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Detect faults of Zubair and Mishrif Formations– ZubairOilfield by integrateStructural geology and Pressure transient analyses (PTA)to selected wells:

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Abstract:
The current study aims to combine the interpretations of the structural geology and pressure transient analyses (PTA) to detect the presence of faults in Zubair and Mishrif Formations in Shuaiba Dome (or culmination) - Zubair Oilfield. The structural analysis included geometric and genetic analysis. The PTA analysis used the fluid rates, the pressures (preferably downhole), the fluid PVT, and a few additional parameters (well radius, pay zone, etc.) required from well tests to switch from a qualitative to quantitative analysis. The current study assured the efficiency of using the PTA analysis to detect the faults and it confirmed the presence of major parallel faults of Zubair formation. Besides, the study detects that the major parallel faults may extend to Mishrif Formation not just to Rumaila Formation as per 3D seismic interpretation results. The thickness of the crest of Zubair and Mishrif Formations are less the thickness of limbs. This is maybe related to a bending force that happens because of tectonic movements, reactivated basement faults, and Hormuz salt structures. Consequently, extensional force stretched, and thinned with faults are characterized in Zubair and Mishrif Formations. These faults detected by seismic, structural geology, and PTA analysis.

Keywords:*Zubair Formation, Mishrif Formation, ,Pressure transient analyses (PTA) analysis, structural geology, ZubairOilfiled*

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I. Introduction

Zubair and Mishrif Formations are important reservoirs in Iraq. Seismic interpretation of Zubair field confirmed the presence of faults in Zubair and Mishrif Formations, and there are two major parallel faults extend from Yammam till Rumaila Formation [15]. The study combined the structural geology and PTA analyses to detect and confirm the presence. Zubair Oilfield lies in southern Iraq, within the Zubair Subzone of Mesopotamian basin [7]. Zubair Formation belongs to the Lower Cretaceous depositional cycle in Iraq. It consists mainly of interbedded sandstone and shale [5]. Mishrif Formation is a carbonate Formation that deposited in the Middle Cretaceous (Cenomanian-Early Turonian) [16]. The structural analysis included geometrical and genetic analyses. Geometrical analysis interested in the geometric elements of Zubair and Mishrif Formations. While, genetic analysis employed the results of geometric analysis and the geophysics interpretations to determine the forming causes, type, and the origin of Zubair and Mishrif structures. The PTA analysis used the fluid rates and the pressures preferably downhole, in addition to the fluid PVT and a few additional parameters (well radius, pay zone, etc.) required from well tests to switch from a qualitative to a quantitative analysis [13].The previous analyses connected to detect and confirm the presence and Extension of faults to understand the geological situation and its effect on the results of well test data ad results.

II. Geologic Setting

According to the tectonic division of [4], Study area lies in Mesopotamian Zone within an Unstable Shelf of Arabian Platform. While [12] and [13] mentioned that Zubair Oilfield lies in the sagged basin within the Mesopotamian zone of the qusiplatform Foreland belt of the Arabian plate. Study area located in the Zubair Subzone of the Mesopotamian Zone, whereas the structures of this Subzone controlled by the basement structures and Infracambrian salt [6]. [2] stated that Zubair Oilfield belongs to the Unstable Shelf, and the causes of instability are basement faults, salt structures, and Alpine Orogenic Movements. These causes form anticline subsurface structures in southern Iraq. Zubair Subzone bounded by basement faults which are Takhadid-Qurna Transversal fault from the north and Al-Batin fault from the south [6] as shown in figure no 1. The negative gravity anomaly of the primary Zubair Subzone structures confirmed the presence of deep-seated Infracambrian salt rocks [6], [7], [8], and [9].

III. Materials and Methods:

PTA:The interpretation made by Ecrin software v3.4 for the 6 selected wells Zb-(A, B, C, D, E, and F) to determine Reservoir model, Boundary, Productivity index (PI), Permeability (K), Formation damage (Skin), Radius of investigation (ri), Reservoir pressure for selected wells of Zubair and Mishrif Formations. The current study used the well test data of the pressure-temperature test (PT) in the shut-in phase for each selected wells. The PT test used with wire-line (Gamma Ray (GR), Cacing collar log (CCL), Pressure, and Temperature sensors).

Structural geology: the current study used a geological model of the Zubair Oilfield to construct depth via Petrel v2016 software with scale 1:50000. Steronet 9 software used for stereographic projection to determine the structural geological attitude (interlimb angle, hinge line, and axial surface). The dip and strike [clockwise] calculated from the depth contour maps and thickness variation from drilling data of Zubair and Mishrif Formations.

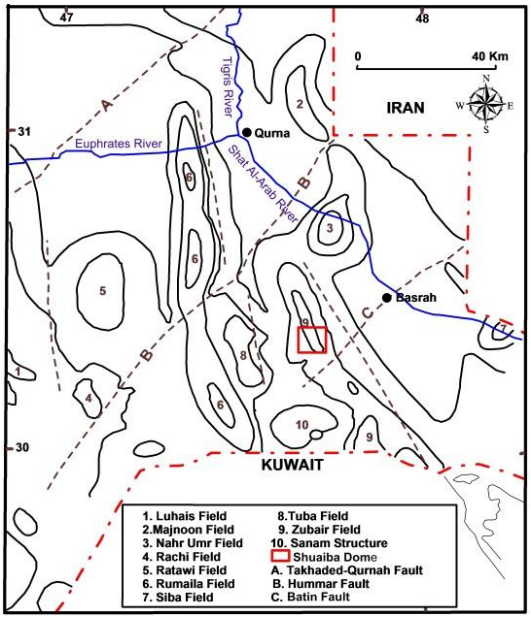


Figure no 1: The location of Zubair field with respect to the surrounding major parallel structures at the depth (4000m), suothern Iraq with some of the basement faults in Mesopotamian zone, Modified from [1].

