Effect Of Tectonic Movements In The Composition Of Different Structural Patterns In The Sangonghe Formation, Baolang Oilfield, Baobei District, Northwest China

Fahd A.Q. Al-qaraafi, Yao Guangqing

Abstract:- Problem statement: The study area is located between the Indian and Eurasian plates. The area was subjected to many tectonic movements that led to the formation of a complex structural environment. The present work is to study the different structural features of folding and faulting. Approach: The study evaluated the tectonic settings from previous studies and developed a three-dimensional structure model using petrel software and through the analysis of core samples. Result: Tectonic movement is the main reason for the deformation of the sedimentary basin and for the division of the basin from north to south. Moreover, the Yanshan and Himalayan movements have led to the division of the basin system into Yanqi uplift, static depression, and the Bohu depression. The Yanshan (Early Jurassic) movement is also responsible for the folding of the sedimentary layers because of the southwest (SW)-northwest (NW) pressure resulting from the subduction of the Indian plate beneath the Eurasian plate. Due to the inhomogeneity of the movement force, the compression force in the middle of the fold is much greater than at the peripheries. The axis of this folding extends from northsouth (NS) to southeast; therefore, the resultant fold axis is in the NS of the southern part. The northeast (NE) limp dips 45° while the SW limp dips 11°. This folding is accompanied by the formation of a series of complex faulting. This series of faulting is divided into three groups according to location, comprising NE, NW, and central parts. The biggest fault is F1, which extends for 7 km. Most of the faults are parallel to the fold axis.

Index Terms:- Baobei Anticline, Baobei District, Baolang Oilfield, Sangonghe Formation, Tectonic Movements, Yanqi Basin.

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1 INTRODUCTION

There is a close relationship between tectonic movements and attendant deformation in the deferent structure of the Yanqi basin, which has a special tectonic background due to continuous convergence between the Indian Ocean plate and the Eurasian plate. In the Mesozoic sedimentary, the Yanqi basin experienced a complex structural change. Dynamic and strong later reconstruction occurred, including the Mesozoic prototype basin in the Yanshan movement. The middle and late stages suffered from varying degrees of uplift and transformation, denudation was serious, and the Cenozoic basin superposed after suffering strong transformation of the Himalayan movement[3-26] .Currently, the basin is of a Jurassic prototype, but is more controversial and mainly exhibits the following several views: stretch down faulted basin;[26-3] pull points basin;[9] mountain gap basin;[27,32] piedmont fault basin;[11] and class foreland basin[18.30,29] of the final three under the background of tension, depression basin,[4] and the kuqa foreland basin system. In terms of orogenic wedge top part deposition,[33] the region has witnessed many tectonic movements (movement Yanshan (II & III)), lower Cenozoic, and then movements of the three built to the Himalayas (I, II, & III) (middle and early Cenozoic, respectively). As a result of the collision of the Indian and Eurasian plates, subsequent to the Eurasian plate moving northward, this is the extensive influence of the Tibetan plateau and its surroundings, including Eurasia within geological tectonic evolution.

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This is extremely important in the evolution of earth's structural history. During this period, the formation of a structure known as the "roof of the world" occurred on the Qinghai-Tibet Plateau and the Pamirs mountains. After the collision and extrusion stress of the Tianshan mountains, the inland orogenic belt produced a significant effect, making it one of the world's most intense tectonic movements on the inland orogenic belt.[16,15,19,2,8,18] This plate convergence influences the topographic landforms of western China and much of Central Asia, controlling the geological tectonic evolution and destructive earthquakes of these regions.[17,20] Since records commenced on the South Tianshan area of historical earthquakes, earthquakes of a magnitude of 6 or more on the Richter scale have occurred 58 times, earthquakes of more than 7 on the Richter scale have occurred 7 times, with one earthquake registering more than 8 on the Richter scale, suggesting a region of intense tectonic activity.[6] The GPS observation data show the movement rate of the Pamirs and Tarim plate to the north is about 20 mm/a and the Middle Tianshan to the northeast is about 9.6mm/a. The southern Tianshan area absorbs about 10 mm of crustal shortening each year, indicating that earthquakes are frequent in the southern Tianshan area and that it also shows intense tectonic movement.[24, 22, 21]

