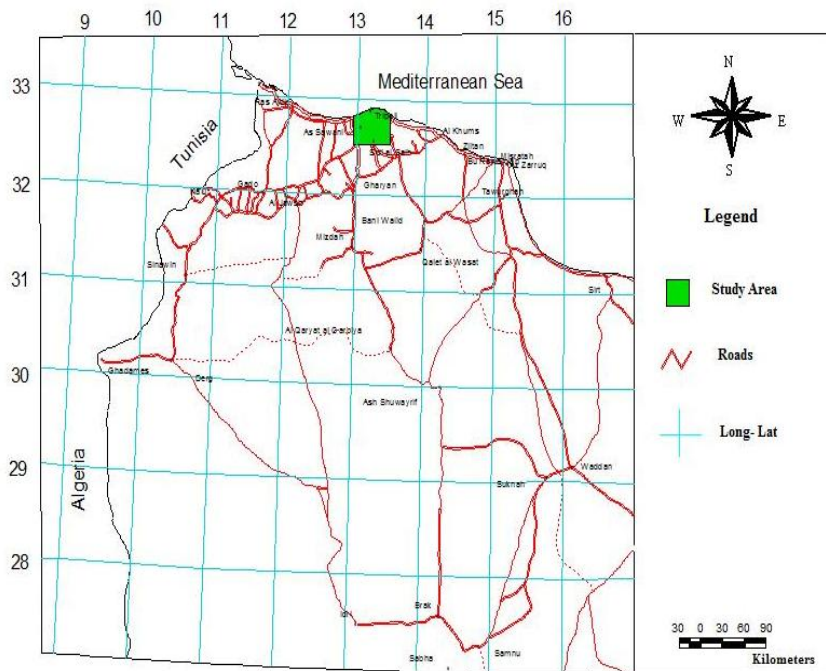


Figure 1 : Map of the study area.

The water resources for agriculture, domestic and industry is groundwater pumped using shallow and deep water wells. The shallow wells are tapping the unconfined aquifer of Quaternary and Miocene deposits and the deep wells are tapping the confined aquifer of Abu Shaybah and Al Aziziah Formations. The shallow aquifers are mostly depleted in the southern part of the area and polluted by sea water intrusion in the northern part. The Abu Shaybah aquifer is the promising aquifer extends under the whole area with total dissolved solids (TDS) of less than 2000 mg/l and good hydraulic properties. While the deep aquifer of Al Aziziah is of low quality water (TDS) exceeds 3000 mg/l.

This study is aimed to study aquatic status of Abu Shaybah aquifer in the study area using the available information .

The climate of the study area is classified as Mediterranean to semi-arid having hot dry summer and cold rainy winter with high variation in seasonal and diurnal temperatures. The maximum temperature recorded during the period from June to September ranging from 29 to 49° c, and the minimum temperature recorded during the period from December to March ranging from 1 to 15° c .

The average annual evaporation rates varies from 1200 to 2100 mm in the coastal area and from 1500 to 2500 mm in the southern areas. Jafarah plain receives rainfall mainly from October to March . Its amount varies from an average of 350mm/ year in Tripoli to less than 200 mm/year in the south west of the area. The average annual surface runoff is estimated to

be 87.6 M m<sup>3</sup>/year which represents about 5.2% of the total rainfall. It is estimated that the ground water aquifers in the Jefarah plain are annually recharged by 200 M m<sup>3</sup> from rainfall and surface run off.

### MORPHOLOGY AND GEOLOGICAL SETTING :

The topography of the area declines from about 100m in the south to the north where the coastal line extends from the sea to a distance varies from 20 to 35 Km to the South, which is covered by the deposits of the Quaternary represented by the Ghargarish Formation, Jefarah Formation and sand dunes with silt and gravel deposits, sometimes limestone deposits where all belong to the Quaternary . in addition several valley deposits which cross the area from south to north . Most important wadi is wadi Mageneen which extends to the sea in the north. In addition to this is the existence of limestone and dolomitic of Middle Triassic (Al Aziziyah Formation) on the surface in Al Aziziyah area south of the study area. Figure (2) showing the topographic map of the study area.