IV.Structural Geology Analysis:

Geometric Analysis:

The study area is Shuaiba Dome, the southern part of Zubair Oilfield. The northern part of study area separated from the Hammar Dome by the shallow saddle and the southern part separated by another saddle from Rafidhiya Dome**f**igure no 1**.** There are many classifications of the folds and each one uses certain geometric parameters of the fold. The current study used the depth, thickness, and dip contour maps of Zubair and Mishrif Formations, as shown in figuresno 2, 3, and 4respectively**,**and Stereographic Projection results, asshown in table no1. According to the essential parameters of the fold, Zubair and Mishrif Formations classified depending on:(a) Fold facing, (b) Fold orientation (dip of axial surface, a plunge of the hinge line, and symmetry of fold), (c) Fold the shape in profile plane (interlimb angle and variation in thickness), and (d) Fold dimensions [14], the results of these classifications of study area,as shown in table no 2.

Table no 1: Sterographic Projection results

Formation	Dip of Left Limb	Dip of Right Limb	Interlimb Angle	Hinge Line	Axial Plane
Zubair	3.5º/339º	3.5º/159º	173º	0º/339º	89.7º/159º
Mishrif	3º/342º	3º/162º	174º	0.2º/342º	89.7º/162º

The thickness of the crest of Zubair and Mishrif Formations is less than the thickness of the limbs. The reason and the implications of thickness variation will clarify in the genetic analysis because it is so important to understand the structural picture of Zubair and Mishrif Formations and its reservoir implication.

Table no 2: Results of Geometric Analysis for Zubair and Mishrif Formations.

Structural Parametres		clasification
Fold Facing		anticline structure
Fold Orientation	dip of axial surface	upright fold
	plunge of the hinge line (fold axis)	non-plunged fold
	Symmetry of fold	asmmetrical
Fold shape in profile plane	Interlimb Angle	gentle fold
	Variation in thickness	Supratenous fold
Symmetry of the fold		Asmmetricl fold

Genetic Analysis:

Three combined main forces worked to form subsurface anticline structures in southern Iraq included study area. These are tectonic Movements, reactivated basement faults, and Hormuz salt structures [2], [6], [7], [8], and [11] as shown in tectonic model in figure no 5**.** Geophysical surveys of southern Iraq indicated that the association of negative gravity could be a result of deep-seated salt beds of Infra-Cambrian salt beds, while the positive gravity referred to basement uplift [6] [7], [8], [9]. [15] referred to negative anomaly associated with study area, which may be related to Infra-Cambrian salt structures (Hormuz salt).

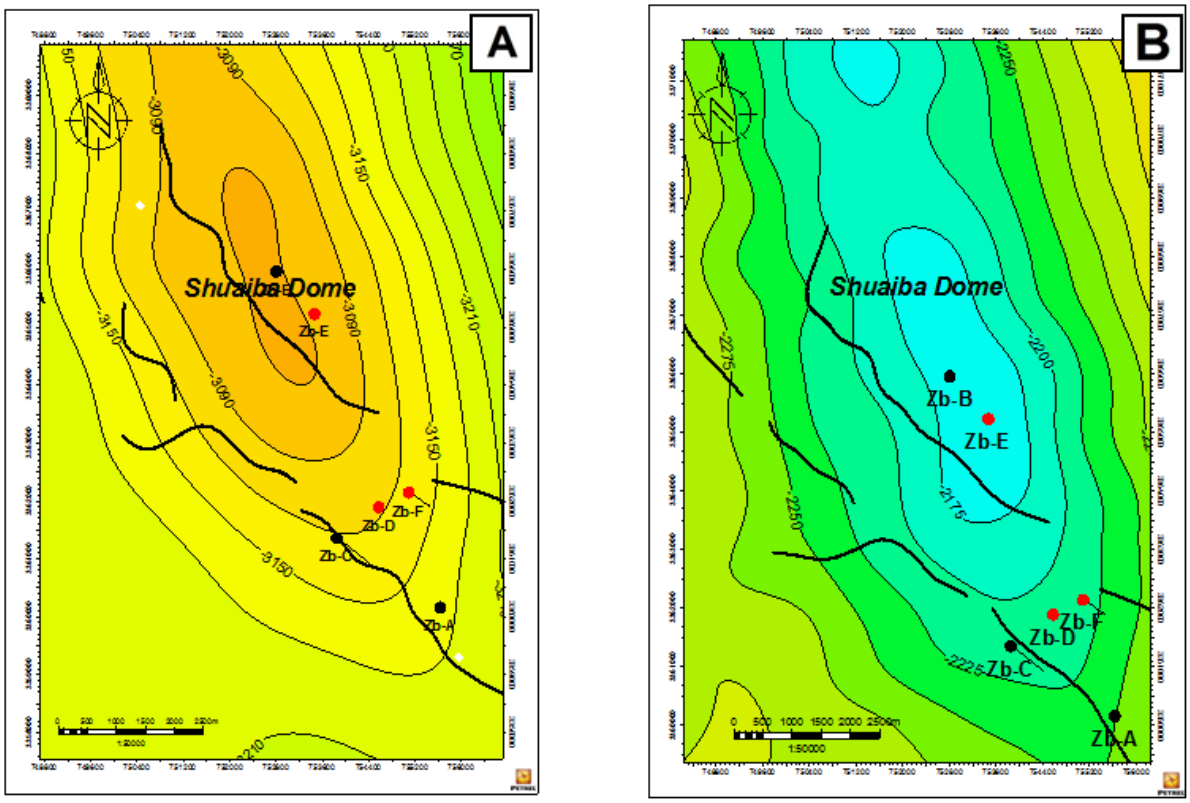


Figure no 2: Depth Contour map of (A) Zubair formation (B) Mishrif Formation of Zubair Oilfield, Southern Iraq.