2 Geological situation

The Yanqi Basin is an intermountain basin located on the southeastern flank of the Tianshan. The Bosten Lake, the largest lake within the Chinese Tianshan with an area of 13,000 km^2 is located in the center of the basin, in Xinjiang between the three big basins: Tarim, Junggar, and Turpan. From south to north, it can be divided into the Bohu depression, the Yanqi uplift, and static depression first-order three tectonic units, with the Bohu depression further divided into the northern sag, the central fault uplift zone, and the southern sag. The Baobei Block in the Baolang oilfield is located in the Yanqi Basin in the north sag central of the Bohu depression. The Baolang hematoxylin structural belt at the northwest end is one of the local shear stress fields, with a multiple stage tectonic axis shape high dipping anticline. The basin indicates the presence of the complex evolutionary history of the Mesozoic and Cenozoic composite intermountain basin. Different periods of geological history and tectonic evolution stages have different prototype basin and tectonic patterns. In the Baobei Block, a tectonic uplift area in the Yanqi Basin, tectonic evolution is extremely complex; the Mesozoic in the early extensional, post-extrusion, with late Cenozoic in the pressure and torsion-based complex tectonic background. Having multiple tectonic movements superimposed, the development of faults and folds is a strong characteristic. The Yanqi Basin is mainly developed near the eastwest (EW) (north-west-west, NWW) and northwest (NW) to the two groups of faults. The near-EW trending fault controls the basin uplift and the depression of the trunk fracture is large-scale, extending far through the basin, with the south pour dominating. The near EW trending faults limits restrict the NW-trending fault. The near-EW trending fault has a sinistral strike-slip compress-shear nature, and the NW faults have dextral strike slip compressive properties. As a result of the NW faults and near EW-ward fault intersection compound and inheritance development, the basement and cover in the Yanqi Basin are cut into many similar rhombic blocks. Planar tectonic deformation is in the N-S zonation, while the east and west sub-blocks exhibit a diamond-shaped pattern. The Baobei Block oil bearing intervals for shallow lake facies and Braided River delta deposits in the early Jurassic continental basin Sangonghe group of freshwater environment. The reservoir lithology with fine conglomerate, gravel sandstone, and coarse sandstone, is a typical low porosity and low permeability light low viscous oil reservoir. The stratigraphy of the Yanqi Basin is comprised of the Putaogou, the Hetaoyuan, the Xisanyao, the Sangonghe, the Badaowan formation, and Karadaban formations in turn from top to bottom.

3 Materials and Methods

In this study, three-dimensional (3D) structural models for the Baobei anticline from 124 well log data analysis using petrel software structural modeling was divided into three steps:

1. Fault modeling: defining the faults in geological modeling used for the 3D grid.
2. Pillear gridding: the geometry the grid represents at the base of all monetization.
3. Making horizons: building the layer of reservoir III of the Sangonghe formation in the model and then creating the layer in the zone.

4 REGIONAL TECTONIC

The tectonic evolution of the Baobei Block can be divided into five stages:

4.1 The basal formation stage

This phase consists of a Proterozoic crystalline basement and the Paleozoic fold basement formation stages. The end of the early Permian Qiangtang block collision with the Eurasian plate formed the extrusion effect from south to north, resulting in the Tarim and Kazakhstan plates with strong collisional orogeny. The study area and the entire Bohu depression in the north recessed to form a shallow metamorphic fold basement.

4.2 Mesozoic Indosinian: the cap-rock extrusion

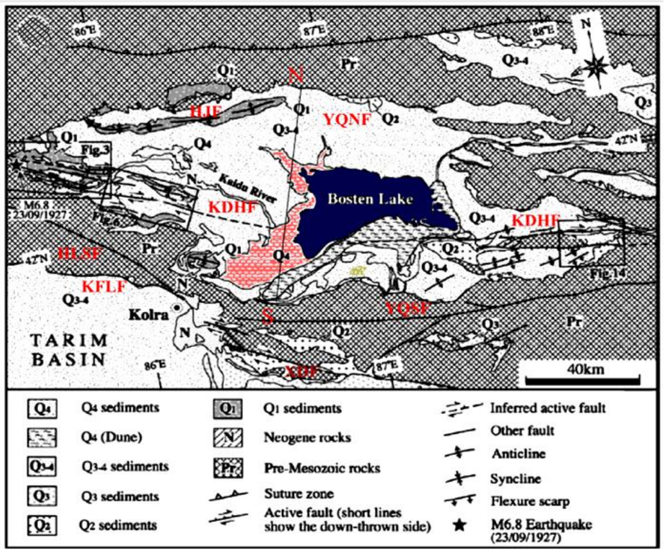
The Yanqi Basin in the Early Triassic is the uplifting stage, with strong stress and extensional faulting.

