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Geometry Analysis of Ratawi Field

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Abstract— *Ratawi Field is a promising hydrocarbon bearing structure conforming several reservoirs. Ratawi Field lies northwest of the Basrah city and west of Northern Rumaila Field.The study focuses on the structural analysis (geometric analysis) of Ratawi Structure. Reinterpretation of Seismic Data proved that no presence of any Fault in Ratawi Structure. The Fold Classifications (Geometric Analysis) proved that Ratawi Structure is Dome and Anticline shape, Gentle, Upright and Supratenuous Fold.*

Keywords— Ratawi Field, Structural Analysis, Geometric Analysis, Fold Classification.

I. INTRODUCTION

A fold is a structure produced when an originally planar surface bent or curved as a result of deformation [1]. There are many classifications of the folds ; each one uses the certain geometric parameters of the fold [2], as shown in figure (1).

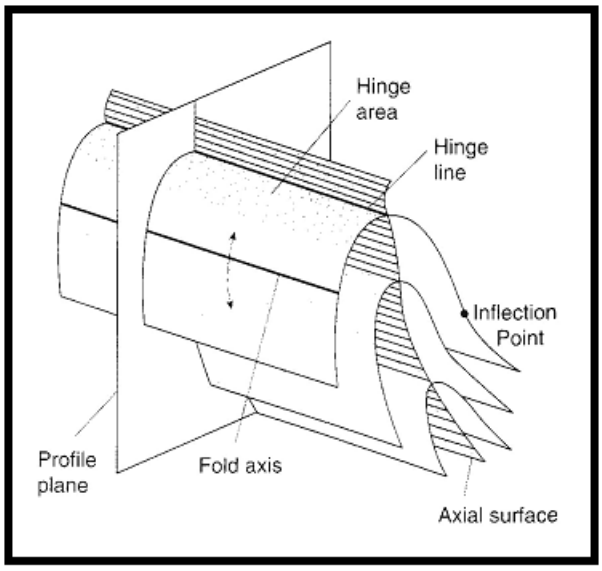

Fig. 1: The geometric parameters of a fold [2].

All Studies carried by Iraqi National Oil Company and it's companies were focused on geological exploration, evaluation, reservoir and petrophysic, reports in addition to the seismic studies. But there is no one report deal with structural side of Ratawi field. The target of this study is to integrate all data (well, geophysical data and structural contour maps) and use them as tools in carrying geometric analysis for Ratawi structure.The geometric analysis include description the Fold, Fold description includes geometrical fold classification based on (Fold Facing, Fold orientation, Fold shape in profile plane and Fold dimensions).

II. LOCATION OF THE AREA

Ratawi Field lies about (70 km) northwest of the Basrah city and approximately (12 km) west of Northern Rumaila Field. The Study Area is about (35) km long and (20) km wide, with surface area about (700) km² [3]. Figure (2) :

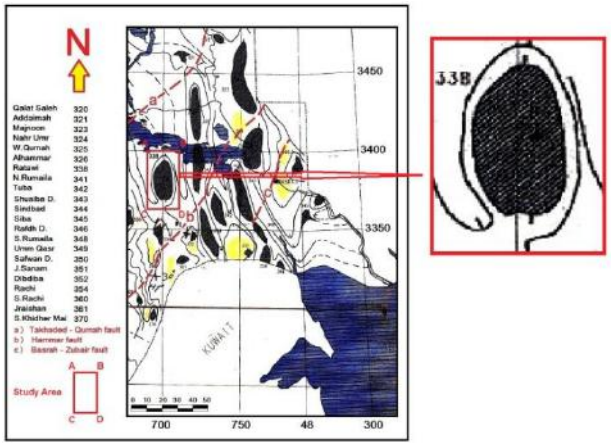

Fig. 2: Location of Ratawi Structure ().