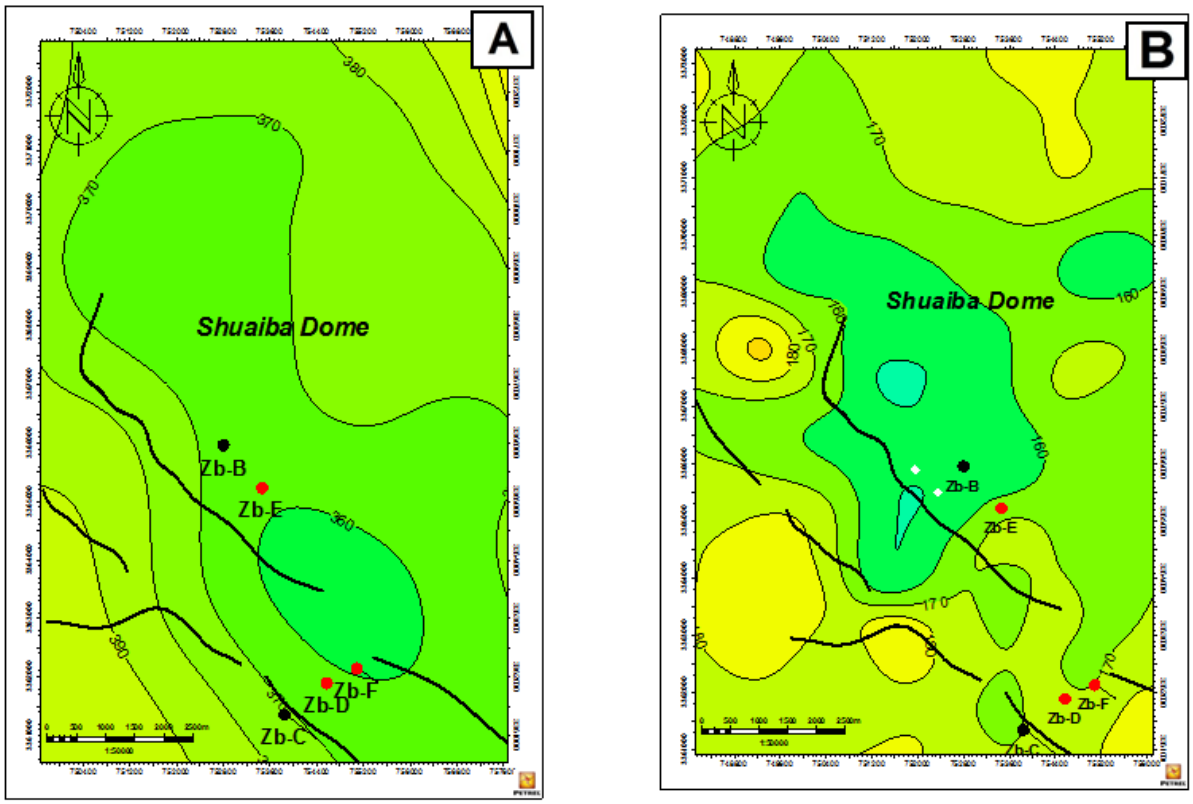
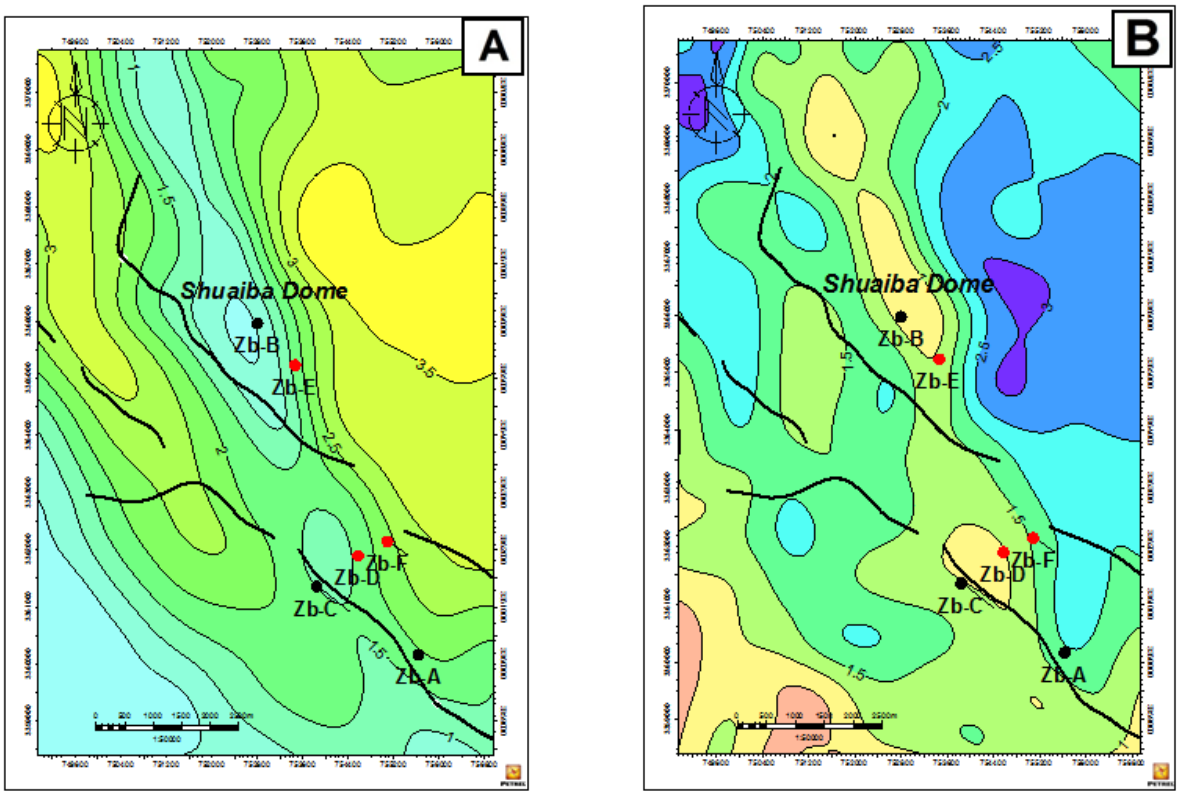


Figure no 3: Thickness Contour map of (A) Zubair formation (B) Mishrif Formation of Zubair Oilfield, Southern Iraq.



