



3D-STRUCTURES WITH INTEGRATION GEOLOGICAL AND GEOPHYSICAL DATA: IMPLICATION FOR RESEARCH WATER RESOURCES IN TUNISIA: CASE OF BOTH SE JEFFARA AND UTIQUE BASIN, TUNISIA

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Abstract:

Tunisia is enriched by many natural resources (natural water and geothermal water) that are located along the South to the North. This paper aims mainly to evaluate the resources water potential. The available remote sensing images for two typical examples (SE Jeffara basin and Utique basin) are analyzed and many seismic profiles are interpreted to delineate the surface and subsurface structures.

The 3-D structures of Mio-Plio-Quaternary and Upper Cretaceous aquifers in South-East of Jeffara basin show an important reservoirs of water resources. The Upper Cretaceous aquifer "Complexe Terminal" is one of the most typical examples of exploitation features in hydrogeological research. It is formed by fractured limestones.

The 3D-structure of Utique basin shows an important variation of thickness of Mio-Plio-Quaternary and Triassic series. The Mio-Plio-Quaternary series is formed by sand, clays and gypsum. The Triassic series is considered typical example for research the hydrogeological and hydrothermal water in Tunisia, especially in the North. In the subsurface, the triassic aquifer of Utique regions is formed by carbonates series. The hot spring in Utique basin is directly related to the Triassic dolostones which are extensively fractured [1].

A geophysical survey was undertaken for groundwater in Tunisia. The interpretation of seismic reflection sections and petroleum wells allowed to precise the geometry in subsurface structure.

Keywords:

3D-Structure, tectonic framework, water resources, SE Jeffara basin, Utique basin, Tunisia.

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1. INTRODUCTION

Tunisia is situated in the north of Africa plate. The northern Africa is bounded by an Alpine-type orogen resulting from the subduction and closure of the Tethyan Ocean and from the interaction between the European and African plates [2] and [3]. In the north of Africa is situated the Maghrebian domain. The Digital Elevation Model view of the Maghrebian domain shows a generally decreasing elevation from north (chain Atlasic) to south (Saharan platform) (Fig. 1 a). Tunisia is considered to be one of the countries least well-endowed with water resources in the Mediterranean basin. It is characterized by a semi-arid climate with mild, dry summers, wet winters and warm. Pressure on fresh water demand is increasing as a result of demographic increase, agricultural water use and the development of the industry and tourism sectors. These conditions forced Tunisian authorities and policy makers to encourage for new research for potential resources water.

2. GEOGRAPHICAL, GEOLOGICAL AND STRUCTURAL SETTING

The Digital Elevation Model (DEM) of Tunisia, which shows a wide variation in the topography (Fig. 2). A maximum depth of 1600 m above sea level is the highly elevated mountainous in central Tunisia.

From the North to the South, the geological and structural context of Tunisia shows five domains:

- 1) The Tellian domain corresponds to "Alpine zone". This domain is characterized by the stacking of allochthonous units [4], [5], [6], [7], [8] and [9].
- 2) The Atlasic domain includes the Northern Atlas, the central Atlas and South Atlas.
- 3) The Northern Atlas is composed by imbricate thrust series [10] and [11] and salt outcrops zone is represented by NE-SW trending Triassic outcrops [12], [13], [14]. [11], [15], [16], [17]. [18], [19] and [20].
- 4) The Central Atlas is characterized by a NE-SW folds structures that are cut orthogonally by a graben system [21], [22], [23]. [24], [25] and [26].
- 5) The Southern Atlas is characterized by NW-SE and E-W to NE-SW folds [27], [28], [29]. [30], [31] [32], [28], [33], [34], [35], [36]. [37] and [38]. and bounded by the major faults Gafsa and Negrine-Touzeur.
- 6) The "North-South axis" is delimited the central Atlas zone and Eastern domain. It is composed by N-S trending faults [39], [40], [41]. [42], [43] and [44].
- 7) The Eastern domain is characterized by different blocks separated by N-S, E-S, NE-SW and NW-SE faults [45], [46], [47] and [48].
- 8) The Saharan domain is representing by folded Paleozoic rocks of African craton and Angular unconformity of Paleozoic series [49], [50], [51] and [52].

3. METHODOLOGY

This Research is based on the structural and strati graphical interpretation of surface data,



seismic profiles and petroleum wells which lies in south-eastern and north eastern parts of Tunisia.

The utilized methods in this work are mainly applied to determine the following issues:

- The digital elevation model of SE Jeffara and Utique basins using remote sensing techniques;
- The surface and subsurface structure;
- 3-D structures of different basin;
- Subsidence structure;
- Deep fault system;
- The research water resources.

3.1. TOPOGRAPHY

The three-dimensional structures are displayed as their intersections with two-dimensional surfaces that may be defined analytically or with grid meshes in the case of irregular surfaces such as the digital terrain models.

The digital elevation model (DEM) of Tunisia shows a wide variation in the topography. The DEM of Tunisia is determined using remote sensing techniques. A maximum depth of 1600 meters is recorded at the highly elevated mountainous in central of Tunisia (Fig. 2)

The south-East Jeffara is situated in South-East of Tunisia. The digital elevation model of SE Jeffara basin is represented by different topographic relief of almost 0 meters to 650 meters (Fig. 3). The high topography relief is represented by mountains such as Jebel Tebaga and Dahar. The low topography relief is marked by lowland zones such as the Chotts and SE of Jeffara basin.

The DEM of north-eastern Tunisia (Fig. 4) is marked by different topographic relief of almost 0 meters to 600 meters. The high topography relief is represented by mountains such as Dj. el Messftine, Dj. Hakima and Dj. Kechabta. The low topography relief is characterized by lowland zones such as the Utique plain.

3.2. GEOPHYSICAL SURVEYS

The resource mineral can be explored and used a variety of geophysical techniques and geological investigation as well as in the exploration of hydrocarbons and groundwater. In this study, geological and geophysical techniques (cross-section, wells petroleum and seismic



profiles) used by to identify the major structures sub-basin aquifers and three dimension structures of study area.