Ratawi field lies within the Stable Shelf , Zubair subzone as a part of Mesopotamian Zone [4]. This subzone has a uniform structural style controlled by the underlying basement and Infracambrian salt [5]. The Zubair subzone is bounded from the north by the Takhadid –Qurnah Transversal Fault. The southern boundary of the subzone is either located at Albatin Fault or a long a transversal fault in Kuwait. This subzone forms the most southern units of the Mesopotamian zone. The southern boundary of the subzone is either located at Albatin Fault or a long a transversal fault in Kuwait. This subzone forms the most southern units of the Mesopotamian zone. The structure of this subzone are long and relatively narrow anticlines, separated by broad synclines, especially in the east. Shorter and oblique trending anticlines are the Zubair and Rumaila structures. Shorter, often broader structures include Nahr Umr, Majnoon, Rachi, Ratawi, Subba and Luhais.

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III. METHODOLOGY

Ratawi Structure is a subsurface structure, therefore, the study reinterpretated four Seismic lines (three were perpendicular on fold axis and one was parallel to fold axis), all of them belonge to Ratawi, Rachi, Rumaila RR survey, figure (3).

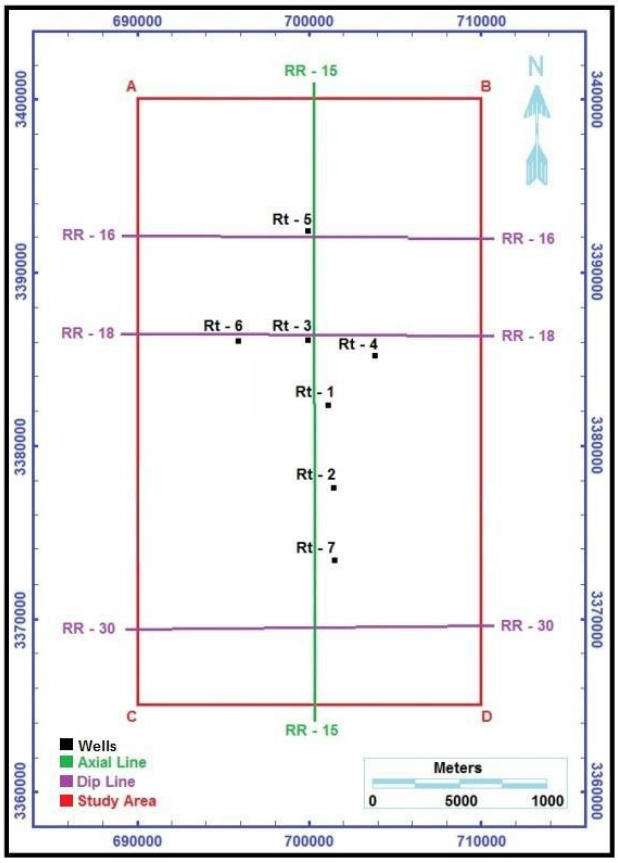

Fig. 3: Base map of Seismic Lines used in this Study.

This survey was carry out by the Iraqi Seismic Party no.8 from 1981 to 1984 by coverage 2400 % and the energy source which used was dynamite and the data were recorded by digital method, The original seismic lines were scanned and the produced tif files were converted into SEGY files. The SEGY data were reprocessed using Omega system which improved their qualities. Reprocessing was carried in the Oil Exploration Company processing center. The continuity was (fair – good) with appearance marked droop in the signal at the level of shallow reflectors, except that, the wave amplitude and the frequency were constant. This processes resulted Seismic dip section, figure (4).

