Hindawi
Geofluids
Volume 2022, Article ID 8922423, 10 pages
https://doi.org/10.1155/2022/8922423

Research Article

The Characteristics and Geological Significances of Tectonic Regime Changes in Chepaizi Uplift, Junggar Basin, Western China

Bang An[1], **Weifeng Wang**[1], **Baogang Li**[1], **Zhaobing Wang**[2], **Shuaijie Yang**[3], **Yifei Sun**[1], **and Xin Li**[1]

[1]*School of Geosciences, China University of Petroleum (East China), Qingdao 266580, China*
[2]*Qinghai Oilfield Company, China National Petroleum Corporation, Jiuquan 736202, China*
[3]*Sinopec North China Petroleum Bureau (Oil & Gas Company), China Petrochemical Corporation, Zhengzhou 450006, China*

Correspondence should be addressed to Bang An; baan4717@163.com and Baogang Li; lbg_upc@163.com

Received 6 January 2022; Accepted 8 March 2022; Published 23 April 2022

Academic Editor: Zhiwei Zhou

Tectonic regime change refers to the process in which the two periods of tectonic movement changes and produce corresponding tectonic regime change surfaces (unconformity surfaces) and other geological responses in the process of basin development and evolution. The change of tectonic movement is the root cause of tectonic regime change. Tectonic regime changes produce different geological responses, which can be used as the signs to identify tectonic regime changes. In order to study the characteristics of tectonic regime changes of Chepaizi Uplift in Junggar Basin and the control on oil and gas migration and accumulation, four stages of tectonic regime changes were identified by using the techniques of the rock acoustic emission (AE) technology, tectonic subsidence analysis, and tectonic stratigraphic sequence analysis, which occurred at the end of Early Permian, the end of Late Triassic, the end of Jurassic, and the end of Paleogene, respectively. The main stratigraphic product of tectonic regime change is the unconformity structure. The unconformity structure has obvious stratification, including the bottom conglomerate layer, the weathered clay layer, and the semiweathered rock layer, and plays an important role in controlling oil and gas migration and accumulation. The weathered clay layer and the hydrolysis layer have a sealing and shielding effect on oil and gas; the leaching layer can become the effective reservoir; at the same time, the leaching layer can provide a channel for the lateral transportation of oil and gas.

1. Introduction

The superimposed basin is an important feature of large petroliferous basins in China and has unique structural characteristics. The late superimposed pattern and the degree of reconstructing have an important influence on the hydrocarbon accumulation in the basins, which complicates the process of hydrocarbon generation, migration, and accumulation. During the development and evolution of superimposed basins, there are multi-stage tectonic regime changes, which lead to significant changes in basin properties and basin types. The essence of tectonic regime change is the change of the movement mode or dynamic state of lithosphere or crust which controls the tectonic development [1]. It can control the changes of tectonic stress environment, and then produces obvious changing process of basin types, geological structure characteristics, and sedimentary filling modes and affects the process of oil and gas migration and accumulation. Combined with the regional tectonic evolution process, tectonic regime changes can be identified by analyzing the distribution characteristics of unconformity development, fault development stages, strata response characteristics, and tectonic stress field.

Many scholars have done relevant research on tectonic regime changes. According to the field observation, Sun et al. [2] found that the tectonic regime in the western

Shandong changed from convergence system to subduction system in Mesozoic by analyzing fold superposition stages, structural characteristics, and dynamic mechanism. Brutto et al. [3] analyzed the changes of structural ridge strike and fault combination style of Catanzaro geosyncline in the southern Italy by using high-resolution topographic morphology imaging technology and multi-channel seismic profile interpretation method, and found that there was a tectonic regime change from strike slip system to extensional system in Catanzaro geosyncline in the southern Italy in Pliocene-Pleistocene. Tectonic regime changes can be used as a reference basis for the division of first-order sequences in superimposed basins [4], which play an important role in the reconstruction of the basins [5], forming folds and faults, and causing changes in the geological sedimentary field, temperature field, and chemical field to control oil and gas accumulation [6].

The exploration practices in the Chepaizi Uplift show that oil and gas have been found in many sets of strata, including Carboniferous system [7], which is closely related to the structural development and later reconstruction since Late Paleozoic. Some scholars [8, 9] have explored the tectonic evolution process of the Chepaizi Uplift since Carboniferous, but little attention has been paid to the processes of tectonic regime changes, and the division of tectonic evolution stages is still controversial. On the basis of previous work, this paper considers that there are multistage processes of tectonic regime changes in the study area. We plan to systematically identify the tectonic regime changes of the Chepaizi uplift since Late Paleozoic, summarize its characteristics, and expound its geological significance of oil and gas.

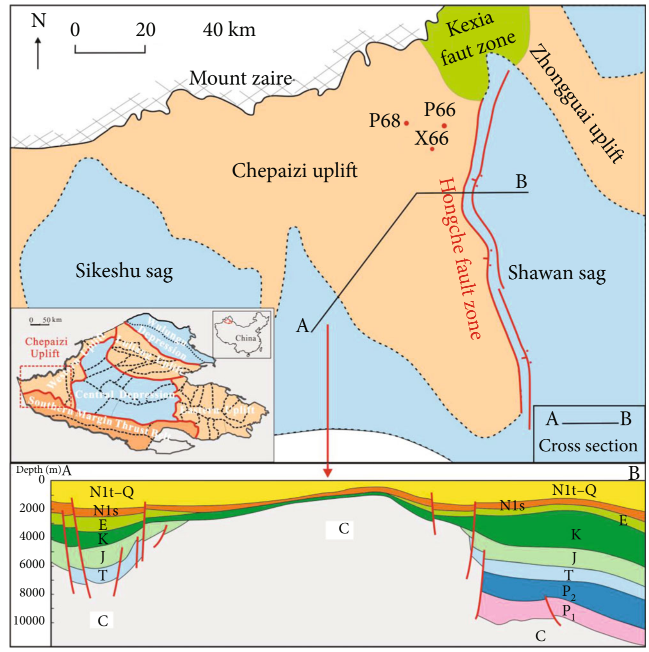


Figure 1: Regional geological map and structural framework of the Chepaizi Uplift.