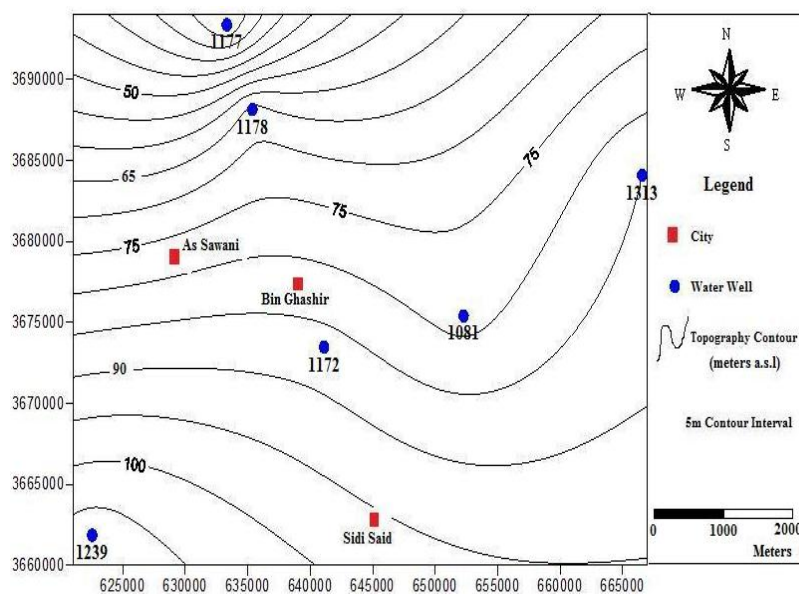


Figure 2 : Topographic map of the study area.

### GEOLOGICAL SEQUENCE:

The following is a summary of the main geological formations that are present in the study area, starting from the oldest formations. Figure (3) shows geological sequence in the study area. This sequence is described as:

**1. Aziziyah Formation :** The Aziziyah Formation of the Middle Triassic age underlies the Abu Shaybah formation and overlies the Kurrush Formation in the stratigraphic

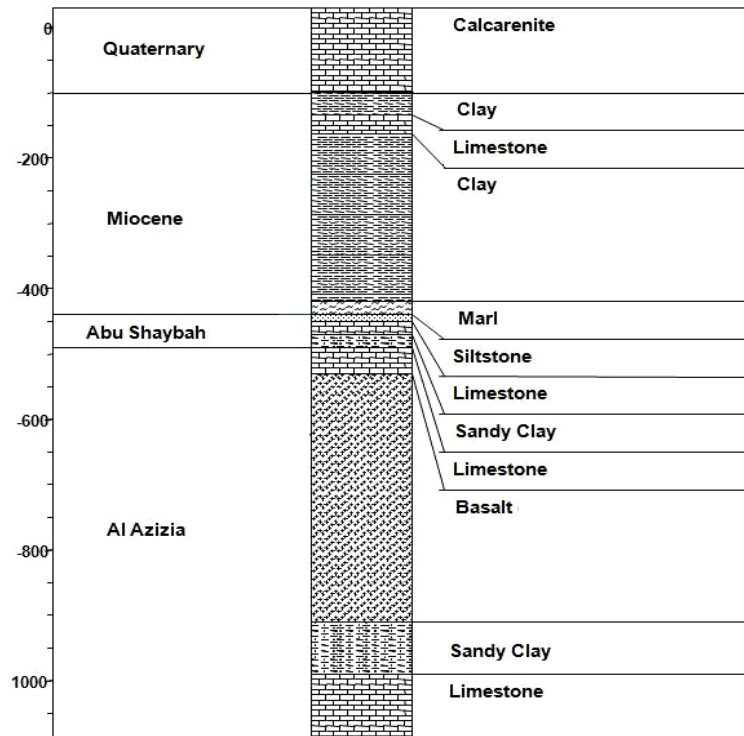


Figure 3 : Geological Sequences found in the deep drilled water wells.

conformity in this area . It is well developed at Al Aziziyah area. It consists of massive beds of dolomite and dolomitic limestone, light grey or beige in colour. The increase in thickness from 390 m southwest of suq Al Khamis and Sidi Said area to 500 m southeast of (Abyar As Sababil) at the northern part of the study area.

Al Aziziyah Formation outcrops regularly southern of the fault dipping to a great depth (about 900m in the coastal area), the depth of the wells which penetrates this formation varies from 600 m to 700 m (b.g.l) and this formation has been utilized in the southern part of the study area.

**2. Abu Shaybah Formation :** The Abu Shaybah Formation of Upper Triassic age overlies the Aziziyah Formation, and consists of thick layers of sandstone red to brown in colour . soft to rough granules and interbedded with red and green clay . Abu Shaybah Formation located under the Miocene Formation in the areas of central and east Jefarah plain. At depth ranged between 400 to 600m. In the eastern central Jefarah the clayey series are overlain by a thick sandstone bed up 370 m, and the lower part is dominantly clayey. The

formation extends below the whole study area and represent the main deep ground water aquifer in this area.

**3. Miocene Deposits :** It forms in some area from thick layers of argil overtopped with a sequence of limestone, dolomitic limestone, and sandy limestone to form what called Lower Miocene.

