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2D Seismic Data Analysis of Judaida Structure, Northern Iraq

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Abstract

This research aims to study the structural analysis of the 2D reflection seismic data for the Judaida subsurface structure located in Kirkuk province, northern Iraq. It is located 60 Km southwest of Kirkuk oil field, and 35 Km southwest of Jambur oil field, the Daquq River passes through the study area. The reflectors in the seismic section were picked and identified by using the synthetic seismograms generated from the logs data of the Jd-1 well. Three main seismic reflectors, Fatha, Jeribe, and the Euphrates were chosen. These mentioned sedimentary formations were deposited during the Middle Miocene, Lower Miocene, and Early-Mid Miocene respectively. Time and depth maps were drawn for these three reflectors by processing average data from Jd-1well. The structural interpretation results showed a structural closure on both time and depth domains in the middle of the study area. Judaida structure represented an asymmetrical longitudinal anticline fold. The Northeast limb has a dipping angle of 6-8 degrees more dip than the Southwest limb that has a dipping angle of 1-6 degrees, and the direction of the axis of the general structure is towards the Northwest-Southeast. The general dipping of the fold is toward the north east.

Keyword: 2-D seismic reflection data, Judaida structure, Structural interpretations.

تحليل المعطيات الزلزالية ثنائية الابعاد لطية جديدة, شمالي العراق

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الخلاصة:

يهدف هذا البحث الى الدراسة تحليل المعطيات الزلزالية الثنائية الابعاد باستخدام الطريقة الزلزاليه الانعكاسية لطية جديدة المحدبة التحت سطحية. حيث تقع منطقة الدراسة ضمن محافظة كركوك في شمال العراق وتبعد 60 كيلومتر جنوب–غرب حقل كركوك النفطي كما انها تبعد35 كيلومترجنوب–غرب حقل جمبور النفطي يمرنهر الداقوق خلال منطقة الدراسة. تم التقاط وتحديد السطوح العاكسة لبعض التكاوين على المقطع الزلزالي, كما تم معالجة الاثار الزلزالية باستخدام معلومات الجس البئري للبئر جديدة–1.تم التقاط ثلاث عواكس رئيسية (الفتحة,الجريبي, والفرات),هذه العواكس كانت قد ترسبت خلال الاعمار الجيولوجية (المايوسين

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الاوسط, المايوسين الاسفل, ووسط المايوسين المبكر) على التوالي, تم رسم الخرائط الزمنية والعمقية للعواكس الثلاثة الملتقطة باستخدام السرع المعدلية المستحصلة من معلومات البئرجديدة-1. اثبتت نتائج التفسير الجيوفيزيائي وجود انغلاق بالمجال الزمني والعمقي للعواكس الثلاثة الملتقطة في وسط منطقة الدراسة, وان تركيب جديدة عباره عن طية محدبة طولية غير متناظرة وان طرفها الشمالي الشرقي درجة ميله (6-8) درجة اكثر ميلانا من الطرف الجنوبي الغربي الذي درجة ميله (1-6) درجة, وان اتجاه محور الطية هو شمال غرب-جنوب شرق, اما الميل العام للطية هو باتجاه الشمال الشرقي.

1. Introduction

The seismic reflection method is the most extensively used geophysical technique it gives a direct and more detailed picture of the geological subsurface structures [1]. Depths to the interface are mapped very accurately. Certain difficulties arise when reflection is used for beds of folding and steep dip [2]. The structural interpretation of seismic data is the basis of seismic structural analysis. This analysis depends on the seismic energy travel time [3]. In general, picking of the reflectors is carried out by checking seismic sections passing near to well, and interpreted based on dominant reflection coefficient [4]. The interpretation of seismic sections firstly emphasizes the picking of the reflectors with accurate analysis of reflection configuration, reflection continuity, and reflection amplitudes [5]. The subsurface structures are studied by collecting geological and geophysical data, different geophysical attributes of the subsurface are measured by a variety of geophysical measuring techniques [6]. The seismic reflection method takes more than 90% of the cost, which is globally spent in applied geophysics [7]. The subsurface geological structures can be studied directly and in detail by seismic reflection that could also be applied to locate subsurface stratigraphic features [8], [9]. The 2D seismic data became a real tool used in the oil and gas industry. Two main interpretation approaches could be applied in detecting subsurface structural features which are the structural analysis and the stratigraphic analysis [10]. Many studies employed the interpretation of 2D seismic data with wells data to evaluate the subsurface structural geology in different countries, such as Pakistan [4], [11], Iraq [12], and Egypt [13]. The aim of the current search is the structural analysis of the seismic reflection data to the Judaida field to evaluate the structural features such as anticline, faults that represent subsurface petrol traps.

2. Study area location

The location of the area of interest is within the administrative borders of Kirkuk Governorate in northern Iraq. It is located 60 Km southwestern Kirkuk field and 35 Km southwestern Jambor field. The Judaida field is bordering from the south by Hamrin field. On the other hand, the Daquq River passes over the study area as illustrated in Figure 1.

Table 1-Coordinates of the study area

Point	East (m)	North (m)
A	425365	3870455
B	429100	3874655
C	439555	3865355
D	436415	3861270