4.3 The Mesozoic Yanshan extensional rift-extrusion strike-slip stage

During the early Middle Jurassic in the study area, the whole basin area and the Tarim Basin in the Xinjiang crust in the extensional tectonic environment, Yannan fracture, and stallion faults exhibited strong sinistral strike-slip movement, causing the entire Sumu structural belt of the fault-depressed Lacustrine basin to expand the scope. The sedimentation velocity was greater than the deposition rate. The Yanshan movement of the late Jurassic period, led mainly by the regional tectonic stress field of tension, transformed gradually into nearly the NE-SW direction with an extrusion effect mainly at the regional level. The area underwent a strong twist, forming a compressive stress field, leading to the north and south sides of the larger NWW fracture having different degrees of a left twisting nature. As a result of strong basal plasticity, the sedimentary cover in thrust, reverse extrusion, folds and left twisting action, continued the uplift and formed a diagonal between the NWW fault, a NW direction of twist compression of the Baobei anticline prototype, with the anticline traps providing a good place for hydrocarbon accumulation. At the same time, in this near-NE-SW direction of regional horizontal compression and block on the south and north sides of the left shearing fracture and the N-W trending Baobei fracture pressure property extended a certain right activity in the upper forming echelon arrangement of three level faults and anticlines.

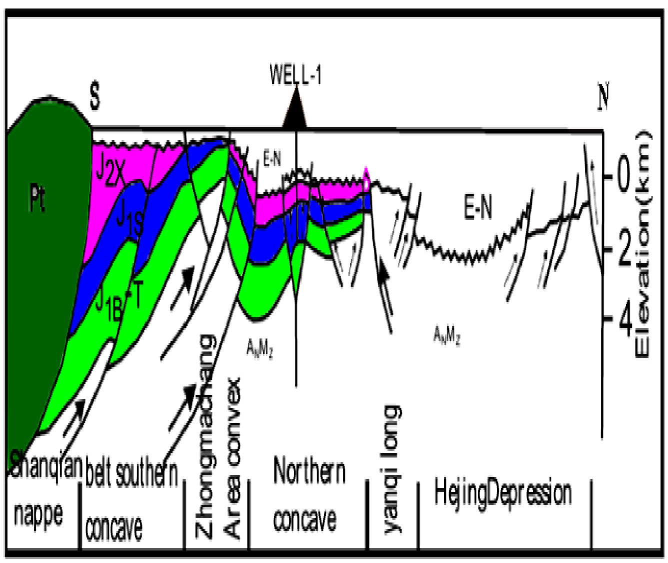
4.4 Cenozoic tertiary back thrust extrusion stage

After entering the new generation, a strong Himalayan movement occurred. Around the basin uplift, center drop, the Yanqi Basin enters the extrusion relaxation stage and the unstable depression stage, fully accepting the angular unconformity contact with the underlying strata of the Tertiary sedimentary. With the tertiary continuing to thicken, the Jurassic hydrocarbon source rocks began forming. The Yanshan Jurassic petroleum system was activated and reconstructed, and oil and gas accumulated in the Himalayan tectonic movement that brought transformation in the ancient structure. Trap stereo types also formed in this period, along with the structural, lithologic trap series formed between the tertiary and Jurassic strata truncated unconformity trap series. This is a relatively large scale accumulation period. Under the back thrust fault system, the action of the Baobei anticline became more complex and entered the same deposition back thrust extrusion



XDF: Xing ground fracture; KELF: Kuerle fracture; HLSF: Hora Qianshan fault; KDHF: Kaidu fault; YQSF: Yanqi Basin, southern margin of fracture; YQNF: Yanqi Basin northern margin fault; HJF: static inverse fracture; XEMD: Charles Wood Gordon anticline; HEMD: Haermodun anticline; AEXT: Al Shuttle worth anticline; QGEL: Amount of its root le anticline; HTHN: Ho Tejado anticline.

Figure 1: Geological and structural map for the Yanqi Basin.[1] (modified by authors)



J2x: Xishanyao formation; J1s: Sangonghe formation; J1b Badaowan formation

Figure 2: North-south cross-section in the Yanqi Basin.

stage. In the new tertiary thrust extrusion stage, the Himalayan late (after the Miocene) reverses the fault thrusting deformation more strongly, displacement, greater thrust, and overlying strata. In addition to the hanging wall deformation being further complicated, the outsider footwall strata widens with gentle folds and thrust faults. The emergence of this new thrust fault of morphologically before the main thrust, both on steep under slow and thrust in the Mesozoic strata and cross the main thrust fault.