4. RESULTS AND DISCUSSION

4.1.CASE 1: SE JEFFARA BASIN

In the SE Jeffara basin, two petroleum wells: W1 (Ben Guerdane-1), W2 (Bir Mastoura) and W3 (Utique-1) obtained from oils company (Mobile and SEREPT) and "Entreprise Tunisienne des Activités Pétrolières" (ETAP). The location of petroleum wells shows in figure 5. Eight seismic reflection profiles (L1 to L8) are analyzed (fig.5). The interpretation of these seismic profiles reveals to determine Mio-Plio-Quaternary and Upper Cretaceous aquifers.

The lithostratigraphical description from deep wells (W1 and W2) shows that fractured limestones and dolomitic of Upper Cretaceous to corresponding the lower part of "complexe Terminal". The Mio-Plio-Quaternary to corresponding the upper part of "Complexe Terminal" is formed by sand and silts.

The correlation of wells W1 and W2 [53], [54], [55] and [56].) Shows reduces series of Upper Cretaceous to corresponding to "Complexe Terminal".

The figure 5 shows the disappearance of the Upper Cretaceous unit and to reduce of the Mio-Plio-Quaternary series towards the southwest (W1 to W2).

The view 3D of geometry Mio-Plio-Quaternary and Upper Cretaceous aquifers of seismic profiles (figs. 5 and 6) The 3D view of combination seismic profiles (L1 to L8) shows the variations of the basin's geometry (Figs. 5 and 6). The variation of the thickness of the Upper Cretaceous is related by a horsts and grabens structure of the Upper Cretaceous and listric faults affected these series.

The 3-D blocks diagram representation of the top (Fig. 7) and the base (Fig. 8) of the Upper Cretaceous aquifer was determined using the seismic sections and borehole data (W1). Its shows that the basin increases in depth from the southwest toward the northeast and also the depth increases toward the southeast.

4.2.CASE 2: UTIQUE BASIN

In Utique basin, the petroleum well W3 is reached a total of 2500 meters. This well shows an important Triassic and Mio-Plio-Quaternary series. Four seismic profiles are analyzed.

In this study, analysis of the lithostratigraphic data was carried out using time-depth conversion wells data from W3. The processed seismic reflection profiles were obtained from "Entreprise Tunisienne des Activités Pétrolières" ETAP with the locations of profiles in Figure 9.



The migrated seismic reflection profiles were analyzed to determine correlations between seismic reflection horizons and stratigraphic horizons determined from the boreholes W3.

All georeferenced subsurface and surface data are integrated, interrelated and analyzed using "midland valley" move 2014 software.

The Porto-Farina and Ariana region is characterized by Triassic to Quaternary series are derived from the geological mapping scale 1/ 50.000 [57], [58] and [59].

In subsurface, the well petroleum W3 shows that the Triassic series are formed by domination of fractured carbonates with an average porosity of 15% [60] and little gypsum.

Under the Miocene tortonian unconformity. Directly beneath the Miocene is a thin 11meter of late Cretaceous. The Mio-Plio-Quaternary is approximately 1378 meter.

The Miocene and Pliocene are composed by sand, clay and little gypsum. The Quaternary substratum shows continental facies.

The different view 3D of interpretation in polygone of seismic profiles shows the geometry of repartition of Mio-Plio-Quaternary and Triassic series (figs. 10 and 11).

The figure 12 shows the top of the late Triassic aquifers is determined using the seismic sections and borehole data (W1). Its shows that the basin increases in depth from the southeast toward the northeastwest. The Triassic aquifer is formed by fractured dolostones and limestones. The Triassic aquifer is considerate a thermal aquifer [1] and it is favorable to the hydrogeological exploitation.

5. CONCLUSIONS

The integration of surface (geological mapping and outcrops) and subsurface studies (petroleum's well, seismic reflection profiles and gravity data) has given an idea of geometry in subsurface of aquifers for prospecting natural resources mineral. The Upper Cretaceous and Mio-Plio-Quaternary of "Complexe Terminal" aquifer in the Jeffara basin and the Triassic aquifer of Utique basin is considerate strategic a new aquifers exploration in the feature.

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FIGURES CAPTIONS

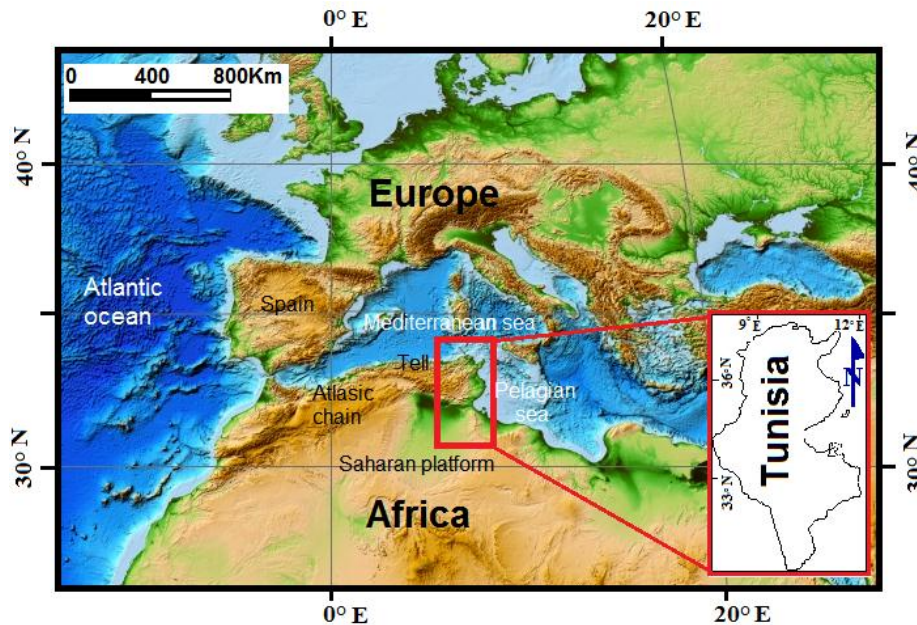


Figure 1: Digital Elevation Model (DEM) of Mediterranean Sea domain showing the generally decreasing altitude from north (Atlasic domain) to south (Saharan platform). Boxed area indicates location of the Tunisia region.