The Lower Miocene overlain by layers of clay which separate the Middle Miocene that formed from layers of sandy limestone. The Miocene deposits are characterized by a change in the geologic facies. For example, in Al Aziziyah area, the deposits are constituted from sandy claystone with lenses of anhydrite at different depths. However in Tripoli area the Middle Miocene constitute of thick sequences of green or blue clay with lenses of limestone, and maximum thickness is about 100m.

**4. Quaternary Deposits :** It consists of a surface deposits includes the sand dunes, valley sediments coastal sands, silt and conglomerate with crusts of gypsum and it is subdivided into the following formations.

**4.1 Gargaresh Formation :** Forms the coastal foot, and it is a detrital limestone (calcarenite) with lenses of silt. This formation is characterized by a cross bedding and it is utilized as building stones.

**4.2 Jefarah Formation :** Covers most areas of coastal strip in the northern and central part of Jefarah plain. It is formed of a sandy deposits and silt with different levels of caliche, also forms of some wind deposits of sand and silt.

## **GROUNDWATER RESOURCES:**

The groundwater system in the area can be represented by the two main aquifer on the regional scale while it may be subdivided into more than three aquifers locally separate by clay bed exists locally. Figure (4) shows the location of the hydrogeological cross-sections in the study area. Figures (5,6 and 7) show the regional configuration of the groundwater aquifers.

**1. Quaternary Aquifer :** It is an unconfined aquifer at depths ranging from 30 to 160 m below ground surface. This aquifer rests on impermeable beds of blue plastic clays of middle Miocene. It consists of sandstone and sandy limestone intercalated with limestone, clay, silt and marl. Its saturated thickness varies from 10 m to 90 m . The depth to water level

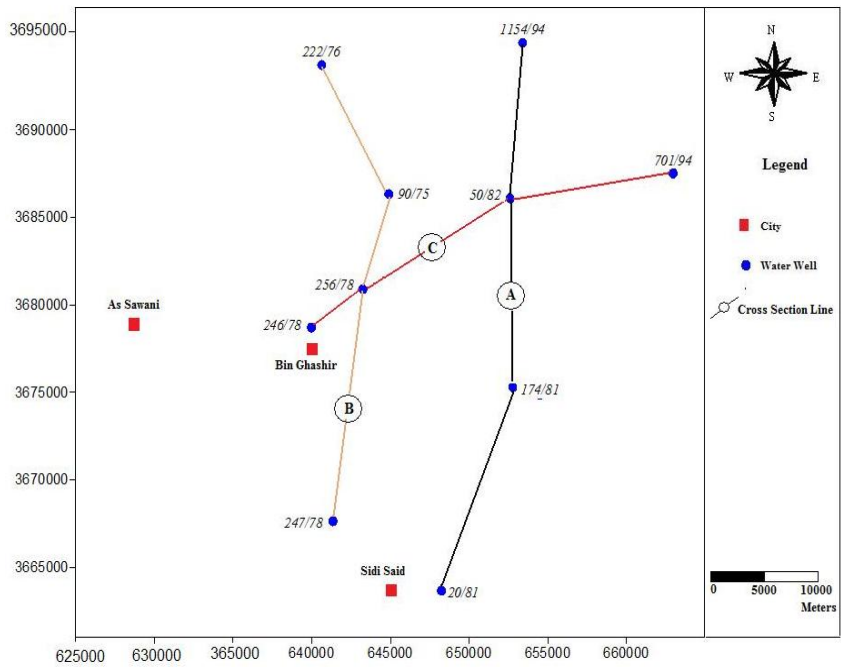


Figure 4 : Location of the geological cross sections.