Figureno 4: Dip Contour map of (A) Zubair formation (B) Mishrif Formation of Zubair Oilfield, Southern Iraq.

Arching and thinning of the layers originated by extensional tectonic are common features associated with the salt structure and this leads to normal faults over the tops of the anticlines [14] and these faults are may be radial or parallel [3]. The interpretation of the 3D seismic survey of Zubair filed to confirm the presence of majors parallel faults. These faults are extended form Yammama Formation to Rumaila Formation [15].

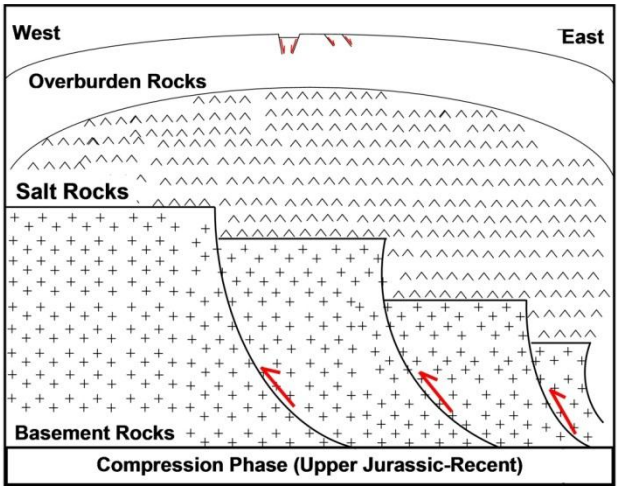


Figure no 5: Tectonic model for Oilfields in southern Iraq [10].

The results of the geometric analysis confirmed that Zubair and Mishrif Formations influenced by tectonic activities. The fold axis of Zubair and Mishrif Formations tends to NW-SE. This direction may be attributed to counterclockwise rotation of the Arabian plate and this direction compatible with surrounding fold axes fields of southern Iraq, likeNahrUmr Filed [10]. Thickness variation between the crest and the limb of Zubair and Mishrif Formations may attribute to the bending fold mechanism due to the effect vertical force of Hormuz salt structures. The dip values of Zubair and Mishrif Formation limbs are almost equal.Consequently, The current study suggests a scenario for Zubair and Mishrif Formation deposition. At Cenomanian-Early Turonian the tectonic activity prevails result of obduction between Arabian and Iranian plates, which led to reactivate the basement faults and induced salt structure below Shuaiba Dome and made uplift (Early Cretaceous uplift).

V. PTA Analysis

The PTA was still called Well Test Interpretation, analyses were performed on data acquired during an operation called well tests. It is a method to make direct contact with the reservoir. [17] Objectives of PTA are to determine the Reservoir model, Reservoir pressure, Productivity index (PI), Permeability (K), Formation damage (Skin), Radius of investigation (ri), Boundary. One of the most important consequences of boundary results is the detection of faults[17] and [13]. Build up or Shut-In test the most common test for a completion/reservoir evaluation, Pressure buildup tests involve recording pressure data while a well is shut in after a period of flow [13]. The two main curves can build test analysis which is [log-log plot & semi-log plot] and from these curves the final results after performing the interpretation and get the match between pressure derivative and reservoir pressure. In the matching process. One of the most important consequences of boundary results is the detection of faults[17]. The results of PTA of build test analysis of 6 selected wells of study area shown in the table no 3 and in (Appendix). The results and graphs confirm the presence of the major parallel faults of Zubair Formation as stated in the 3D seismic interpretation of Zubair filed and referred that the major parallel fault may extended to Mishrif Formation, not as 3D seismic interpretation reported that the major parallel fault extended to Rumaila Formation only.

Table no 3: The results of PTA of build test analysis.

Well No.	Formation	Reservoir model	Boundary	PI (bpd/psia)	K (mD)	Skin (t)	ri (ft)	Reservoir pressure (psi)
Zb-A	Zubair	Homogeneous	Parrallel faults	5.9	106	4.3	1030	3833.4
Zb-B	Zubair	Homogeneous	Parrallel faults	7.75	251	7.49	468	2970.36
Zb-C	Zubair	Homogeneous	Parrallel faults	7.64	144	1.93	1050	2987.6
Zb-D	Mishrif	Homogeneous	one fault	16.69	56	1.89	228	2524

Zb-E	Mishrif	Homogeneous	Parrallel faults	35.85	319	-3.28	525	2776.5
Zb-F	Mishrif	Homogeneous	one fault	7.84	181	-3.11	899	2564

VI. Conclusions:

Zubair and Mishrif Formations reservoir model areHomomgeneous and its boundariesare one fault or parralell faults. The type of boundary of Mishrif reservoir reffered to that the major parallel faults may extended to Mishrif Formation not as 3D seimic interpretation reported that the major parallel fault extended to Rumaila Formation only.Zubair and Mishrif Formationsare an anticline, upright, non plunge, asymmetrical (the length of western limb is longer than eastern limb), and gentle fold. The thickness of the crest of Zubair and Mishrif Formations is thinner than its limbs and this may attributed to bending force due to salt structure effect. The fold axis of Zubair and Mishrif Formations tends to NW-SE and this direction may attributed to counterclockwise rotation of the Arabian plate and this direction compatible with surrounding fold axes fields of southern Iraq. Three combined main forces create Zubair and Mishrif Formations structure (tectonic movements, reactivated basement faults, and Hormuz salt) may worked to form Zubair and Mishrif Formations (structures).