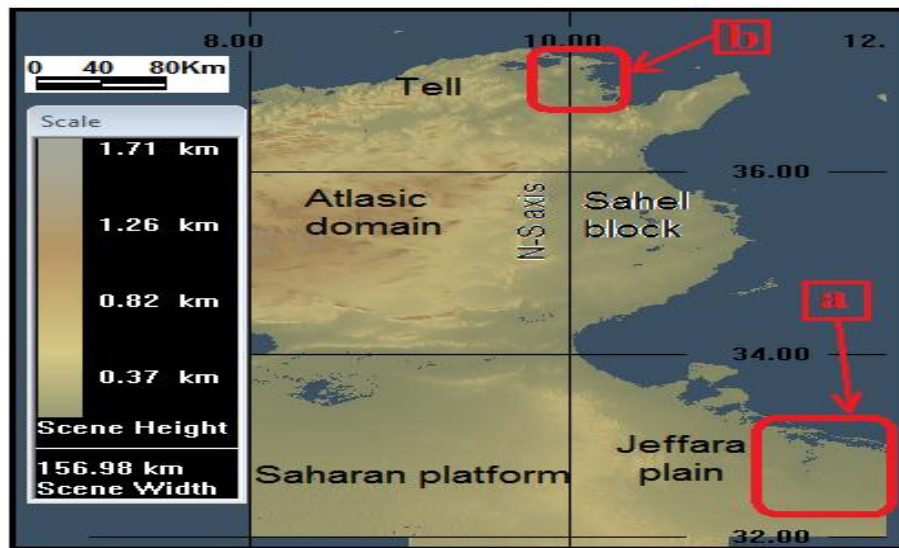


Figure 2: Digital Elevation Model of Tunisia. (a) Boxed area indicates location of the South-eastern of Tunisia. (b) Boxed area indicates location of the north-eastern of Tunisia.

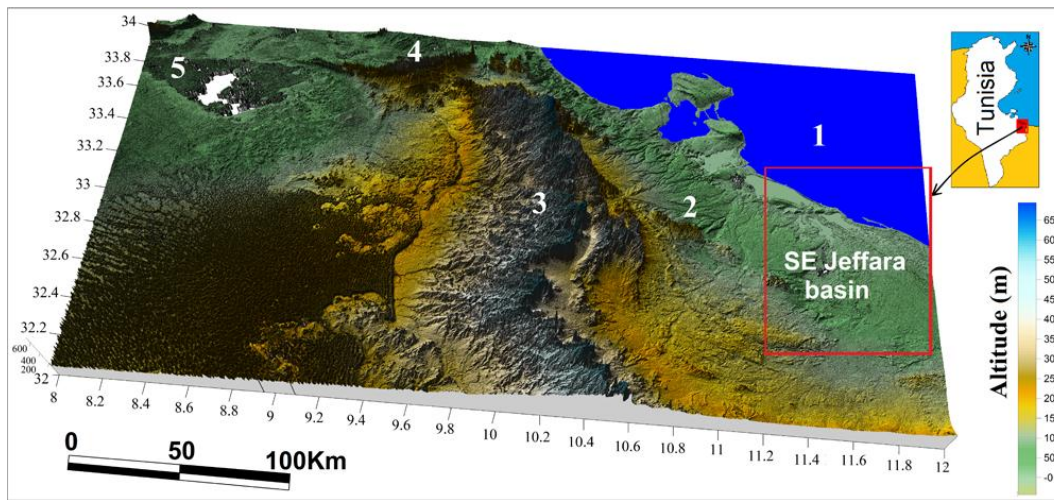


Figure 3: Digital Elevation Model of the South-eastern of Tunisia. 1: Mediterranean Sea, 2: SE Jeffara basin, 3: Dahar, 4: Jebel Tebaga, 5: North chain chotts

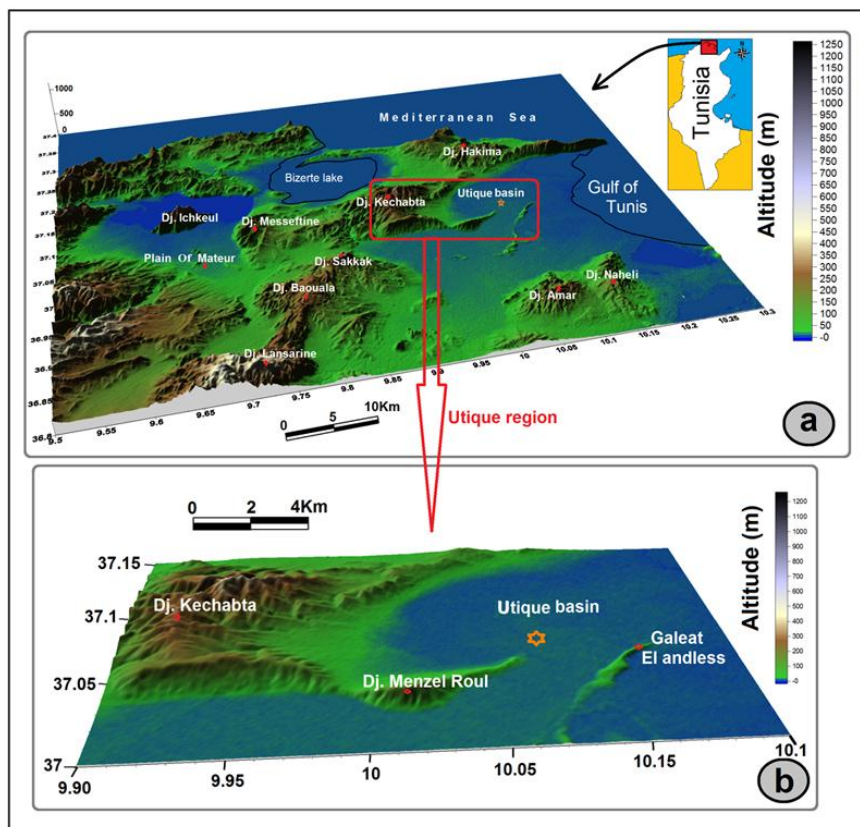


Figure 4: Digital Elevation Model of the north-eastern of Tunisia.