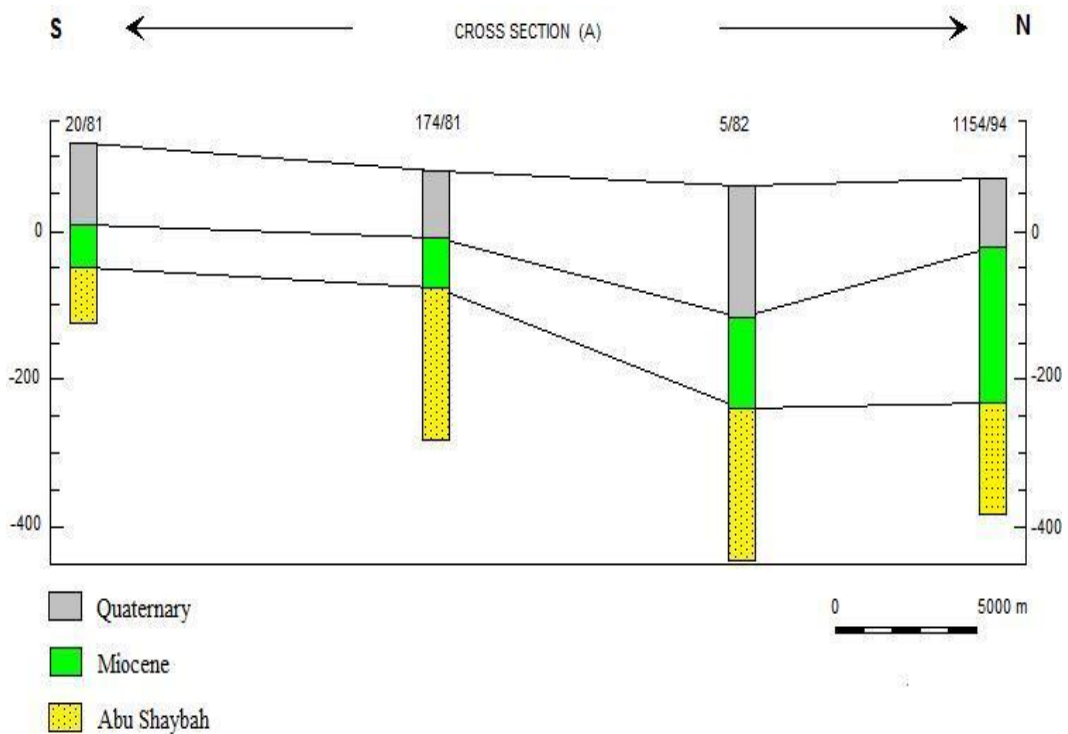


Figure 5 : Hydrogeological cross section (A).

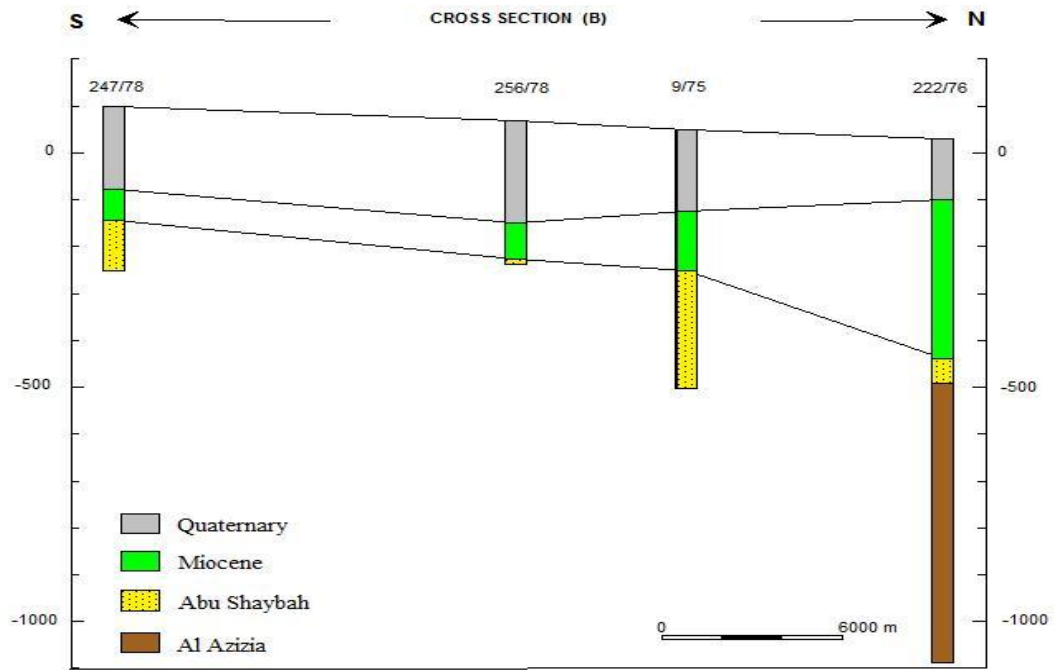


Figure 6 : Hydrogeological cross section (B).