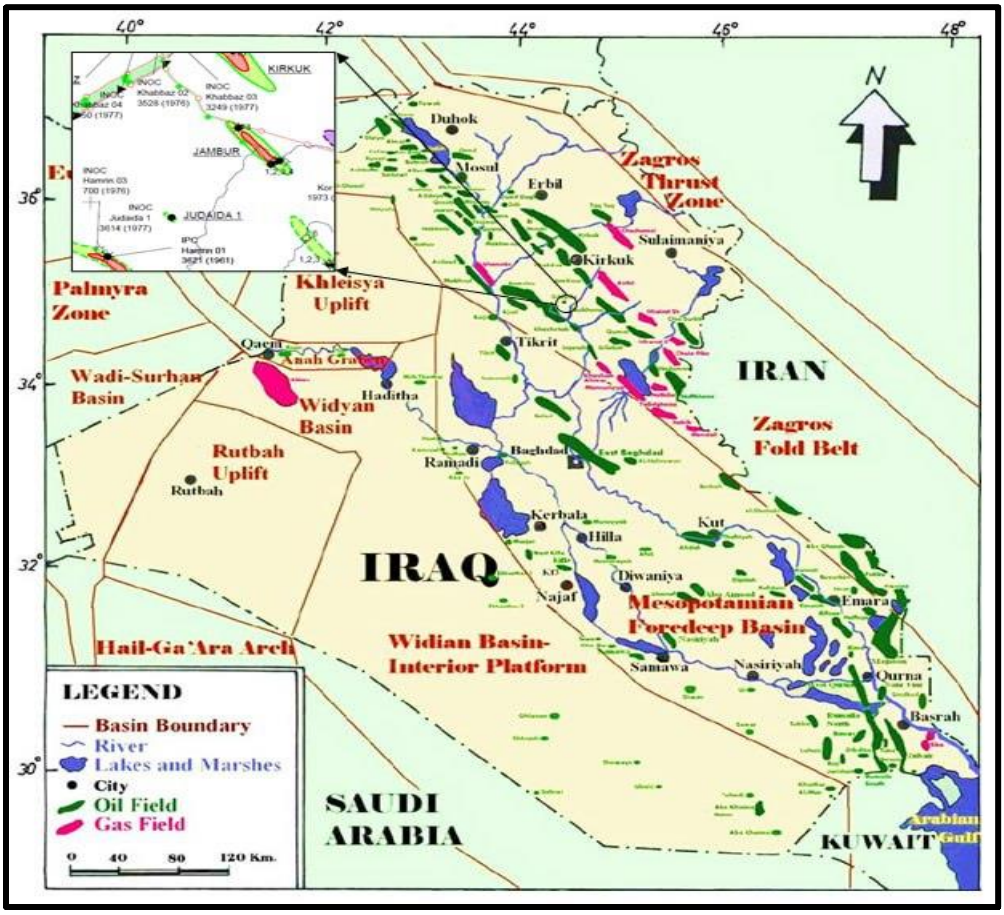

Figure – 1 Location map of the interested area modified from [14], [15].

3. Geological Setting

The tectonic map of the study area, as illustrated in Figure 2, the geological column which started at the surface by the Quaternary sediments (alluvial fan) then penetrates the Tertiary age formations to reach Lower Cretaceous as it penetrates Maoddud Formation. The Tertiary age cycles were deposited in the basin because of Alpine orogeny movement. Tectonically, the study area is located in the northeast part of the Arabian platform [16]. Judaida fold is located in the Low folded zone in the outer platform division. Structurally, the study area is characterized by structural trend and facies change parallel to the Zagros – Taurus belts (NW-SE) [17]. The Paleocene and Eocene formations were deposited over the erosion surface which separates it from the carbonate of the Upper Cretaceous Shiranish Formation deposits. This succession was followed by the semi-basin sediment of Kolosh Formation, basin sediments Aliji Formation, shallow sediments Khurmala Formation, basin sediments Jaddala Formation, and shallow sediments Pilaspi Formation, and the Eocene age ended with the regression of sea level. The Oligocene basin is identical to the Eocene basin with continuous sea-level regression and growth coral reefs which formed the best reservoir rocks. Later on, there was a progression phase which led to the deposition of the transition and represented by the layers of Miocene (Kirkuk Group), as for Jeribe Formation deposition by on lapping manner system, during maximum flooding surface where covered the Dhiban Formation, and this phase continued to include most of the Tertiary sedimentary basin (Neogene) that consist the Fat'ha Formation.

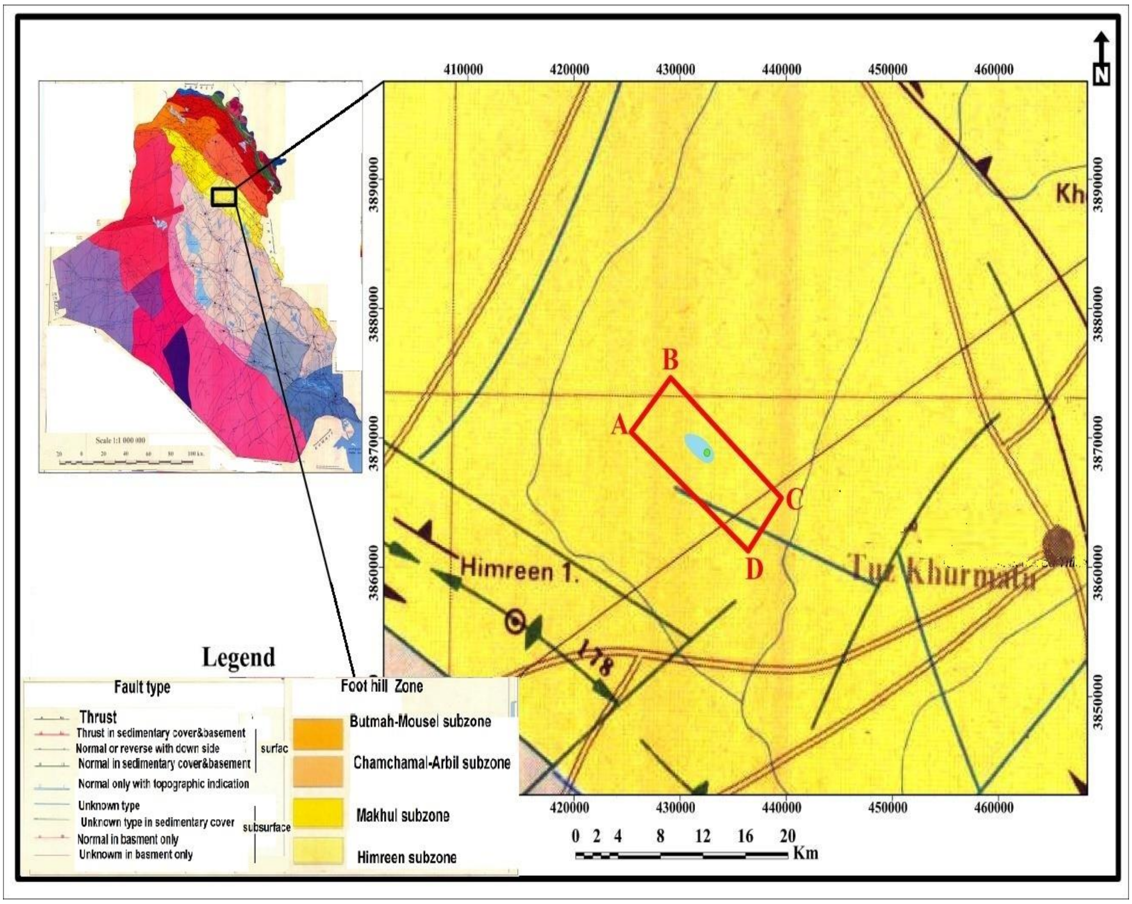

Figure 2-Tectonic map of Iraq showing the study area [18].