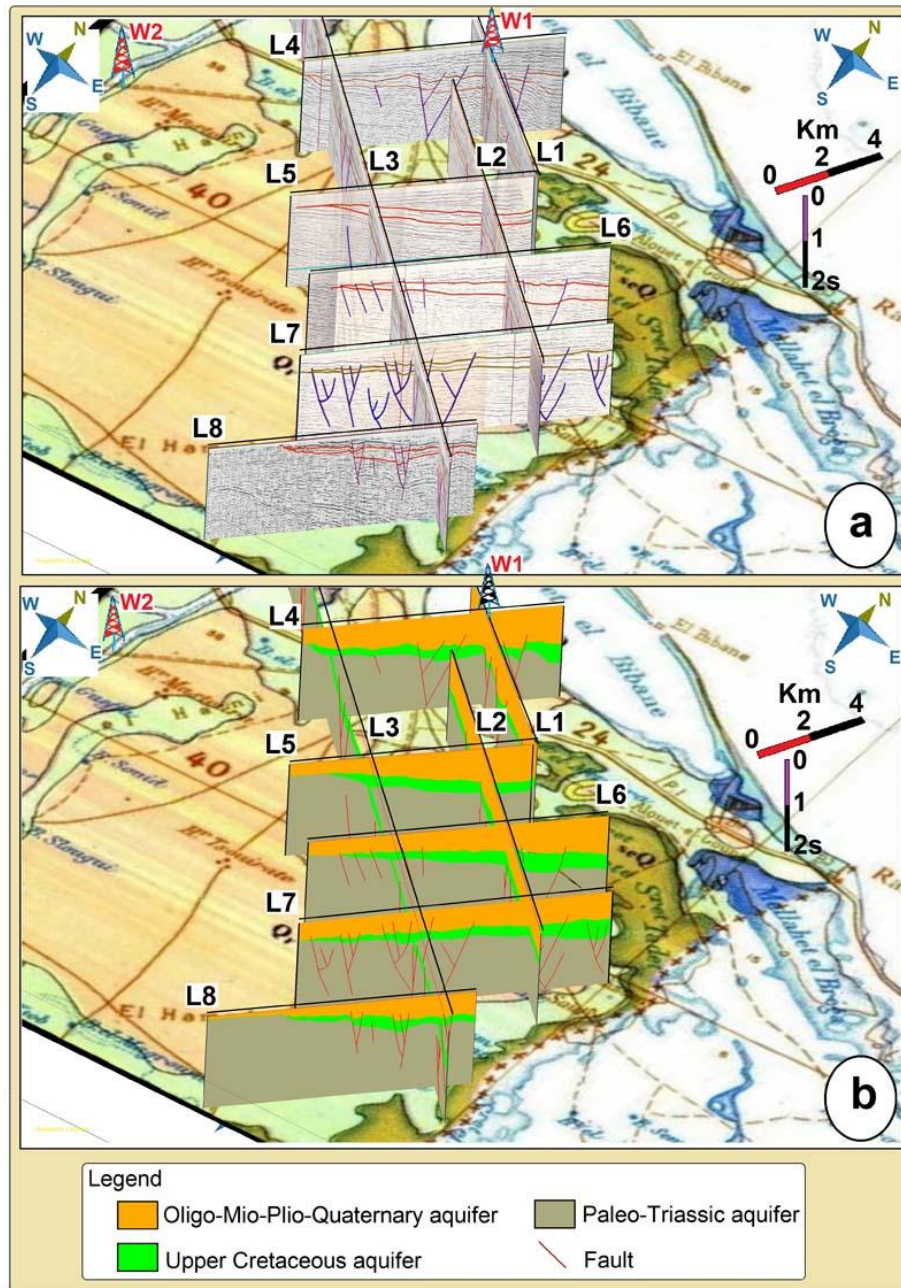


Figure 5: Determination of aquifers in Jeffara basin.(a) Interpolation of seismic profiles and maps at scale 1/500,000 of the south-eastern of Tunisia. (b) Interpretation of seismic profiles view 3D of interpretation of Complex Terminal aquifers.