4.5 The Cenozoic quaternary dextral strike-slip uplift stage

In the Yanqi Basin, the north and south margins of the mountain make the opposite thrust basin, basin to the north and south sides subducted of mountain, and basin marked atrophy. The lower Pleistocene Xiyu group conglomerate and underlying strata came into unconformable contact, and the Xiyu group constituting a planation surface, was elevated, reflecting the strong uplift of the Yanqi Basin and the Tianshan Mountains. At the same time, the Yanqi basin was in the Quaternary sedimentation center along the long axis of the basin from NW to SE direction of the migration of the mountain. The Baolang hematoxylin tectonic belt east and west sides of the fault in the north and south two-way under compressive stress, stress transfer, torsion, and compression properties changed strongly with pressure and torsion. The strike-slip movement in the study area's tectonic deformation have been gradually strengthened and dominant, with the fold block in the two sides of the torsion fracture under the effect of strike-slip uplift. The Yanqi Basin in the quaternary strong strike-slip movement under the action the final present by nearly EW-ward fault and the NW: the trending fault control of the diamond-shaped morphology.

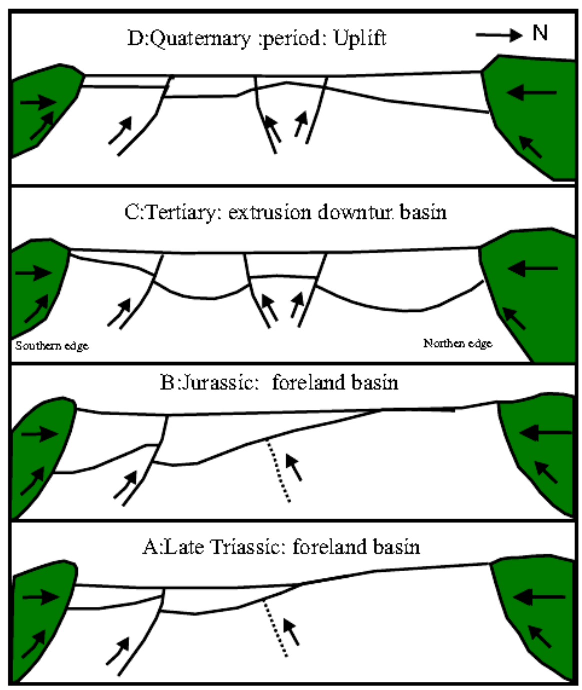


Figure 3: The tectonic evolution stages.

5. STRUCTURAL PATTERN RECOGNITION

The Baobei block anticline structure perpendicular to the anticline axis was squeezed strongly under pressure, resulting in the overall thrust fault in the opposite direction, which formed under the influence of the recoil fault.[7,10] The strong extrusion deformation that formed the strong uplift structure led to the formation of many thrust structures. In the folds of the NW end, the F1 fault in the north plate exhibits a strong sinistral strike-slip movement. In the folds of the SE end, the F1 fault north pan exhibits a strong dextral strike-slip effect; while in the south, it folds in a strong sinistral strike-slip. At the same time, in the SW end of the formation of a strong pressure torsion effect, a fracture is developed. The slip effect caused by the regional stress field direction deflection at the reset structure forms a mechanism fault zone to deflect generally axially parallel and fold. A hedge reverse fault also formed in the wings. In thrust structure mode, the fold of the wings on both sides received an uneven extrusion effect, forming the wings of the hedge reverse fault system, a fault system roughly with fold axes parallel to the axis fold. Therefore, the Baobei anticline shows a three-fault plane combination pattern and profiles occurrence pattern and level of fracture (F1 and F4), and two level faults (F17 and F18) coincide.