4. Preparation of base map

The first step to prepare the base map of the study area is project creation, which is prepared to illustrate the required information to be loaded. Oil Exploration Company (OEC) using the (Echoes) version software processed the data. SEG-Y format is loaded to process seismic data to interpret the seismic section by adopting the interactive workstation Petrel Software. This operation comprises the insertion of all strike line numbers, dip line numbers, and directions, also, the separation distance between bin sizes along strike line. In addition, furthermore, geographic coordinates in UTM were entered into the interactive workstation, Figure 3.

5. Synthetic seismogram

Synthetic seismograms represented an artificial reflection record which was deduced made from velocity logs by converting velocity log information with depth into a function of time, and by convoluting this function with a presumed appropriate wavelet or source pulse [19]. Using the information of well Judaida-1, represented by well logs sonic & density log, and seismic data to create the synthetic seismogram. In addition creating the best (Wavelet) from seismic data in a well location. Also using the Check-shot survey information to obtain the best corresponding between well information and seismic signal to define the reflectors. The acoustic impedance (Z) and reflection coefficient (R) can be calculated, as follows:

To detect the acoustic impedance [5].

$Z = \rho * \nu$

ν: velocity ρ: density from log.

The reflection coefficients:

$$R = \frac{(\rho i + 1)(\nu i + 1) - \rho i\, \nu i}{(\rho i + 1)(\nu i + 1) + \rho i\, \nu i}$$

Where:
(ρi, ρi+1) the density at the interval (i), (i+1).
(νi, νi+1) the velocity at the interval (i), (i+1).

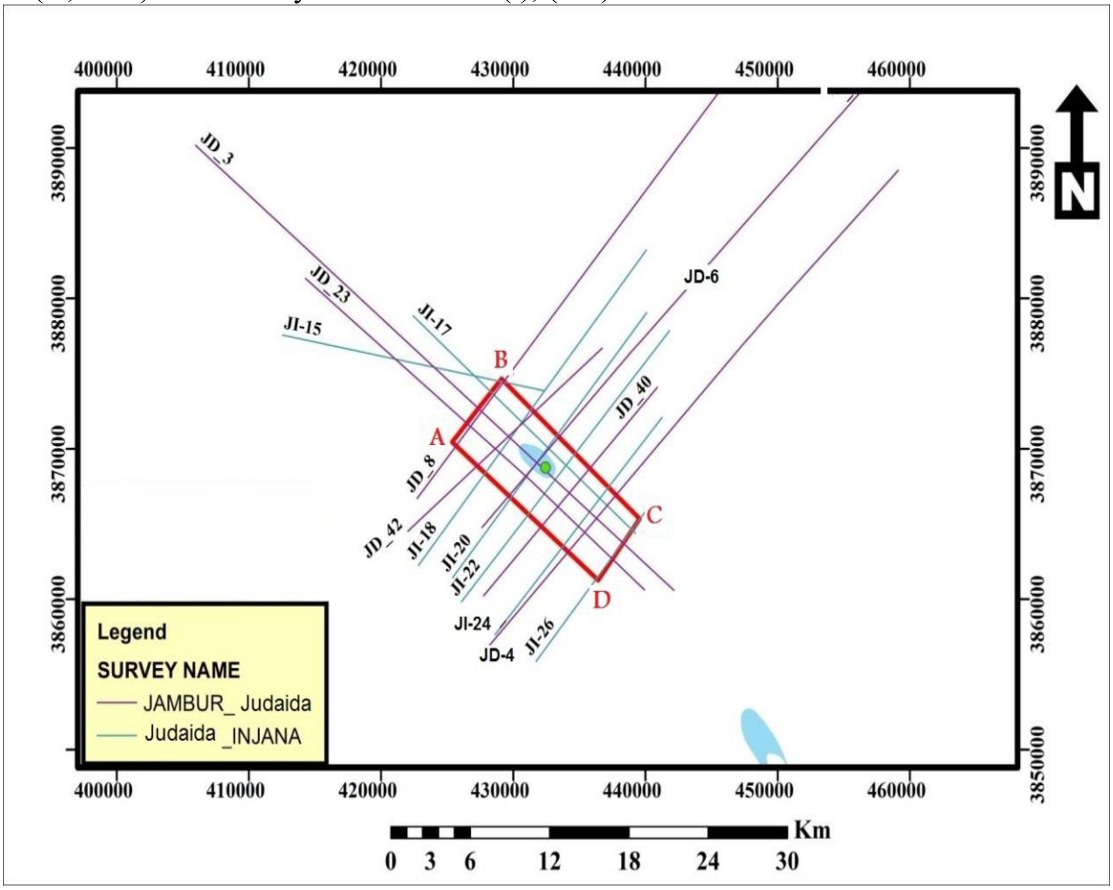

Figure 3-Base map of the study area.

A perfect wavelet was used to obtain the synthetic seismogram by applying the convolution operation between the reflection coefficients and the experimentally chosen wavelet. And the average velocity of geological layers was obtained by comparing sonic log data with a well velocity survey, which represents the direct method. In the current study, a synthetic seismogram was generated for well Judaida, Figure 4. Figure 5 shows the comparison between seismic sections trace and synthetic trace, to define and pick up the required reflectors.