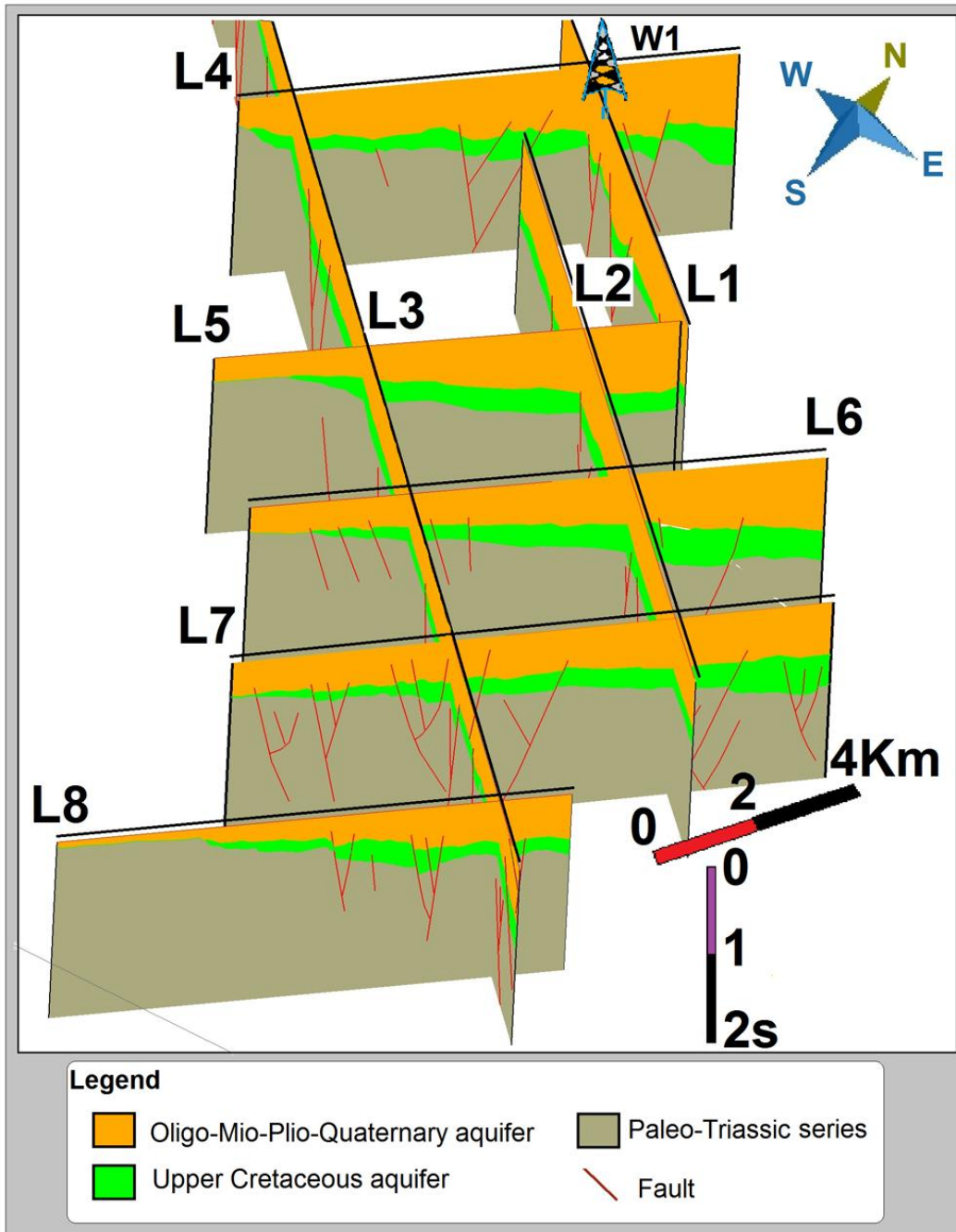


Figure 6: View 3D of geometry of aquifers of Jeffara basin.

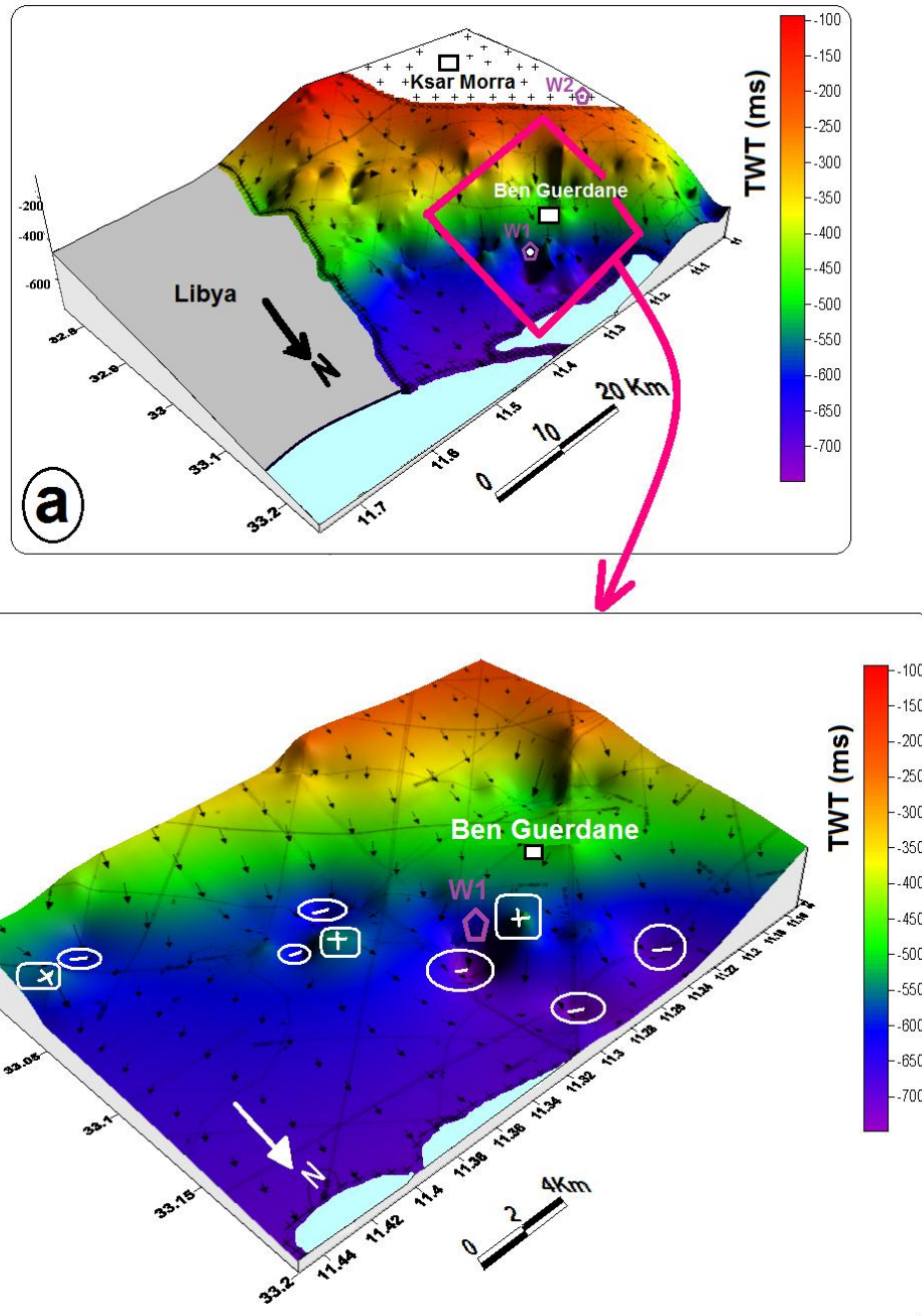


Figure 7: View 3D of geometry of top of Upper Cretaceous aquifer of Jeffara basin. (a) Top of Upper Cretaceous aquifer. (b) Detailed of 3D Top Upper Cretaceous aquifer in South-eastern of Jeffara basin.