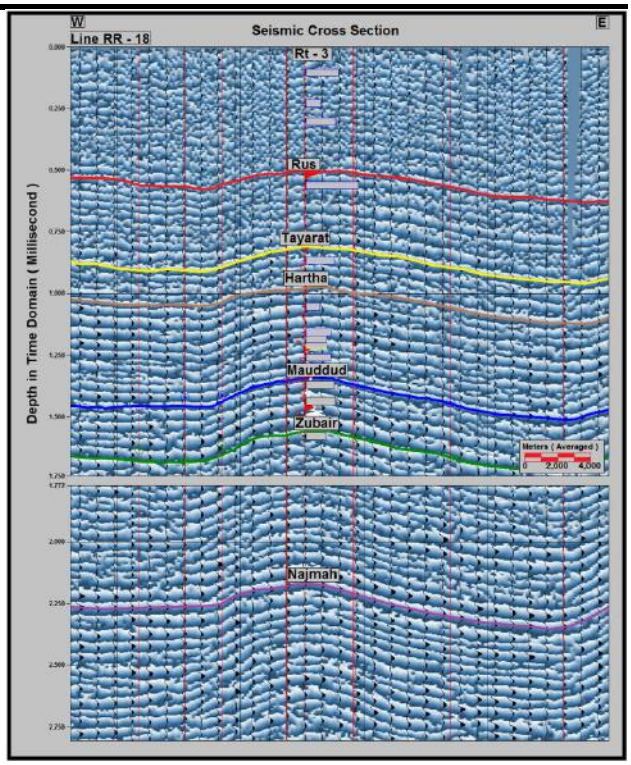

Fig. 4: Seismic dip section represent the number and identification of the picked up reflectors from Line RR – 18 and well Rt - 3.

Six time maps scale 1 / 100000 were prepared from sea level and one contour interval equals (10 millisecond two time) on the top of each reflector.

In this study run the average velocity from calculated by dividing the picked up time of a reflectors at any well and the depth value from a formation tops of well. That is because the velocity data from well are more accurate. Six velocity maps to scale 1 / 100000 were constructed from sea level with contour interval amount (10 m / sec).

Six structural contour maps were constructed, for Rus Formation (Tertiary) Tayarat Formation (Late Cretaceous) Hartha Formation (Late Cretaceous) Maudud Formation (Middle Cretaceous) Zubair Formation (Early Cretaceous) Najmah Formation (Late Jurassic). Values of dip and dip direction and also the plunge angle data are calculated from the contour maps for the formations of Ratawi Structure. Four cross sections were consructed figure (5).

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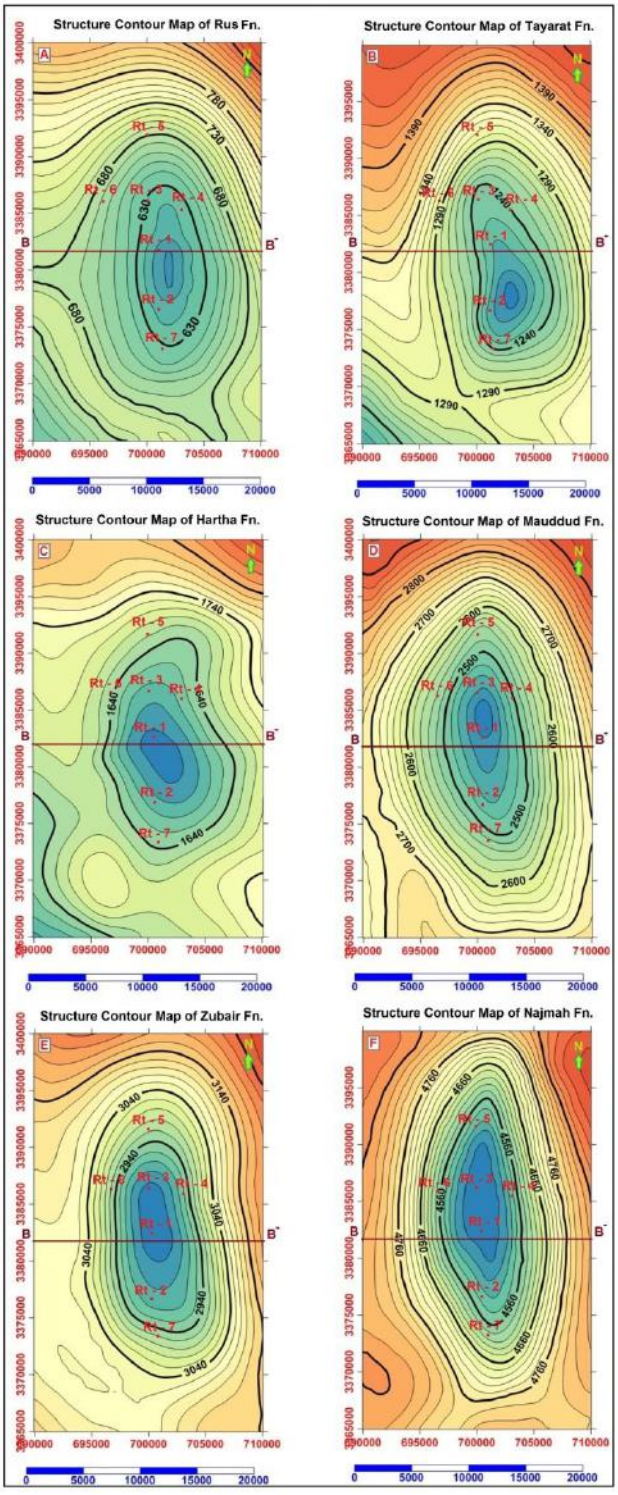