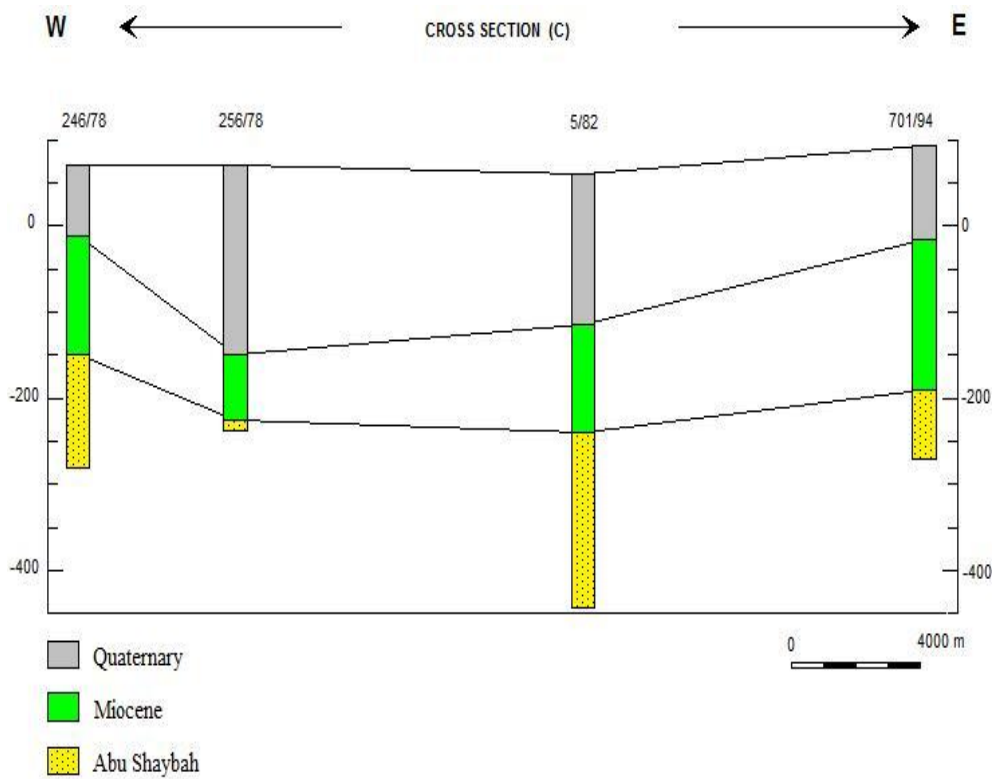


Figure 7 : Hydrogeological cross section (C).

lies between 10 to 80 m below ground surface. The wells penetrating the Quaternary Aquifer yield from 20 to 80 m<sup>3</sup>/h .The aquifers transmissivity is in the order of 104 to 8640 m<sup>2</sup>/day. The specific yield is 6 to 10% . The water quality is generally good and its total dissolved solids does not exceed 1000 mg/l. The quality deteriorates continuously with time due to sea water intrusion along the coastal belt and the availability of this aquifer as dependable resource of water is very limited now a days due to high water level decline causing drying of this aquifer in the southern parts of area.

**2. Miocene Aquifer :** The Miocene Aquifer is composed of intercalation of limestone, sandy limestone, dolomitic limestone, sandstone and clay forming a confined aquifer underlying the Quaternary deposits in the north of Al Aziziyah. It consists of both Middle and Lower Miocene deposits. The Middle Miocene is well developed in the western part of the Jefarah plain. Its penetrated at depths varying from 70 to 175 m the aquifer's.

The transmissivity of this aquifer is in the range of 43.2 m<sup>2</sup>/day the Storage Coefficient is  $7 \times 10^{-3}$  and total dissolved solids of 3000 to 4000 mg/l.

The Lower Miocene found at greater depths varying from 250 to 500 m with a transmissivity in the range of 43 m<sup>2</sup>/day, the Storage Coefficient of  $1 \times 10^{-4}$  and total dissolved solids concentration (TDS) of 3000 to 4000 mg/l. The Miocene aquifer is mostly depleted in most of the area and its water quality is deteriorated.

**3. Abu Shaybah Aquifer :** Abu Shaybah aquifer outcrops in areas along the foot of Jabal Nafusah escarpment in southern part of Jefara plain. It consists of thick layers of sand and sandstone intercalated with shale, clay, and silt over lies Al Aziziyah Aquifer in the central and eastern part of the Jefarah plain. It is a confined aquifer, its depth varies from 300 to 700m with a thickness of 35 to 300 m. Figure (8) shows the thickness of the Abu Shaybah aquifer.

The production wells penetrating this aquifer are pumped with a ranging rate of 30 to 130 m<sup>3</sup>/h. Depth to water level varies from 10 to 145m depending on the topography. The water quality does not exceed 2000 mg/l.

This aquifer is the target of the high groundwater development in the area after the depletion of the Quaternary Aquifer, causing high water level decline in the last few years.