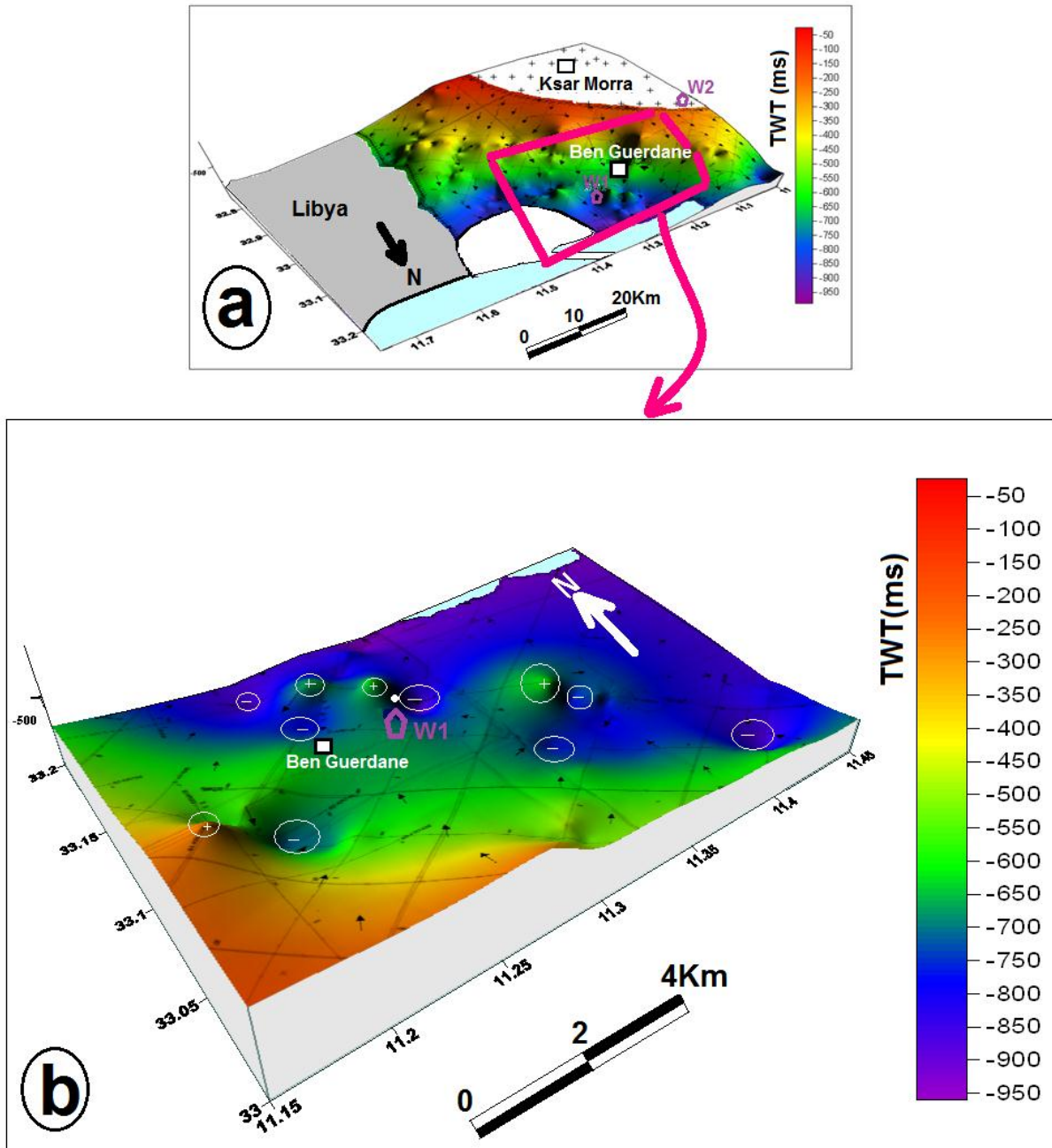
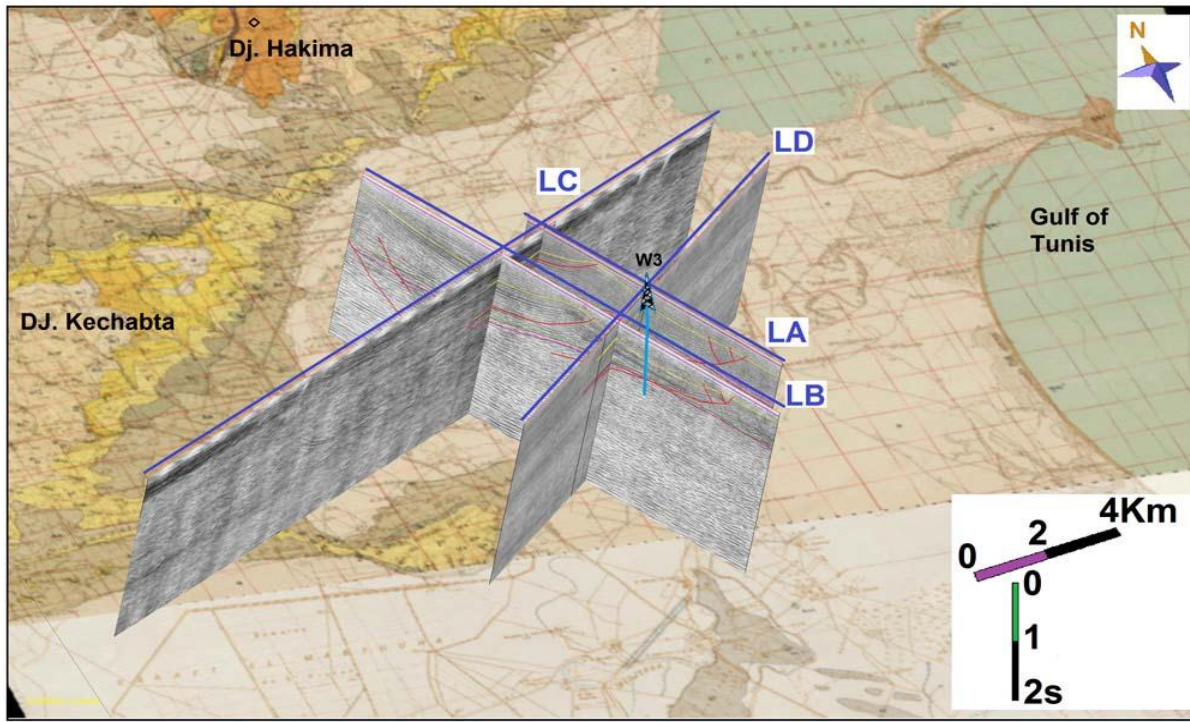


Figure 8: View 3D of geometry of Bottom of Upper Cretaceous aquifer of Jeffara basin. (a) Bottom of Upper Cretaceous aquifer. (b) Detailed of 3D Bottom Upper Cretaceous aquifer in South-eastern of Jeffara basin.