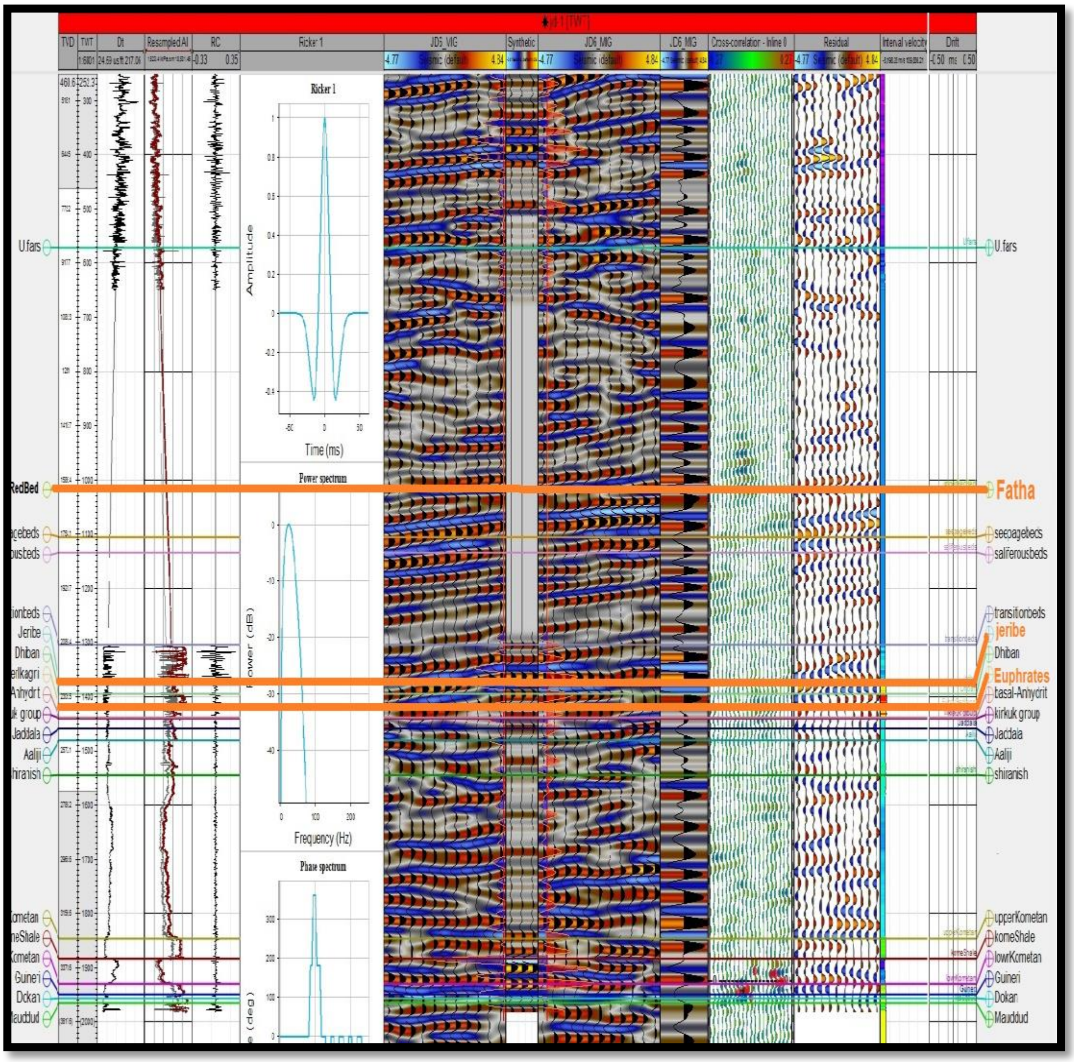

Figure 4-Synthetic seismogram of Jd-1.

6. Interpretation of seismic reflection data

Seismic interpretation provides an assessment of prospects hydrocarbon potential and identifies the best location for drilling exploration and production wells. The interpretation processing is the final stage of transition and interpretation to integrate seismic data and geological information [20].

7. Structural framework interpretation

This includes measuring the Two-way vertical time at the CMP_s of the migrated stacked section. As well as the values. That plotted relatively to a defined datum level along with each seismic line reflector.

7.1 Two-Way Time (TWT) contour maps construction

The time maps are the first image of the subsurface geological feature of the study area in the time domain. It is drawn by taking the time values of each shot point and superimposed to the values at the line on the base map.

7.1.1 TWT contour map within Fat'ha Formation

The TWT contour map of Fat'ha Formation as illustrated in Figure 6 shows the presence of a great similarity in the structural image of a Judaida dome with a contour interval of 10 ms, as it showed that Judaida structure is a narrow longitudinal an asymmetrical anticline in the middle of the area of interest, with a structural axis trend Northwest-Southeast.

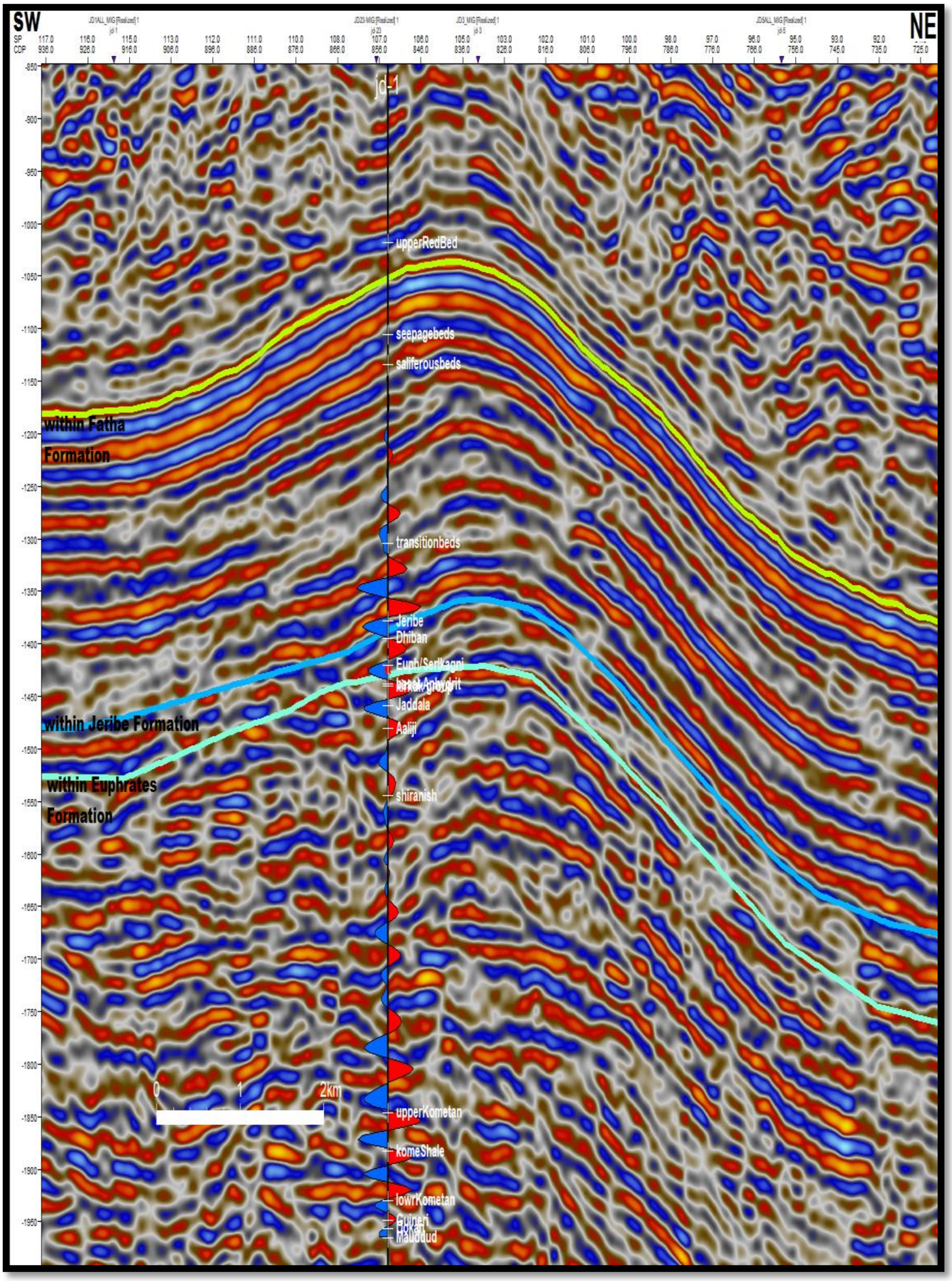

Figure 5-Seismic section with synthetic trace and markers of well Jd-1showing Judaida asymmetrical anticline.