Fig. 5: Structure contour maps . The red dots are the wells and the depth in meter. A, B, C, D, E, F Contour maps of Rus, Tayarat, Hartha, Mauddud, Zubair and Najmah formation respectively.

IV. GEOMETRIC ANALYSIS FOR RATAWI STRUCTURE

According to the geometric parameters of the fold, this study will classify the Ratawi Structure depending on, table (1) and (2).

Table.1: Values of Dip & Dip Direction of Ratawi Structure.

Formations	Dip & Dip Direction	
	Western Limb	Eastern Limb
Rus	275°/ 2.3°	75° / 2.9°
Tayarat	282° / 4°	75° / 5°
Hartha	290° / 6°	54° / 6°
Mauddud	278° / 5.4°	78° / 6°
Zubair	267° / 7°	79° / 8°
Najmah	276° / 7.8°	80° / 9°

Table.2 : Values of dip of Axial Surface, Plunge Angles and Interlimb Angle of Ratawi Structure.

Formations	Dip of Axial Surface	Plunge Angles		Interlimb Angle
		South Plunge	North Plunge	
Rus	89.7°	2°	2°	174.9°
Tayarat	89.5°	4°	4°	171.2°
Hartha	90.0°	2°	2°	169.4°
Mauddud	89.7°	2°	3°	168.8°
Zubair	89.5°	3°	2.4°	165.0°
Najmah	89.4°	4°	4°	163.4°

4.1 Fold facing

According to direction of a closure, which is obtain from the direction of axial surface direction, there are three kinds of folds which are antiforms (close upwards), synforms (close downwards), and neutral (close in a horizontal direction) [6]. The cross sections and the values of dip and dip direction of the Ratawi Structure show that the structure is an antiform structure.

4.2. Fold Orientation

4.2.1. According to the dip of Axial Surface

An axial surface defined as a surface that connects fold hinge lines [7]. According to dips of Axial Surface, folds are classified to three types (Recumbent, Inclined, and Upright). The average dips of axial surface of Ratawi Structure is (89.6˚) are shown in table (2) and these value referred to that the structure is Upright fold.

4.2.2. According to the Plunge of Hinge Line

Hinge line is a line included the maximum curvature on the surface of a layer [7]. According to the plunge of hinge line a fold can be classify to five types [6], table (3).

Table.3: Classification of folds based on the plunge of hinge line [2].