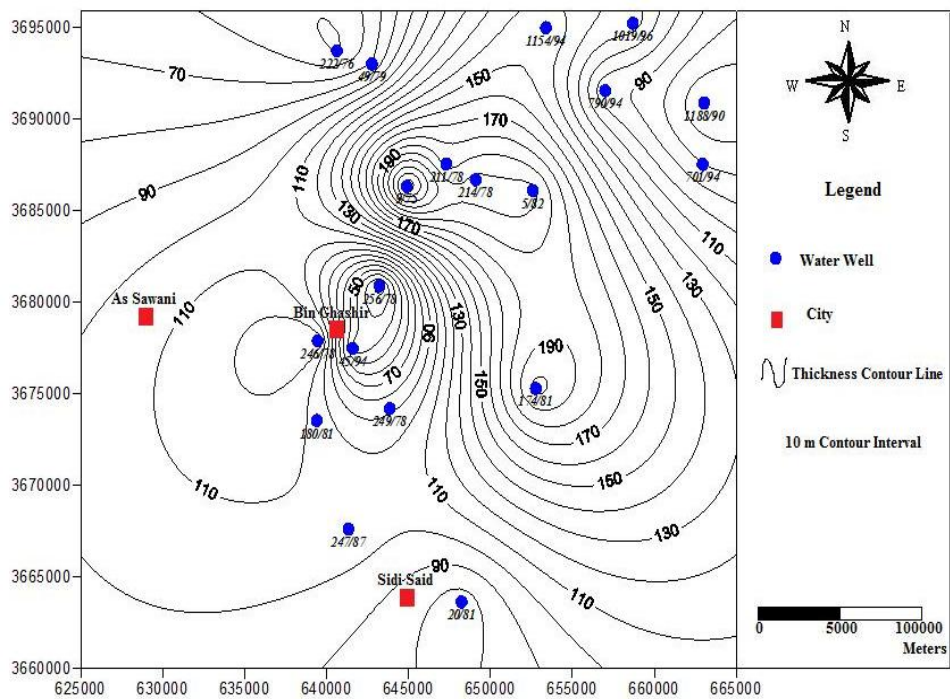


Figure 8 : Thickness contour map of Abu Shaybah aquifer.

4. **Al Aziziyah Aquifer** : Al Aziziyah aquifer is the deepest groundwater aquifer known in this area. Its thickness varies between 150 to 350 m. It is composed of highly fractured dolomitic limestone intercalated with limestone, dolomite, marl and clay. It slopes towards the north where it reaches a depth of about 900m near the coast with a TDS of more t

**THE HYDROGEOLOGICAL SITUATION OF ABU SHAYBAH AQUIFER:**

The aquifer extends under the whole are with a thickness reaching 300 m in the northern part of the study area. The water quality of the aquifer is considered fairly good of total dissolved solids of less than 2000 gm/l.

The aquifer has been utilized mostly for drinking water for Tripoli city water supply since 1980’s to 1996 (the date of supplying the city by the water from Man Made River). Another important exploitation of this aquifer is for agriculture mostly in Al- Garabolly Agriculture project and private farms in Bin Ghashir and As Sawani.

The aquifer in the study area can be represented by semi-confined to confined aquifer and the groundwater is under artesian pressure flowing from south to north, figure(9). Prior to1980 the aquifer in the study area was utilized in a very limited scale due to its depth and the availability of water for agriculture use from the upper Quaternary and Miocene aquifers.