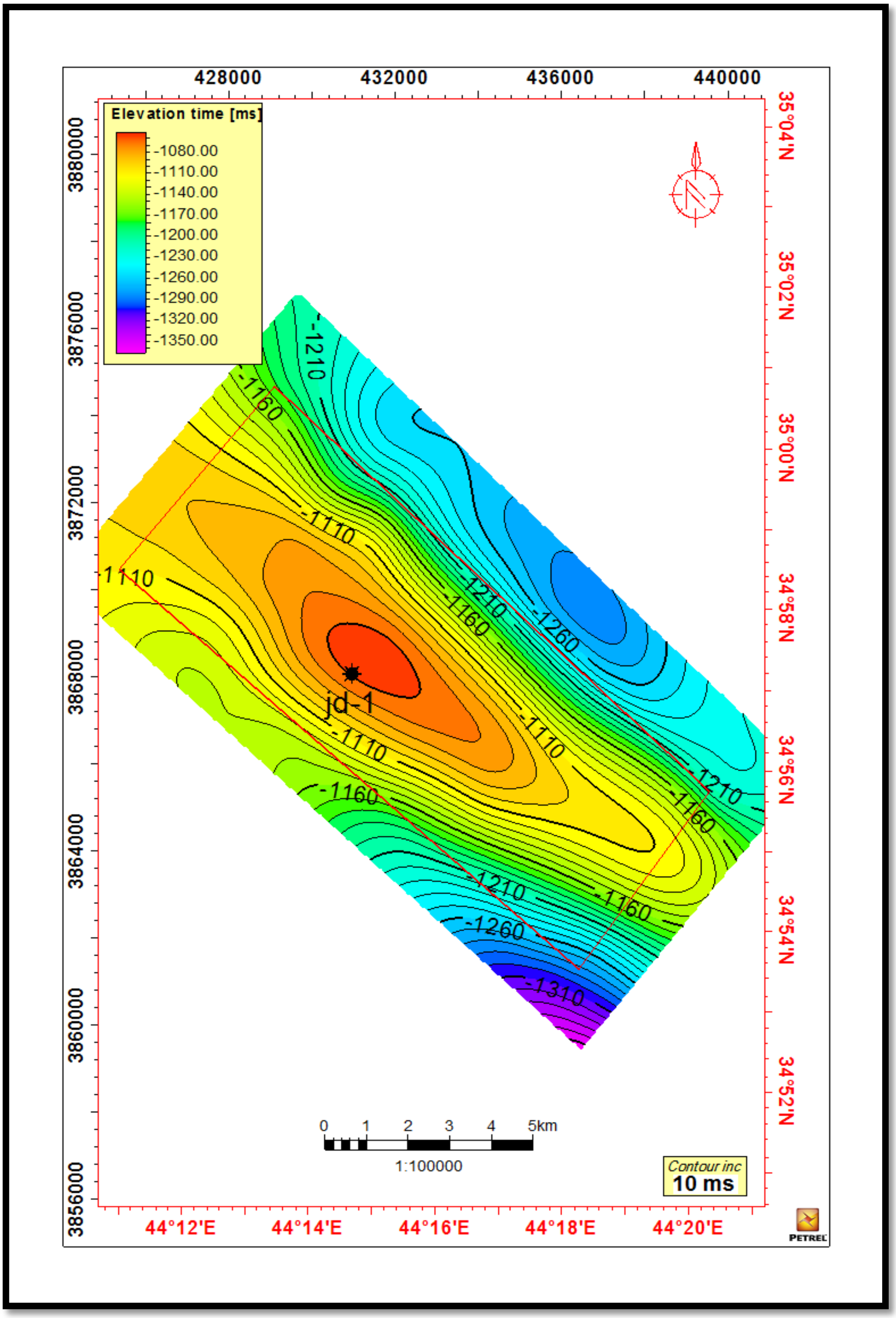

Figure 6-Two-way time (TWT) contour map of Fat'ha Formation showing Judaida anticline closure, its axis is trending toward NW-SE.

7.1.2 TWT contour map within Jeribe Formation

The TWT contour map of Jeribe Formation Figure 7, is not much different from the structural image of the Fat'ha Formation TWT contour map. It shows closure of a narrow longitudinal asymmetrical anticline in the middle of the study area with a structural axis trend extending Northwest-Southeast, with a contour interval of 10 ms.

7.1.3 TWT contour map within Euphrates Formation

The TWT map of Euphrates Formation almost similar in the structural image with Fat'ha and Jeribe TWT contour map, it is shows closure of a narrow longitudinal asymmetrical anticline with structural axis trend of Northwest- Southeast, with a contour interval of 10 ms. As shown in Figure 8.

7.2 Depth contour maps Construction

The velocity model is used for time-depth conversion; three depth maps have been constructed for Fat'ha, Jeribe, and Euphrates formations, with contour interval used for Fat'ha, Jeribe formation of 10m. And Euphrates Formation of 5m. All these maps conformation a structural closure in the middle of the study area, having a general trend in the direction Northwest-Southeast. Figures 9, 10, and 11.