5.1 Baobei folding characteristics

The Baobei high and steep anticline complete integrity, the two wings of asymmetry near the NE wing of the Baobei fault steep dip is 45° with the SW wing gently dipping at 11°. The entire anticline NW trending axis shows a NE striking arc distribution. The anticline axis is very narrow, long (4.5–5.4 km), and short (0.86–0.9 km). The Baobei anticline is a winged, asymmetric strip of a high and steep anticline. The anticline structure has top thin airfoil thickness characteristics, with a wing well formation thickness and shaft well formation. The trap area (3.5–4.9 km^2), with a closed height of 100 m, has an anticline structure at the NW end point for overflow. To a certain extent controlling the Baobei reservoir scale, the NW trending Baobei anticline can be roughly divided into three sections: SE and NW of the relatively coarse, and the middle. Investigating the reason for this, this kind of dumbbell shaped anticline shows that the central areas are affected more strongly by extrusion. Figure 4 shows the uneven extrusion forming of a dumbbell-shaped fold and bending caused by the bidirectional shearing of the Baobei anticline that is another feature of the NE axis striking arc. Figure 4 shows the compressive stress from the SW direction. The pushing effect from the NW direction is uneven, and the push force was significantly greater than the two ends, with the lead ends producing a strong strike-slip.

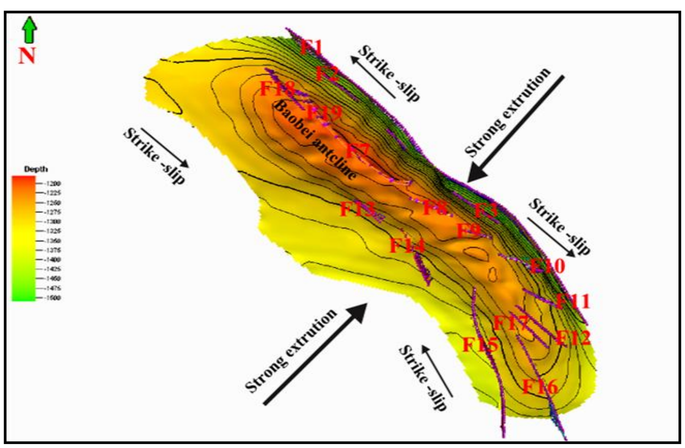


Figure 4: 3D structural model showing the Baobei anticline with faults with interpretation force resulting from the collision of the Indian plate with the Eurasian plate.

5.2 Fault characteristics

According to the latest 3D Baobei structural model, the anticline structural style is a thrust structure, integral to the main squeeze, showing only some strike-slip properties in some localities. The three faults' (F2, F3,and F5) detection and location is based mainly on drilling and well logging data, but the fault as a single point of control cannot be determined by its spatial location. Therefore, the three faults' strike can be based only on the whole structural styles and mechanical characteristics, and the three faults can only be expressed as direction and F1 big fault. Or if they intersect with F1, this indicates that F1, on the whole, is a strike-slip property, such as in contradiction with the thrust structure integral structure styles. According to F2, F3, and F5 fault to modify with fault F1 basic parallel with axis fold.

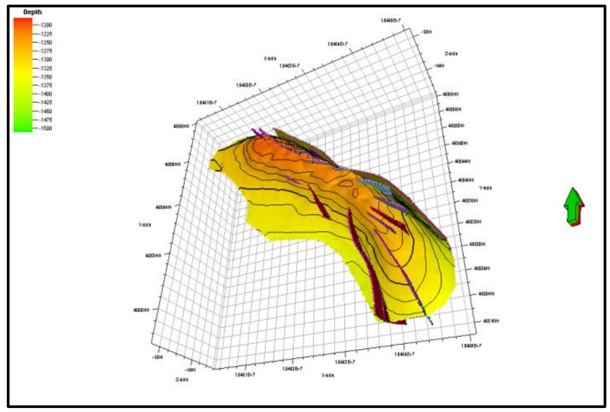


Figure 5: Fault distribution in the middle of the Sangonghe formation

The F15 fault develops in the SW wing of the anticline, and as the 3D structural model shows, the Baobei structure's three faults are shown on the whole NW direction, The eastern boundary fault F1 of the Baobei structure for the north, EW-SW slope thrust faults, dipping 62°, is from the SW to the NE to secondary thrust faults. In the core of the anticline line, it is bounded to the eastern sector. The three levels of fault occurrence of F1 faults are similar, with the WWN dipping reverse faults in the NE. In the Baobei construct with the core as the center, on both sides of the fault opposite tilt, generally the back thrust shows symmetric geometry.