Legend







- | | | |
|--|--|--|
|  Top Pliocene |  Top Upper Cretaceous |  Seismic profile |
|  Top Miocene |  Top Upper Triassic |  Fault |

Figure 9: Interpolation of seismic profiles and maps of Porto-Farina and Ariana (1/50000) and determination of aquifers.

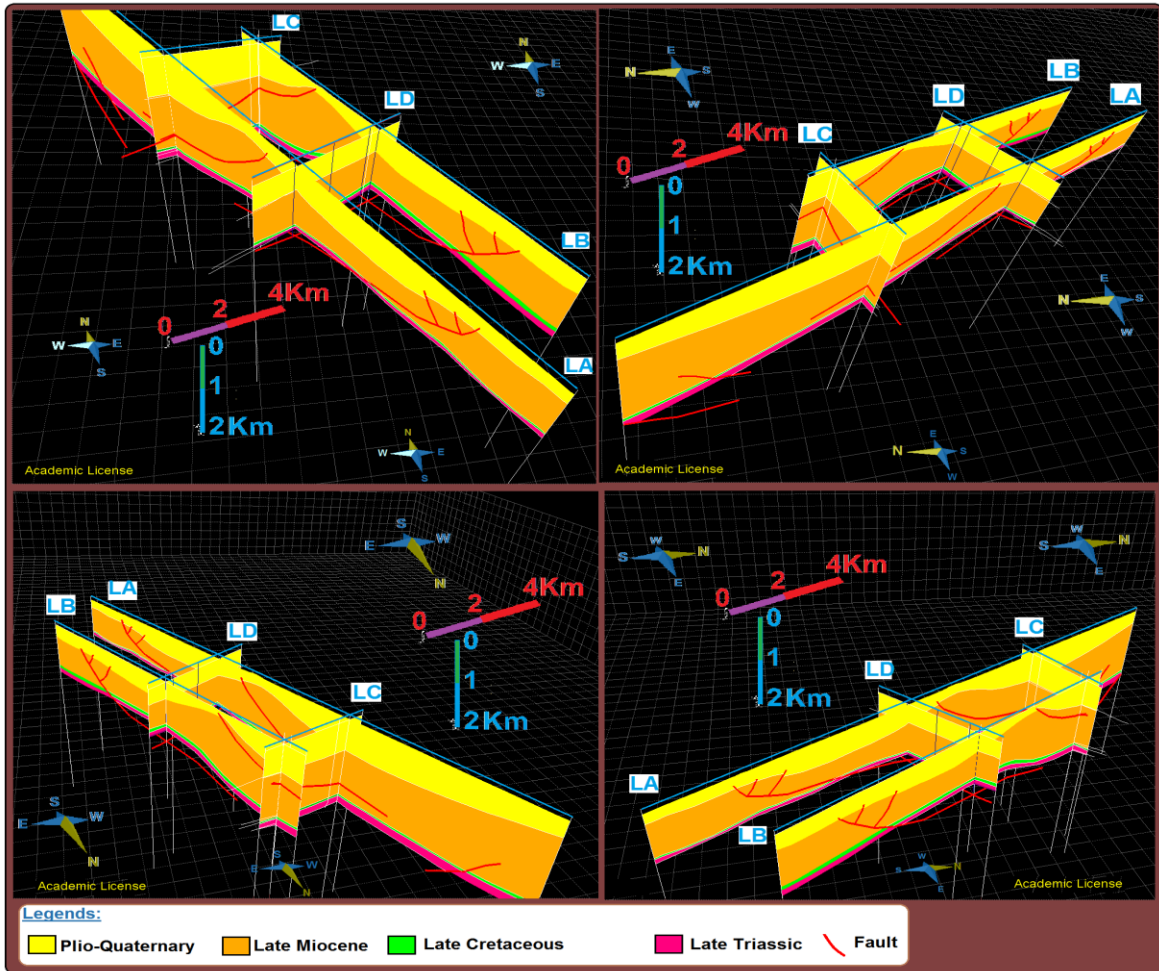


Figure 10: different view 3D of interpretation in polygone of seismic profiles of series.