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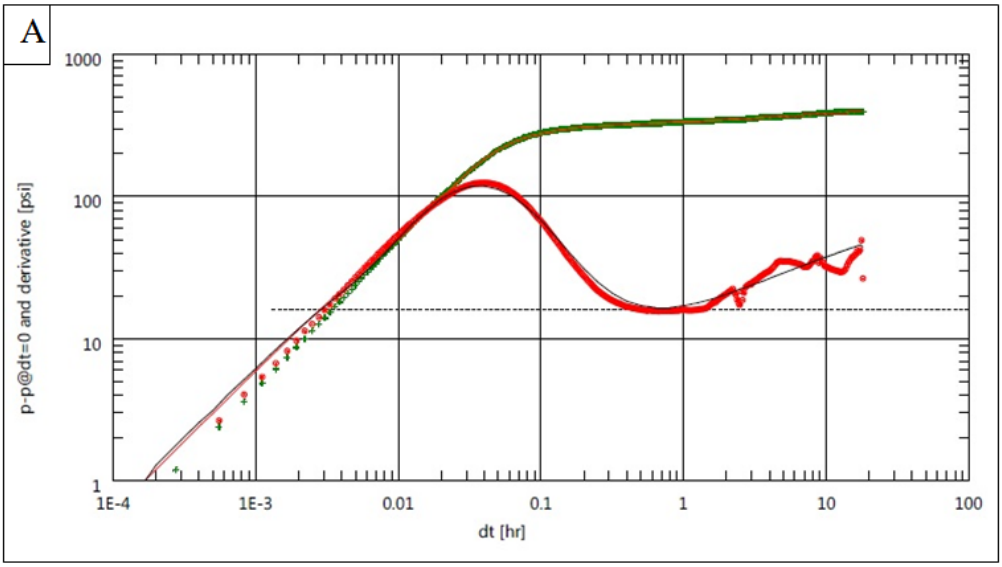
Appendix: PTA logs (Log-Log and Semi-Log) charts of 6 selected wells



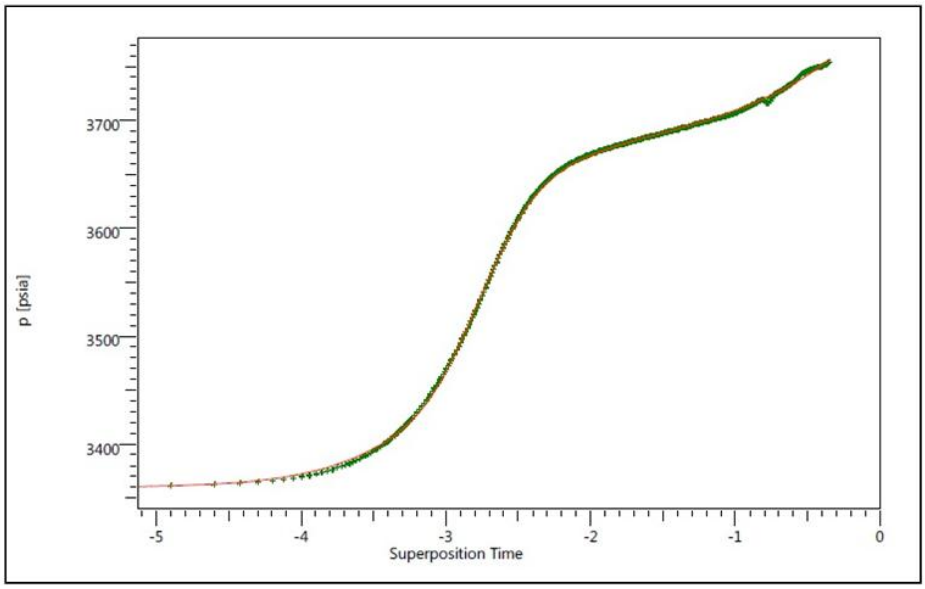
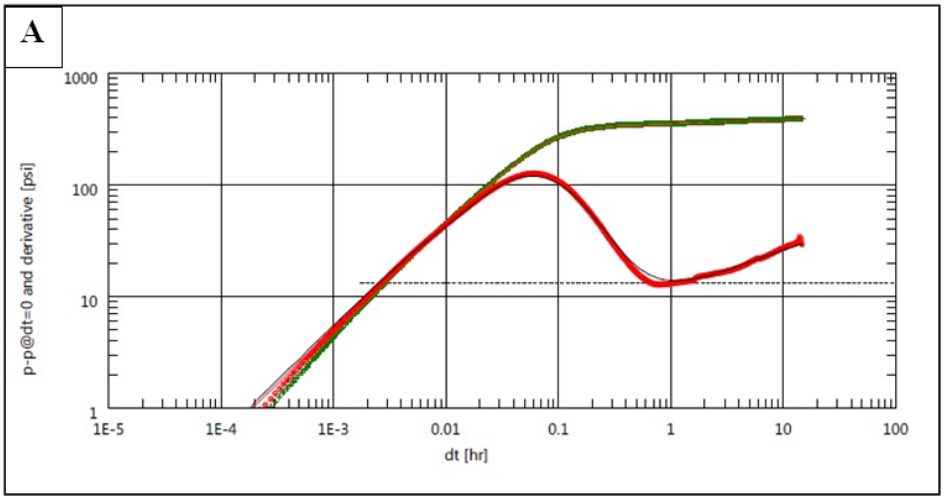


Figure no 1: PTA logs charts (A: Log-Log and B: Semi-Log) of Zb-A.