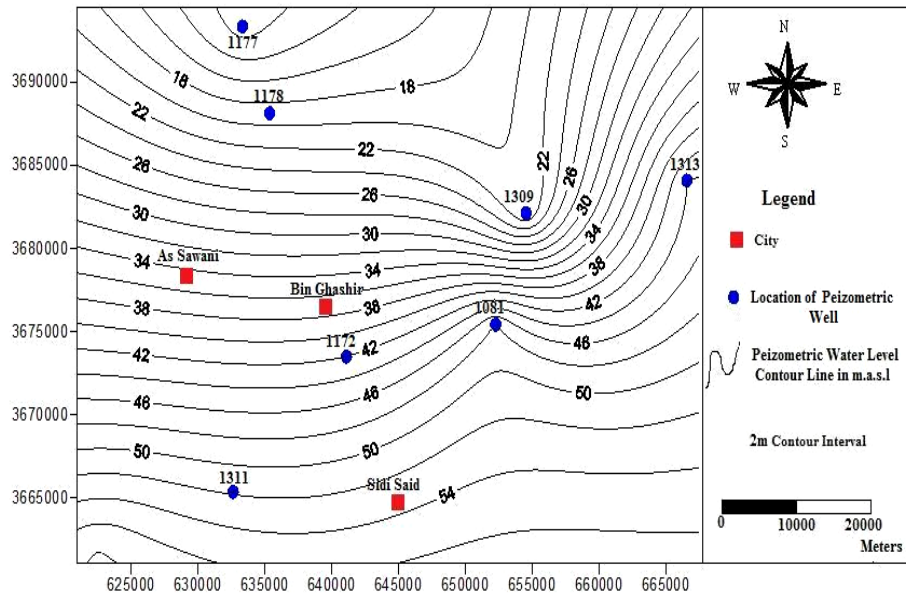


Figure 9 : Piezometric water level of Abu Shaybah aquifer

The piezometric water level in the area historically has dropped drastically since 1970's ( Figure 10). This drawdown was caused by the excessive use of this aquifer in the area after the depletion of ground water in the upper shallow aquifers. The highest drawdown is observed in piezometer 1172 which is located inside of the well field which was used to supply domestic use for Tripoli city (Figure 10).

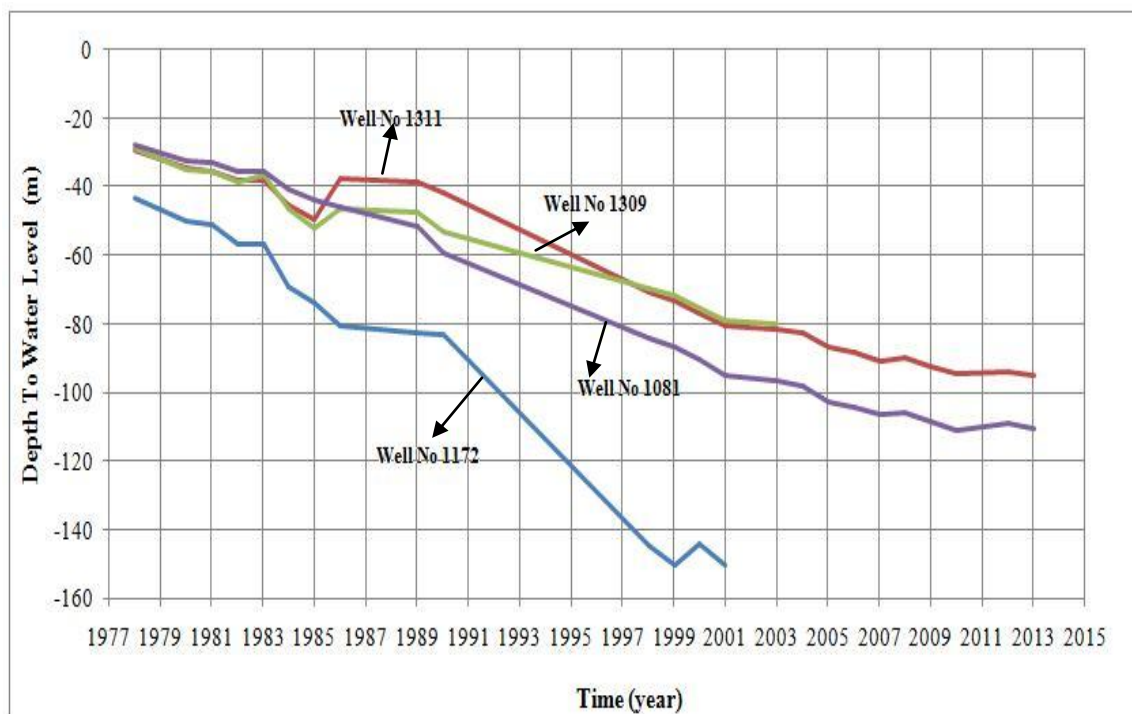


Figure 10 : Hydrograph of Piezometric wells in the area.

The hydraulic properties of this aquifer can be considered to be good with the Transmissivity range from 200 to 2850 m<sup>2</sup>/day. Figure (11) shows the regional distribution of the Transmissivity of Abu Shaybah aquifer in the study area.