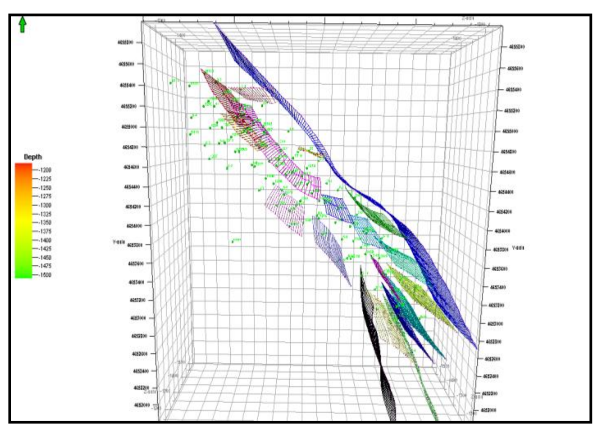


Figure 6 :3D fault distribution in the middle of the Sangonghe formation.

6. Discussion

The tectonic development process has played a significant role in shaping the topographic profile of Xinjiang. Mountains and basins in this area have sharp boundaries and form clear topographic units. The area is divided into a north and a south region by the Tianshan Mountains of China, which extend from the west to the east for over 1700 km^2 with a width of 250–300 km and considered an intercontinental orogen created by Paleozoic. On the basis of the comprehensive analysis of the Yanqi Basin relationship to the Tianshan orogenic belts, it was suggested that the Kuluketage faulted-upheaval was an aulacogen in early Paleozoic, which has undergone multiple opening-closing along with Tianshan orogenic belts, suffered extensive compressing in the late Hercyhian cycle, and formed a "V-type" thrust-fold belt. The Yanqi Basin, located in the northern wing of the "V-type" thrust-fold belt, is related to the reversion of the Kuluketage aulacogen. The tectonic framework in the basin presents lozenge patterns that consist of the W-E structural belts and NW-SE structural belts. The W-E structural belts are primary, and the NW-SE structural belts are the transfer belts related to the former. Based on the regional tectonic setting and sedimentary sequence evolution, the structural physics modeling and balance profile reversion were carried out. The Baobei Block is integrally NW trending towards the anticline. The wings are non-symmetrical with the NE wing steep and the NE wing the relatively more moderate wing. In the plane with the dumbbell shaped fold, the fold axial trace with the NE striking arc exhibits bending characteristics. This can be roughly divided into three sections: the SE, the NW, and the middle. Both ends are relatively wide, and the middle is narrow. The middle exhibits a wide and general anticline, with two narrow opposite. The dumbbell-shaped anticline central compression is strong. Its axis inclines to the NE striking arc, showing that the main power comes from the SW and that push is not uniform, that is, that push force was significantly greater than at the ends.

7. Conclusions

The following conclusions are drawn from this study:

1. A close connection in the formation and evolution of the Tianshen belt in the south part of the basin towards Kuluke in the early Paleozoic resulted in the formation of major fault after the formation of the Tianshen.
2. The tectonic movement was the main reason for the internal deformation of this basin in the north and south regions. Moreover, the Yanshan movement subdivided the basin into the Bohe depression and the Yanqi uplift static depression.
3. The early Jurassic Yanshin movement led to the uplift of the Jurassic layer; therefore, these layers were eroded and consequently, an unconformity developed in this part of the sedimentary section.
4. The tectonic movement resulted in folding, which resulted from compressional forces from the SW and NE directions. These forces formed as a consequence of the subducting Indian plate beneath the Eurasian plate. The Baobei anticline characterized by its axis extended from the NW toward the SE, and the axis is found to be oriented to the NS direction in the southern part. In the northern part of the fold, we found the following faultings: F1, F2, F3, F5, F6, F15, F16, F9 F10, and F11 in the north and center of the fold, and found f4, f12, f22, f18, and f17 in the south part.
5. This series of faulting is divided into three groups according to location comprising NE, NW, and central parts. The biggest fault is F1, which extends for 7 km. Most of the faults are parallel to the fold axis.
6. The tectonic movement resulted in the change of the strike of the faults from the upper part of the fold to the NS in the lower part. The length of these faults are: f1 = 7 km; f2 = 0.95 km; f3 = 0.9 km; f4 > 1.3 km; f5 > 2 km. This fault type is thrust fault and extension length for f7 = 1.15 km; f18 = 0.52 km; f14 = 0.52 km; F14 = 0.15 km; f8 = 0.46 km; f9 = 0.36 km; f17 = 1.27 km; f16 = 1.17 km.
7. The Baolang oilfield comprises two types of fractures: structural and depositional. The structural fracture is related to shear fractures. The dominant fracture is related to the depositional settings.

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9. References

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