Type of Fold	Plunge of Hinge Line
Horizontal	0° - 10°
Shallow	10° - 30°
Intermediate	30° - 60°
Steep	60° - 80°
Vertical	80° - 90°

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The values of plunge of the hinge line of Ratawi Structure were calculated for the south and north ends of the structure. These values are ranged from 2˚ to 4˚. Therefore, Ratawi Structure is classified as a horizontal fold or non – plunged fold.

4.2.3. According to the Symmetry of fold

The symmetry of a fold can be determined by the relationship between lengths of limbs. Symmetrical folds have limbs of equal length and asymmetrical folds have unequal limbs [8]. The cross section confirmed that Ratawi Structure is asymmetrical Structure because the eastern limb is shorter than western limb, figure (6).

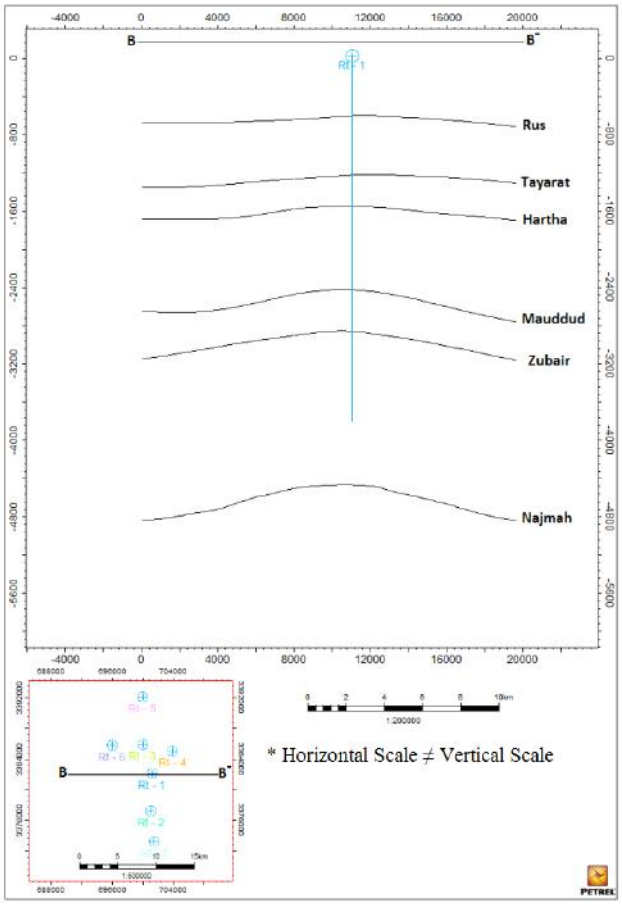

Fig. 6: The Cross Section B – B¯

4.3. Fold Shape in Profile Plane

The plane taken perpendicular to the hinge line is called the profile plane of a fold [2]. It used two parameters : the interlimb angle and variation in thickness.

4.3.1. According to the Interlimb Angle

The angle between the limbs of a fold is called the interlimb angle [9]. The values of interlimb angle can be obtained through the values of dips of the formations instantly or vai using Stereonet software . Table (2) show that the interlimb angle of the Ratawi Structure is ranging between (Rus Formation) to (Najmah Formation) . The values indicated that the Ratawi Structure is a gentle fold and stated the effect of folding deceased toward the recent formations .

4.3.2. According to the Variation of Thickness

Thickness ratio (R), the ratio existing between the hinge thickness and the limb thickness. Axial Angle (α) which is the angle for a given (outer or inner) trace or arc of a fold as across at the apex (hinge). The outer axial angle (α_o) and inner axial angle (α_i) are the acute subtended by the outer and inner arcs respectively at the apex [10]. The study used the cross section (B - B¯), because it pass through crest maxim, used Mauddud Formation as outer arc and Najmah Formation as inner arc of Ratawi fold section and then calculated the values of thickness ratio (R) and the axial angle (α), as shown in table (3).

Table.3: The results of axial angle and thickness ratio classification of Ratawi Structure .