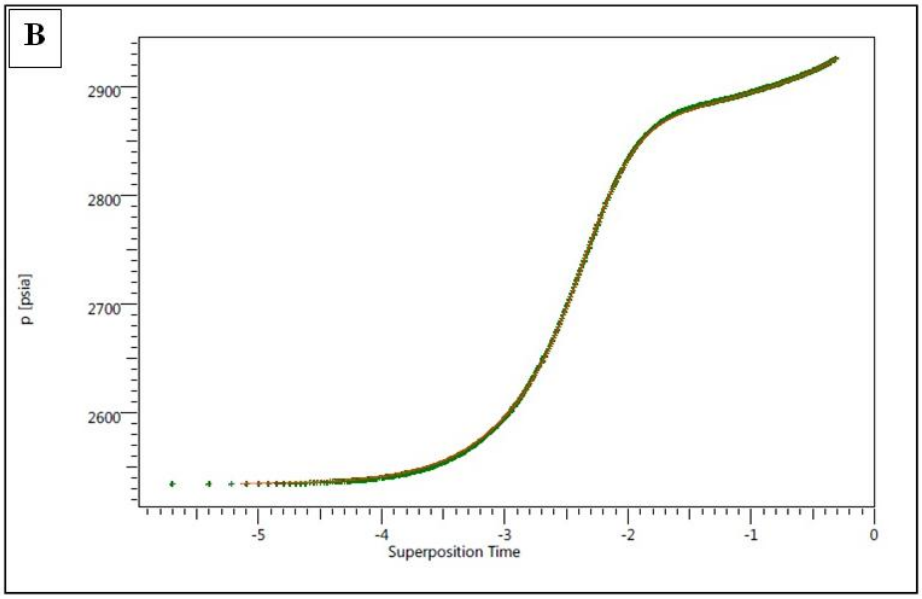


Figure no 2: PTA logs charts (A: Log-Log and B: Semi-Log) of Zb-B.

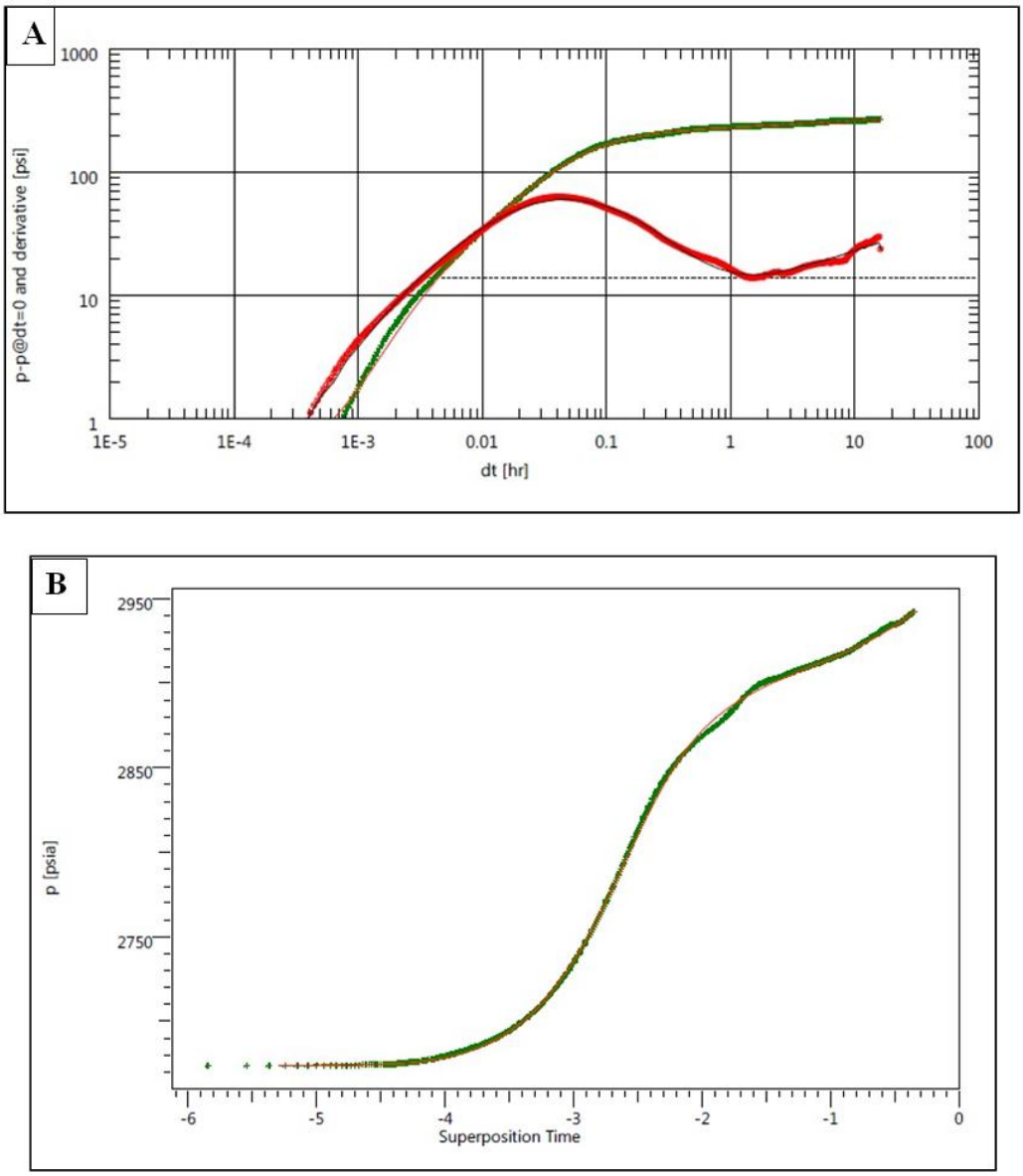
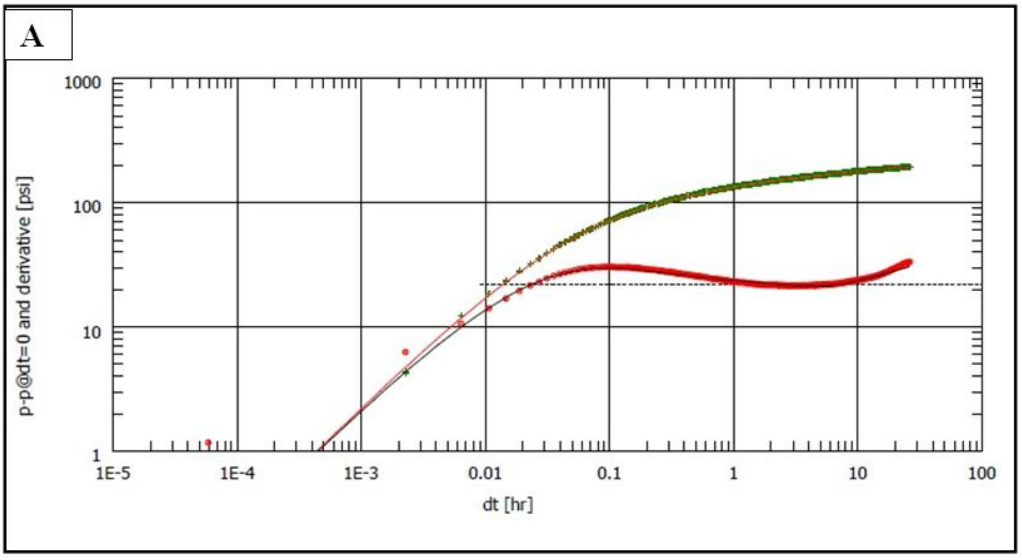