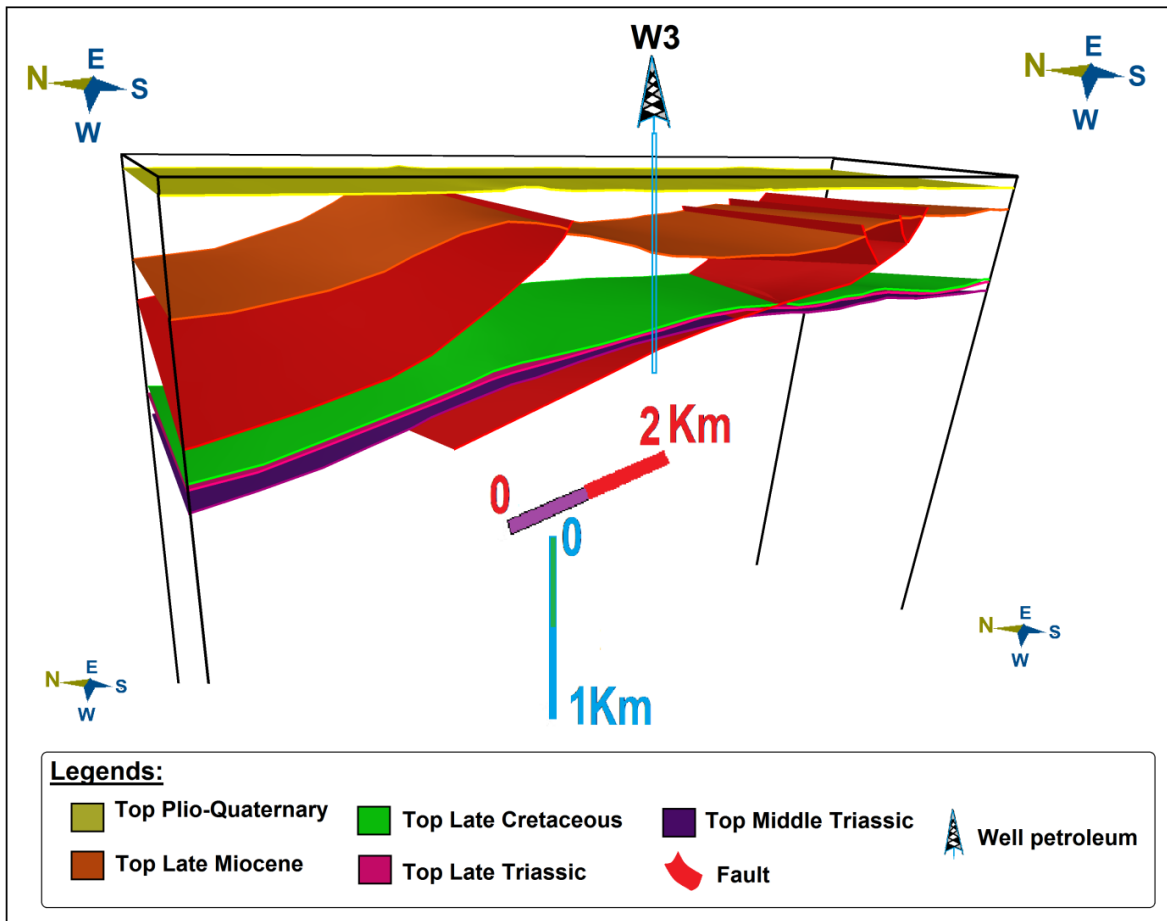


Figure 11: 3-D view of geometry in subsurface of aquifers.

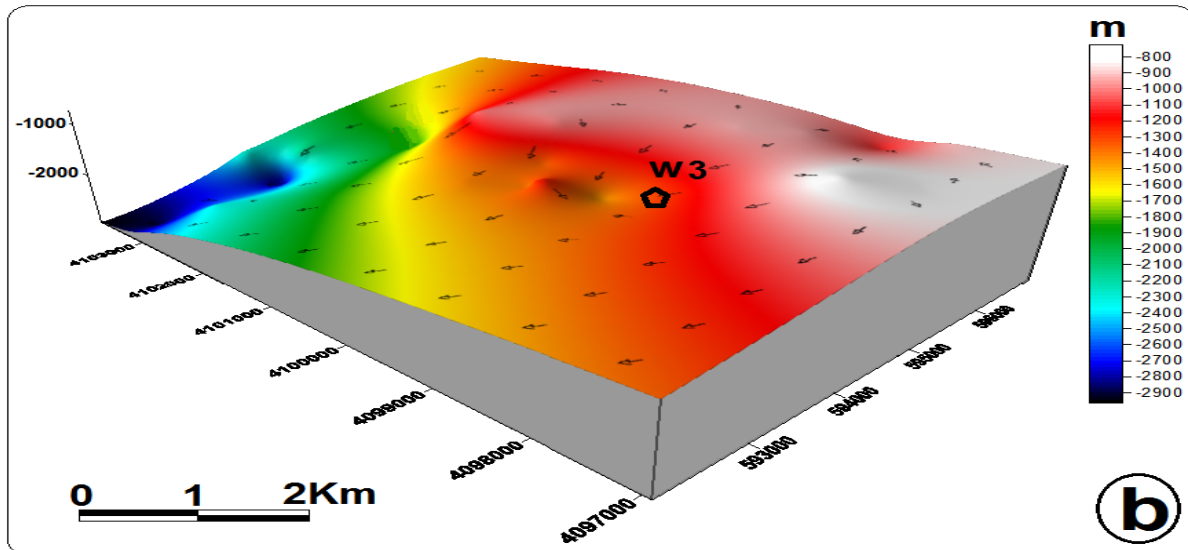
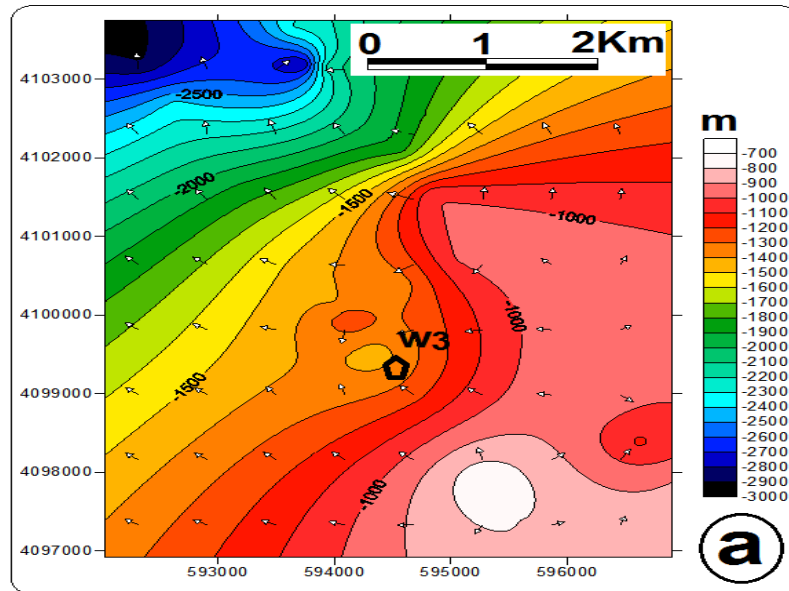


Figure 12: Top of the late Triassic aquifers (meters). (a) Contours maps of top of Triassic aquifer. (b) 3-D block diagram representation of the top depth distribution in the study area of late Triassic aquifer in meters.