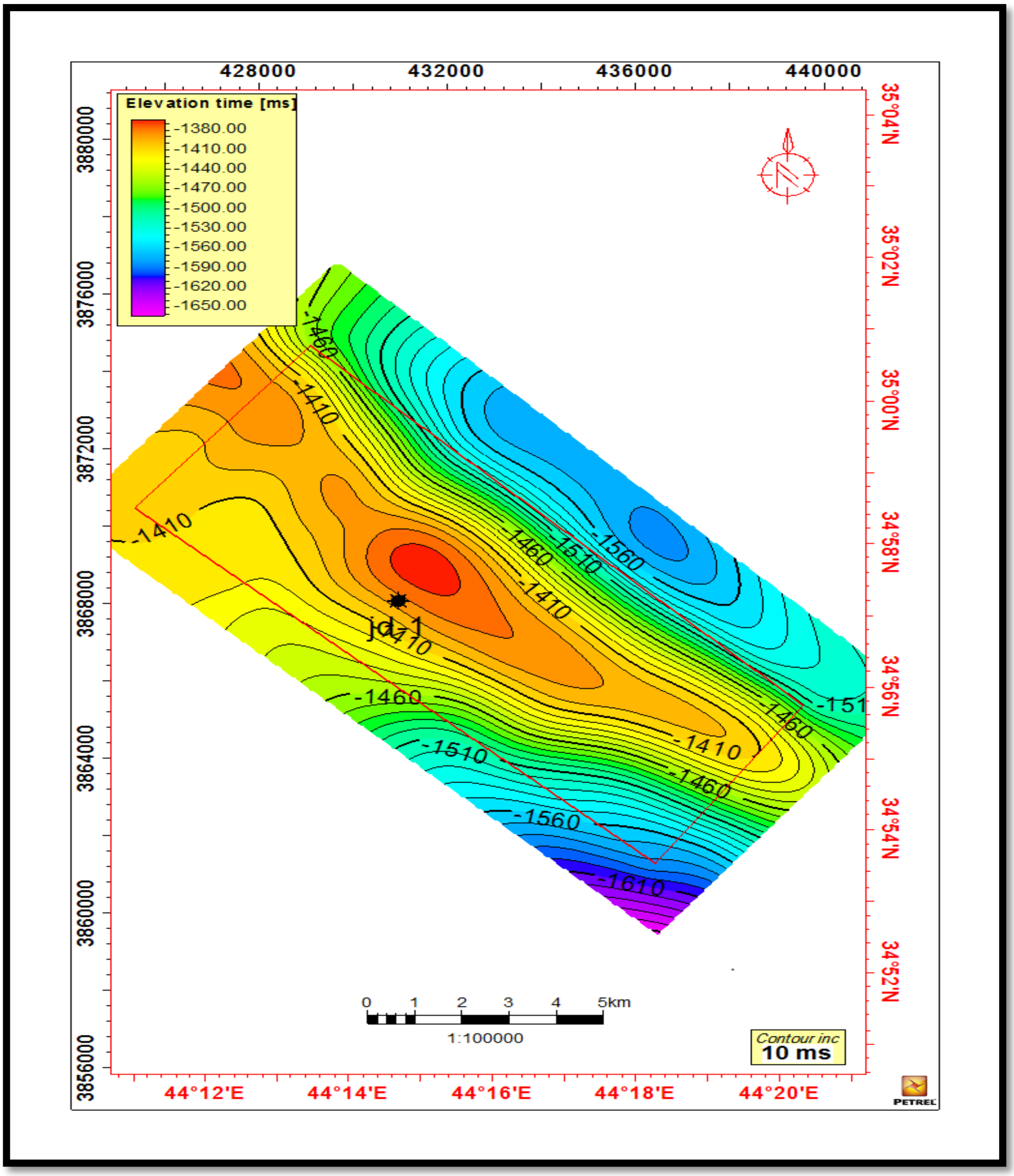

Figure 7- Two-way time (TWT) contour map of Jeribe Formation.