Figure no 3: PTA logs charts (A: Log-Log and B: Semi-Log) of Zb-C.



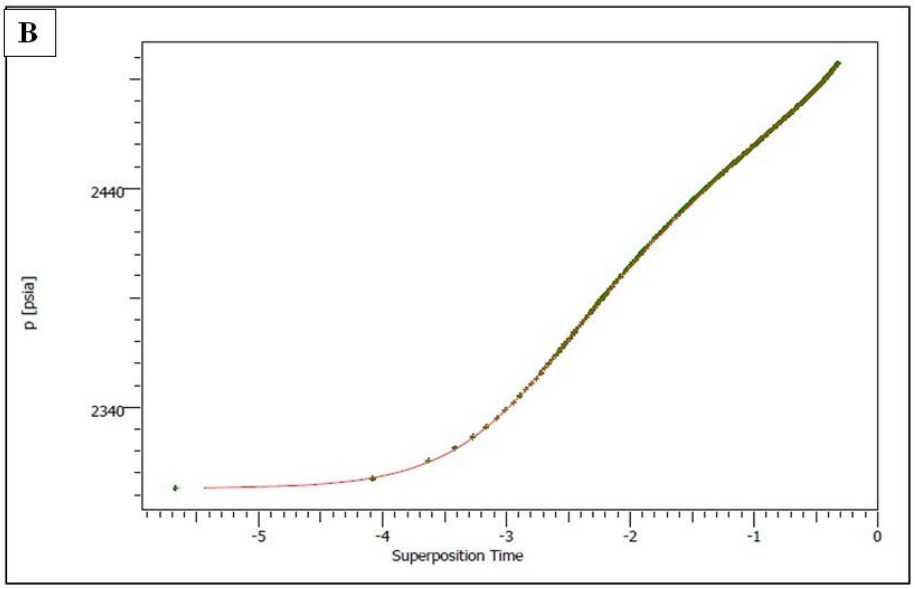
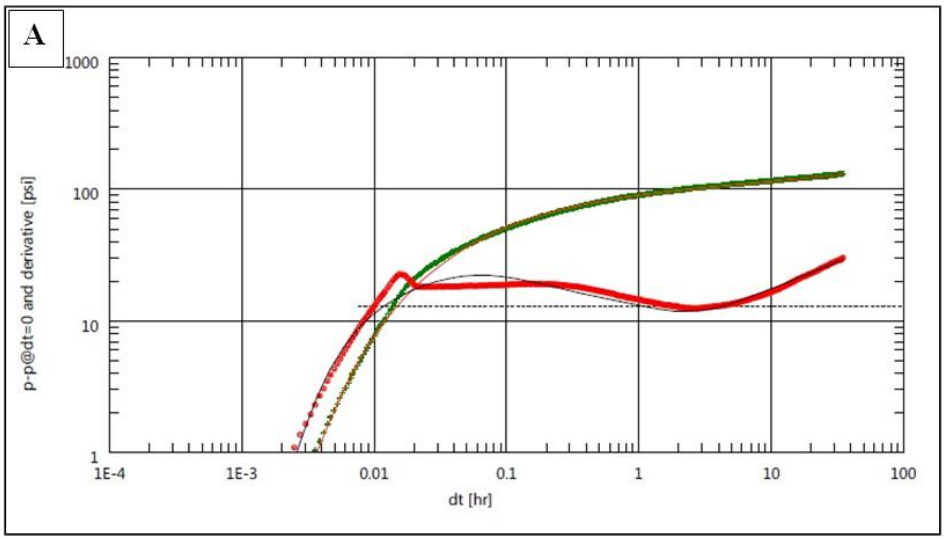


Figure no 4: PTA logs charts (A: Log-Log and B: Semi-Log) of Zb-D.