Axial Angle Inner Arc (α_i)	163.4°
Axial Angle Outer Arc (α_o)	168.8°
Thickness Limb (T_1)	2120
Thickness Hinge (Th)	2060
R	0.972
α	166.1°

According to the results, the Ratawi Fold is Supratenuous Fold.

4.4. Fold Dimensions

This classification is based on the ratio between the lengths (L) to width (W) of the folds relative to same layer boundary. It has three types [11] : Linear fold (L / W > 5), Brachy fold (5 > L / W > 2), Domes and Basins fold (L / W < 2). The axial length and maximum width measured from the contour maps of Zubair Formation and Najmah Formation , as shown in figure (7) and table (4) :

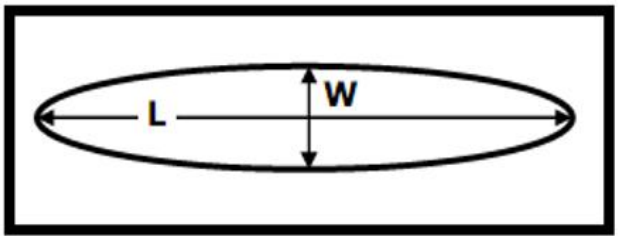

Fig.7: Classification of fold based on the ratio between the length (L) and Width (W) of fold [11].

Table.4: The results based on fold dimensions .

Formation	Zubair	Najmah
Contour no.	3060	4760
Axial Length (L) (m)	24923.1	25461.54
Max.Width (W) (m)	12969.2	13846.15
Ratio (L / W)	1.88	1.84

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Based on value of the Ratio (L / W) for Zubair and Najmah Formation , Ratawi structure belongs to Dome and Basin Fold .

4.5. Fold Curvature

According to [12] and [13], Curvature analysis is a method used the orientations and values of two perpendicular principal curvatures, which is the maximum curvature (K1) or (Kmax) and minimum curvature (K2) or (Kmin) in the principal directions. In addition, the contour pattern and the signs of K1 and K2 can use as an indication to a structure type. Whereas, if K (K1*K2) more than zero with positive sign, and the contour pattern . Ratawi Structure belongs to dome and basin pattern because the positive sign of K values (K>0) table (5) and according to its contour line style.

Table.5: Summarize the values of K1, K2, KG and KM for each of Rus, Tayarat, Hartha, Mauddud, Zubair and Najmah horizons.

Formation	K1 (m) $* 10^{-7}$	K2 (m) $* 10^{-7}$	KG $* 10^{-14}$	KM $* 10^{-7}$
Rus	4.2	1.27	5.33	2.74
Tayarat	4.6	1.38	6.35	2.99
Hartha	5.3	1.41	7.47	3.36
Mauddud	5.9	1.46	8.61	3.68
Zubair	6.1	1.48	9.03	3.79
Najmah	6.5	1.51	9.82	4.01

V. CONCLUSION

Ratawi Structure is Anticline and Dome structure. The average of values of axial surface is (89.6°), while the plunge of hinge line between (2° - 4°) reffered to that Ratawi Structure is Upright and Horizontal fold. The length of eastern limbs lesser than western limbs. While, the dip amounts of eastern limbs are more than western limbs. This confirmed the asymmetrical characteristic of Ratawi Structure. The amount of dip to Cretaceous Formations more than Tertiary Formations. Contrary, the average of interlimb angles of Tertiery Formations less than Cretaceous Formations. This probably because the Cretaceous Formations are closer to Salt Structures and the influence of tectonic movement more than Tertiary and Recent. The cross sections and Isopach maps confirmed the differences in thickness between crest and limbs. This referred to vertical compression force of Salt structure . The difference in dimensions (Length / Width < 2) confirmed the dome feature of Ratawi Structure. The pattern of contour lines and values of Ratawi Structure's curvatures (positive and more than zero) verify the dome characteristic of it.

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