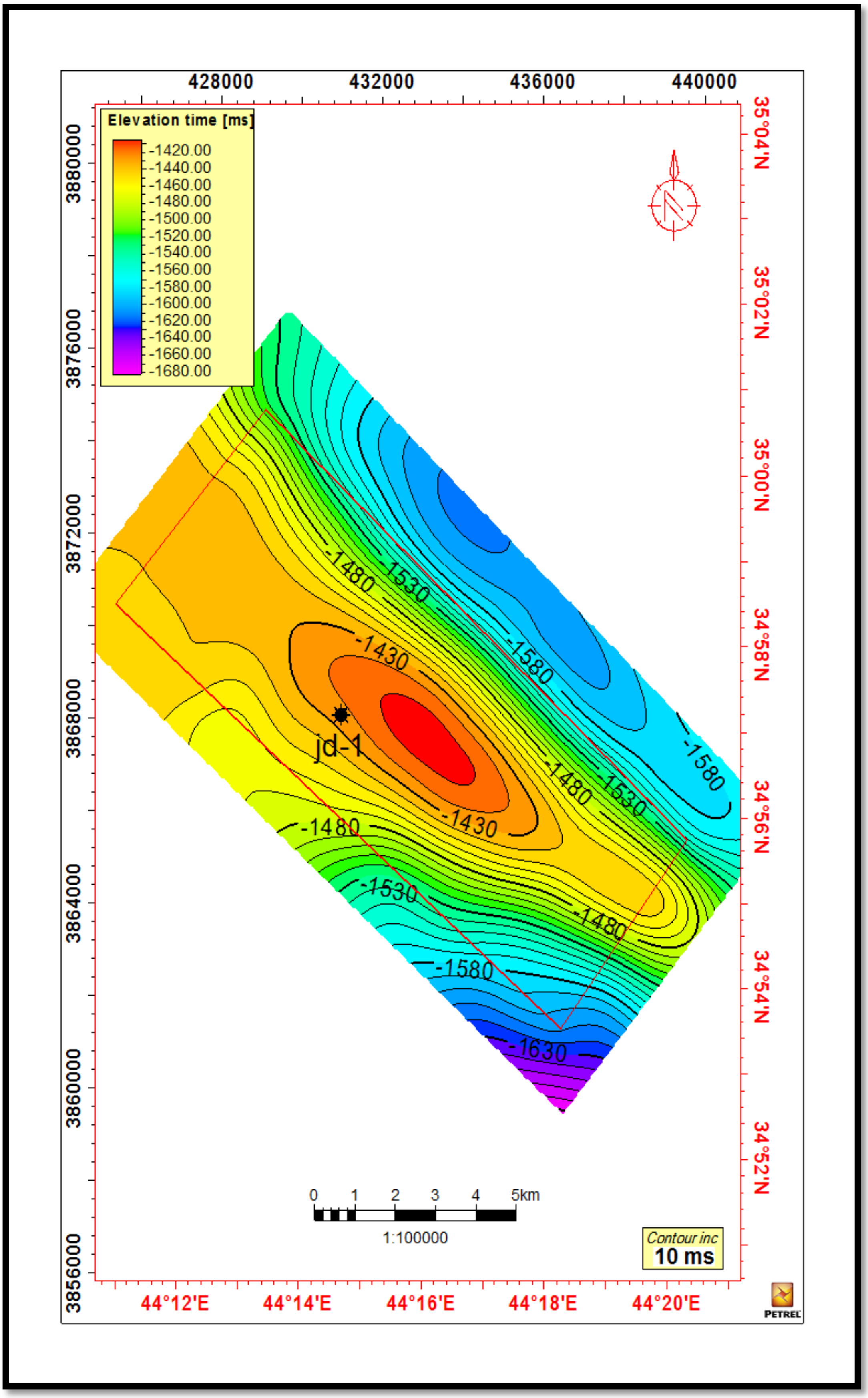

Figure 8 -Two-way time (TWT) contour map of Euphrates Formation**.**

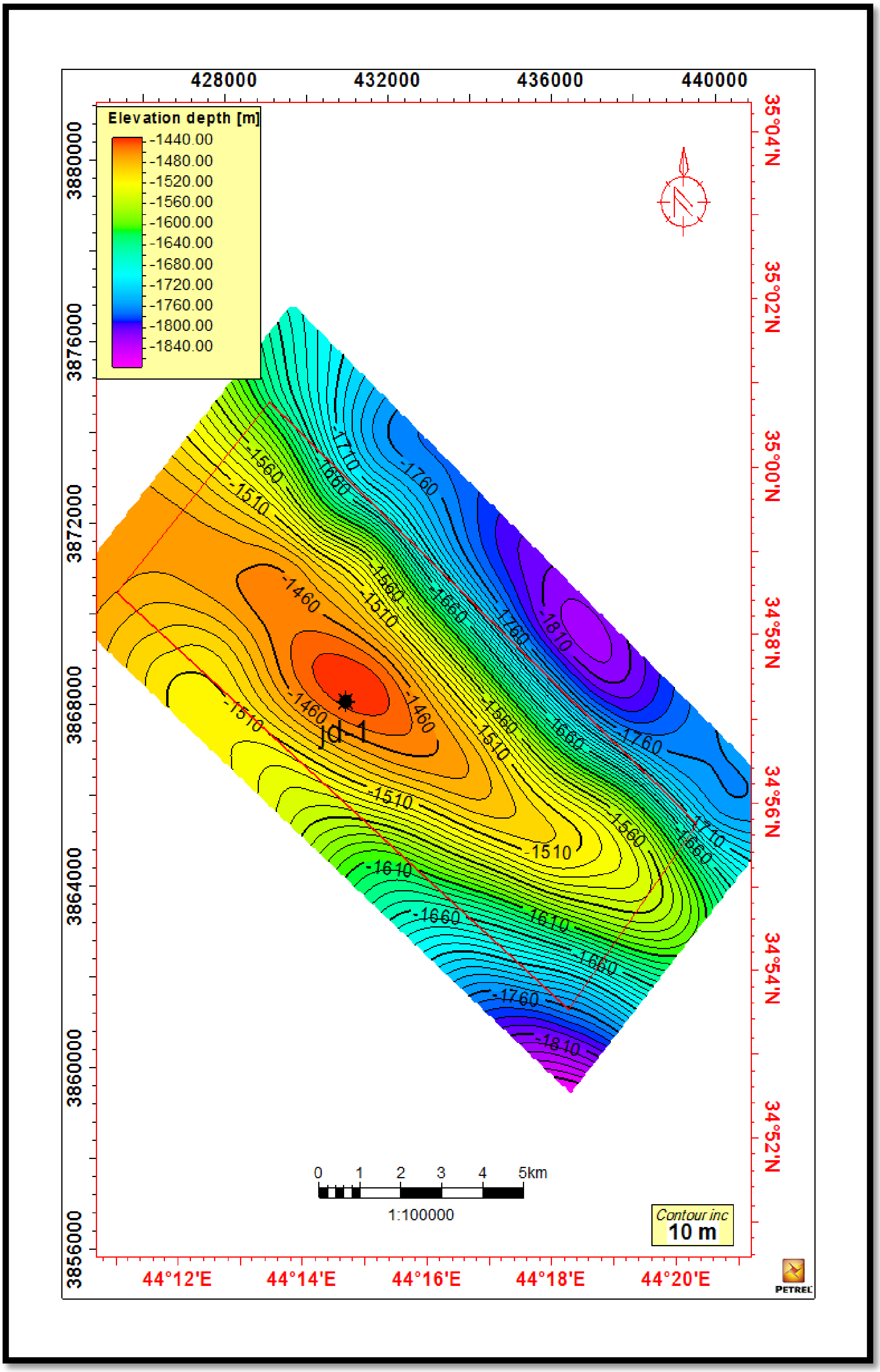

Figure 9-Depth contour map within Fat'ha Formation.