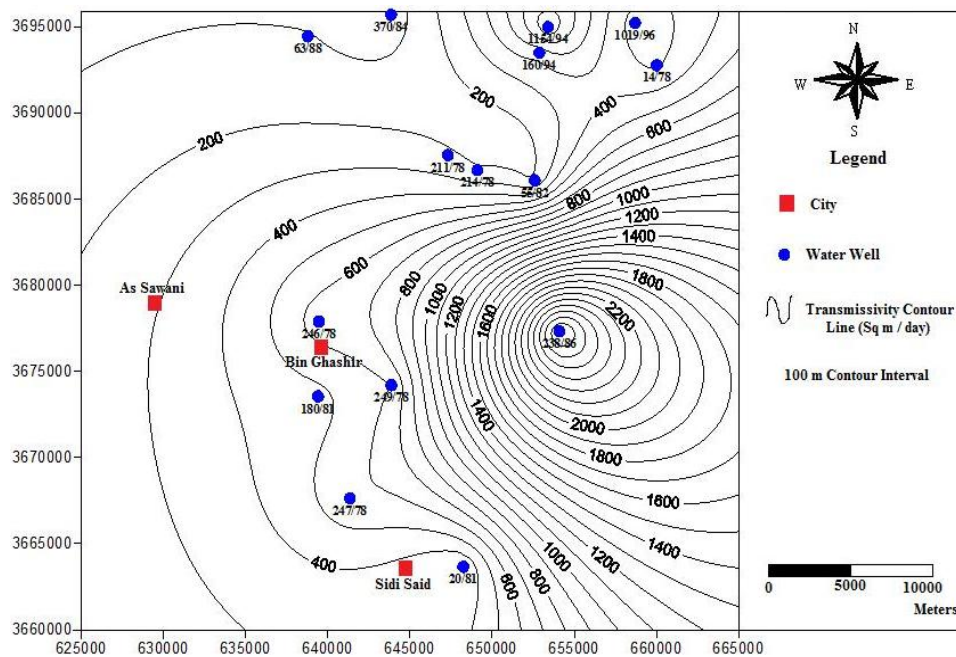


Figure 11 : Transmissivity of Abu Shaybah aquifer.

The aquifer average range of Storage coefficient is in the order of 10<sup>-4</sup>. The water quality of this aquifer is fair to good water for agriculture and domestic uses. The total dissolved solids is in the range of 1000-2000 ppm . Figure (12) shows that the water type is of sodium chloride type of water which indicates that the water in the aquifers very old and the recharge to this aquifer is limited to the groundwater flow from the south.

## CONCLUSION :

The most important groundwater resource in the study area is represented by the Abu Shaybah sandstone aquifer. The depth of this aquifer varies from 300 to 700m with a thickness of 35 to 300 m and the Transmissivity is in the range of 200 to 2850 m<sup>2</sup>/day . The depth of water ranges from 10 to 145 below ground surface . The pumping rate is in the range of 30 to 130 m<sup>3</sup>/h. The water quality does not exceed 2000mg/l. This aquifer has been effected locally by over pumping to supply domestic water for Tripoli city in the past put it has been relaxed since 1996 (the date of supplying Tripoli with the Grate Man-Made River). The aquifer should be managed carefully for sustainable development.

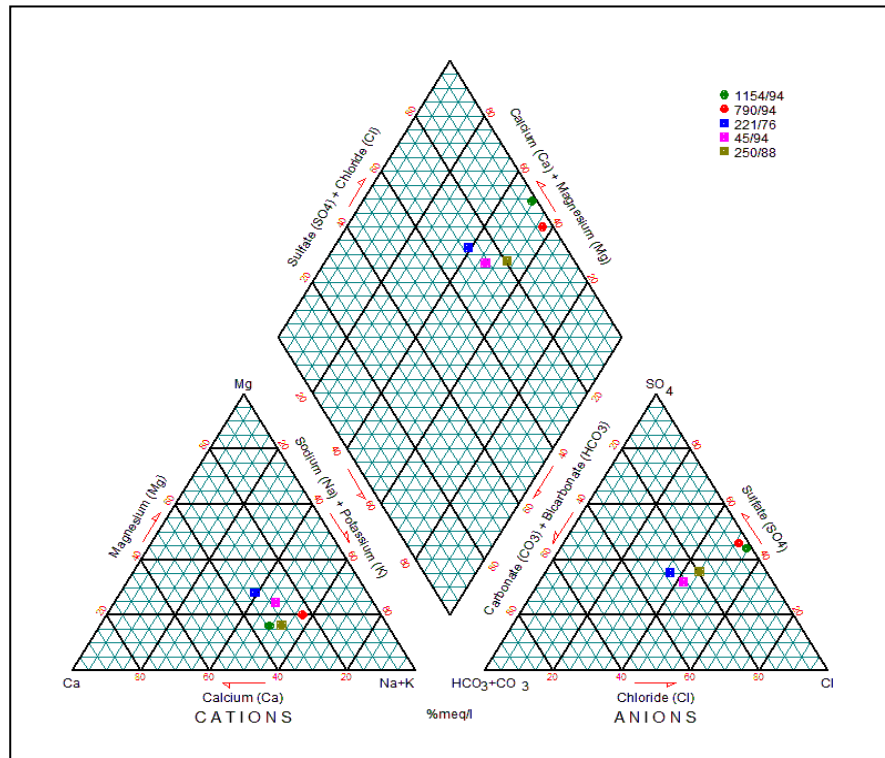


Figure 12 : Water quality of Abu Shaybah aquifer (trilinear diagram).

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