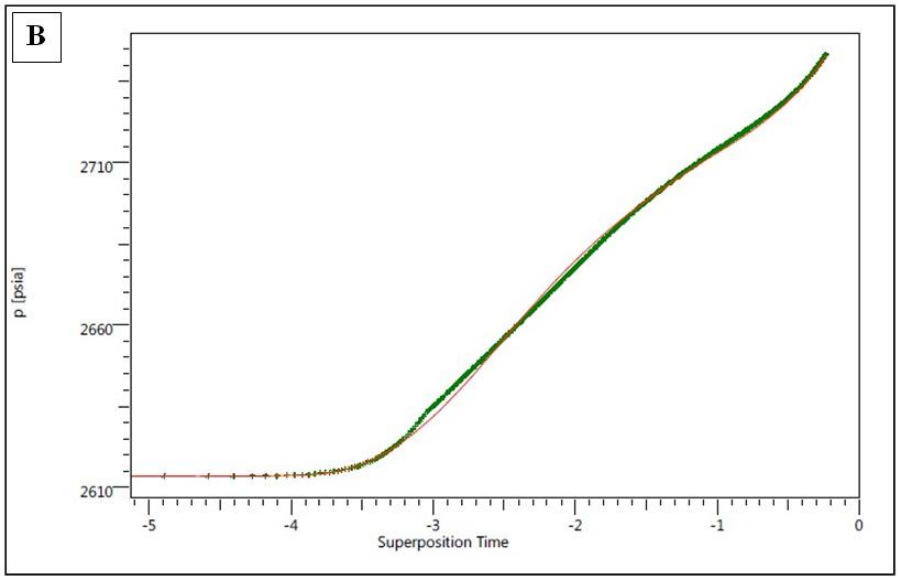


Figure no 5: PTA logs charts (A: Log-Log and B: Semi-Log) of Zb-E.

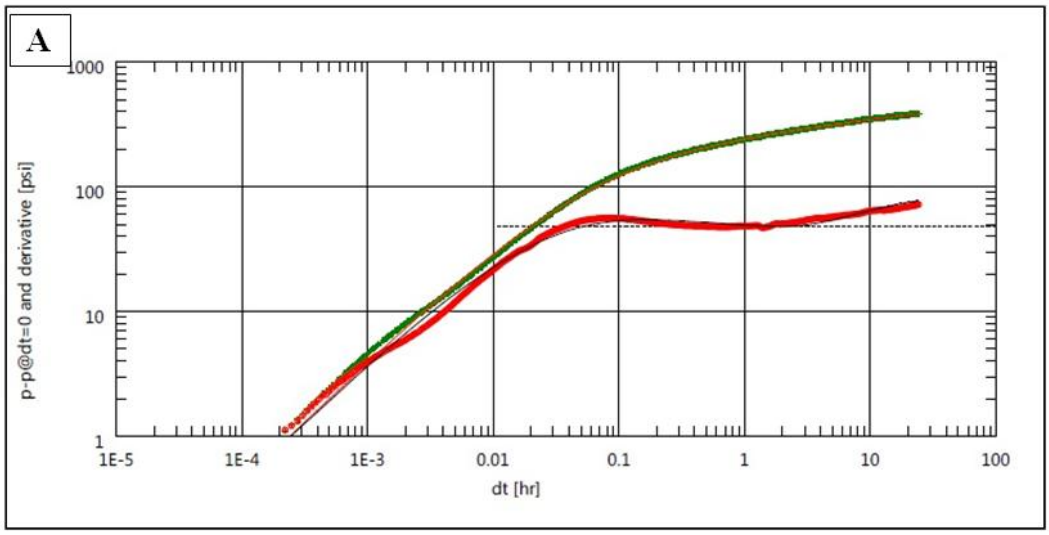
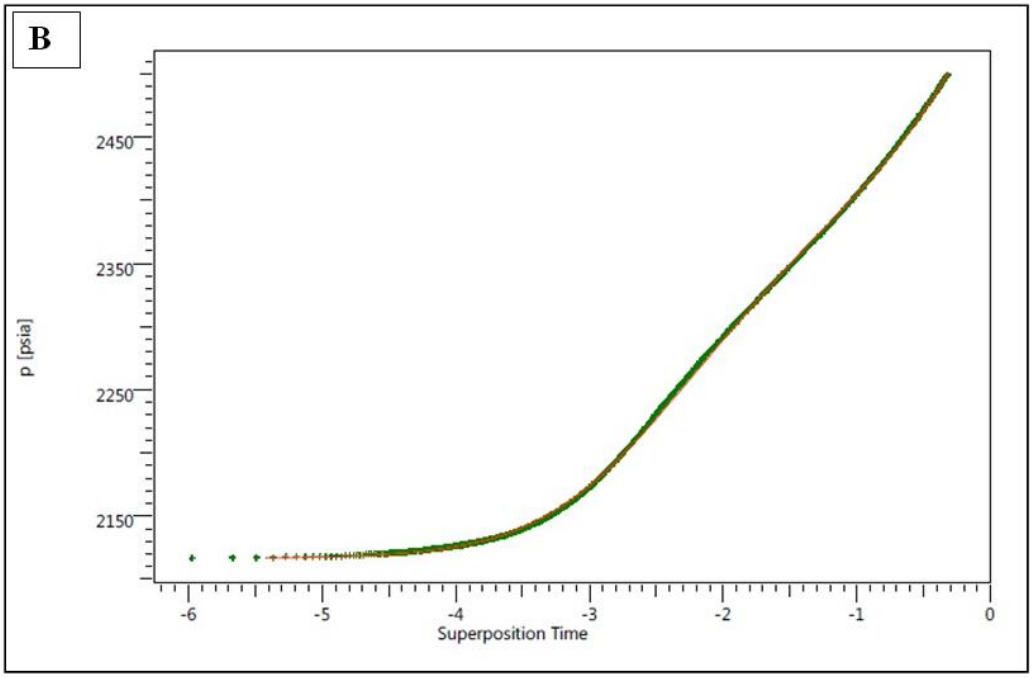


Figure no 6: PTA logs charts (A: Log-Log and B: Semi-Log) of Zb-F.



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