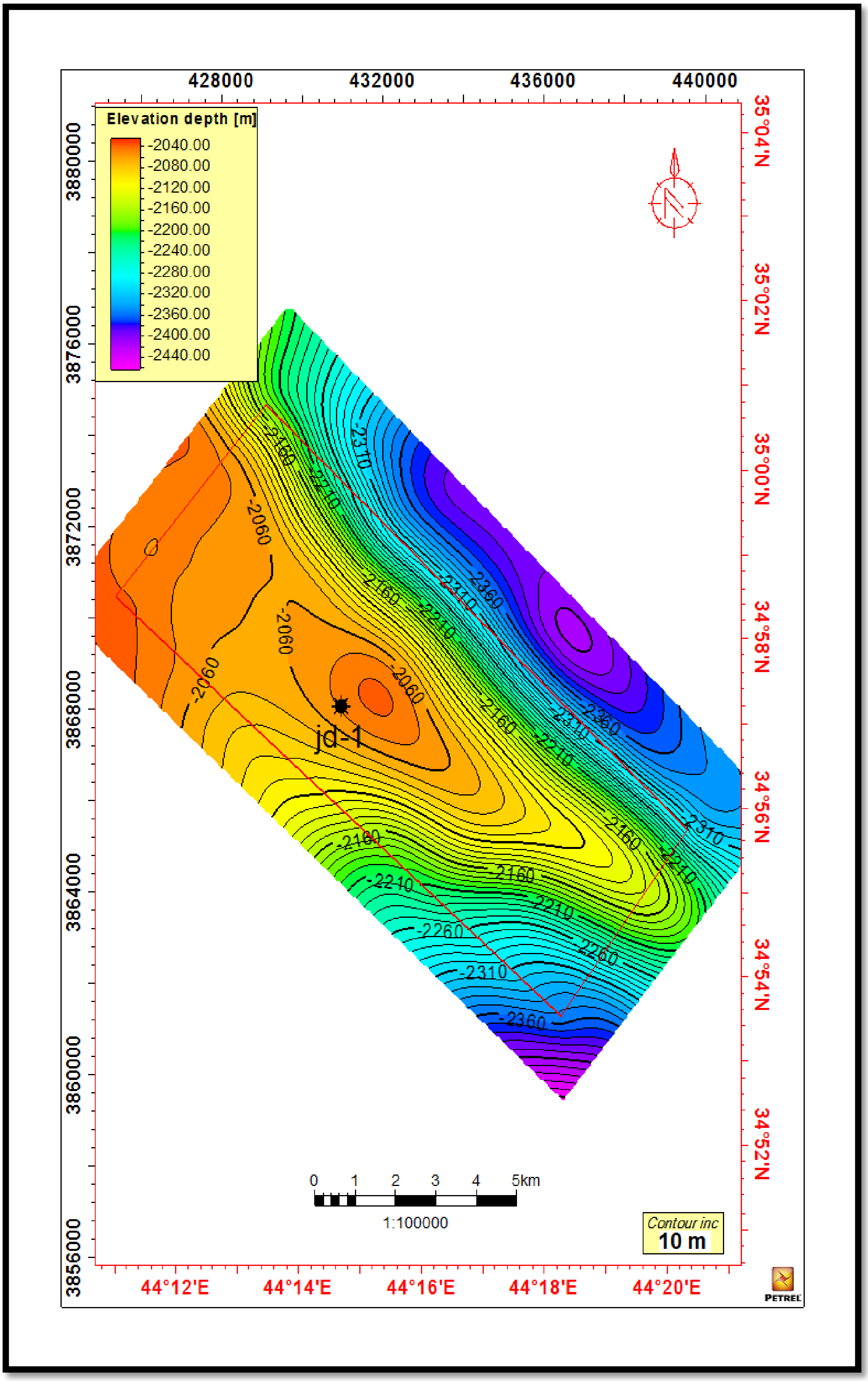

Figure 10- Depth contour map of within Jeribe Formation.

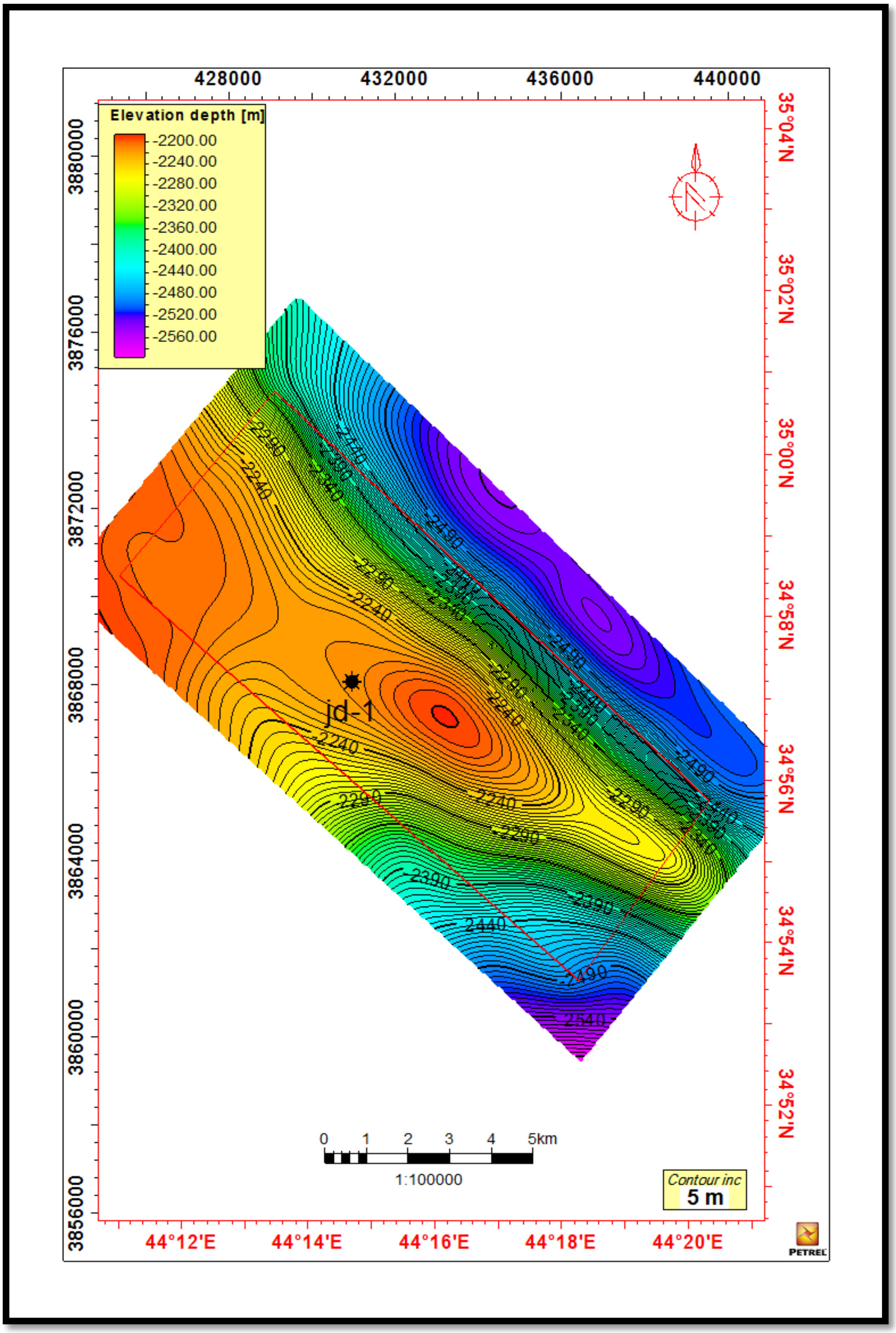

Figure 11-Depth contour map within Euphrates Formation.

8. Conclusion

According to the results of this research, major notes could be stated as the following:

1- Judaida structure represented an asymmetrical longitudinal anticline fold, and the

2- Northeast limb has a dipping angle 6-8 degrees more dip than the Southwest limb that has a dipping angle of 1-6 degrees [21].

3- Three TWT contour maps have been built from the selected horizons of three formations Fat'ha, Jeribe, and the Euphrates respectively by considering the sea level as a datum plane. All maps display the highest area is located in the middle of the study area, and the direction of the axis of the general structure is towards the Northwest-Southeast. The general dipping of the fold is toward the north east.

4- Three depth contour maps, which represent the top of reflectors Fat'ha, Jeribe, and Euphrates formations respectively were constructed and exploited to illustrate the subsurface structural image of the Judaida area. In general, the structure has a general trend in the northwest-southeast direction, all of the depth contour maps for the three reflectors show a structural closure within the area.

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