2. Geological Setting

The Chepaizi Uplift is an important geological structural unit in the Western Uplift of Junggar Basin. It is adjacent to Zaire mountain in the north, Shawan sag in the east, and Sikeshu sag in the west, respectively (Figure 1). The plane of the study area is triangular, which is an inherited ancient uplift developed since Late Paleozoic. It has experienced the stages of formation and development, uplift and erosion, sedimentation, and stratum tilting. The Carboniferous system at the bottom of the study area is relatively thick. In the area near the Hongche fault zone, the Lower Permian Jiamuhe Formation stratum [10] is found. Triassic system is absent, and other strata are developed, but the thickness is relatively thin.

3. Methods

In order to deeply distinguish tectonic regime changes and investigate their characteristics, we adopt a comprehensive method, including the rock acoustic emission (AE) technology, tectonic subsidence analysis, and tectono-stratigraphic sequence analysis.

When a material deforms or loses stability under external loading, its local energy source is quickly released to produce transient elastic waves, which is called acoustic emission (AE) phenomenon. The AE activity produced by metal materials under tensile load has stress memory characteristics. The previous stress of materials can be measured through the significance of acoustic emission activity, which is called acoustic emission Kaiser effect. Goodman [11] confirmed that rock materials have obvious Kaiser effect in the process of deformation and damage through the test, which means rock materials have the ability to remember previous stresses. Therefore, the Kaiser effect of rock AE has become a common method to measure the stress of original rock [12]. In the experiment, when the stress loaded on the rock reaches the strength of the paleostress field, the previously formed microcracks will open again to emerge Kaiser effect. Under the continuous loading stress in the experiment, the stress fracture forming periods of the rock can be inversed by identifying the number of Kaiser effect points on the AE response curve. The fracture forming periods into each experimental sample is determined by drawing the relationship between AE characteristic parameters and loading time. Taking the rising point of the cumulative curve of AE parameters as the Kaiser effect point (Figure 2) has become a commonly used identification method [13]. Tectonic subsidence analysis can determine the tectonic subsidence process and its change characteristics and analyze the tectonic subsidence mechanism of each stage and the transformation characteristics of subsidence between different stages. Based on the comprehensive establishment of regional geological profiles such as drilling, seismic, and outcrop, the development and distribution characteristics of stratigraphic unconformity are determined by analyzing the composition of tectonic stratigraphic sequence and its chronological stratigraphic framework. The chronological stratigraphic framework can clearly show the characteristics of stratigraphic overlap, erosion, and unconformity in different areas on the time frame.

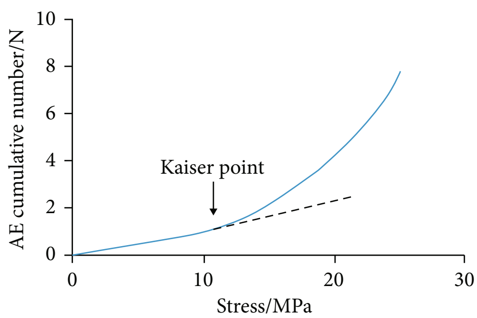


Figure 2: Identification of Kaiser effect points by AE cumulative parameter sudden increase point method.

4. Result

4.1. Fracture Formation Period Identification. The Carboniferous volcanic rocks are widely developed in the Chepaizi Uplift, and a large amount of natural fractures are formed by the influence of multistage structural movement. The fracture formation periods can be identified by the Kaiser effect of rock AE. The fracture forming periods of each experimental sample is determined by drawing the relationship between the cumulative number of acoustic emission and loading time (Figure 3). From the result, we can identify 6 Kaiser effect points on the AE curves of Carboniferous volcanic rocks. It means 6 main paleotectonic movements are remembered by the Carboniferous volcanic rocks in the study area. Combined with the analysis of regional tectonic evolution history, the six paleotectonic stress field stages remembered by the Kaiser effect point of Carboniferous volcanic rocks correspond to middle Hercynian movement, late Hercynian movement, Indosinian movement, phaseII of Yanshan movement, phaseIII of Yanshan movement, and Himalayan movement, respectively. The AE experimental analysis mainly obtains the development periods of structural fractures under the system of multiepisodic tectonic movement. The Kaiser effect points corresponding to weathering fractures and diagenetic fractures of nonstructural origin are generally weak or not obvious.

4.2. Division of Tectonic Evolution Stages. The tectonic evolution stage of a basin can reflect the time series superimposed by different tectonic sequences in the process of basin development. Therefore, the division of tectonic evolution stages can help to identify the tectonic regime changes. In this paper, the tectonic subsidence analysis is used to divide the tectonic evolution stages.

According to the drilling data of well-X66 and well-X68, the basement settlement curve and structural settlement curve are made (Figure 4). It can be seen that the Chepaizi Uplift is interrupted by three times of uplift and erosion in the continuous settlement process: (1) C-P_1 subsidence period: the tectonic subsidence controlled by the normal fault activity; (2) P_2-T uplift period: tectonic inversion occurred at the end of Early Permian, and the nature of regional tectonic stress field changed from extension to compression; (3) J_1-J_2 subsidence period: the basement settlement shows a sharp subsidence, but it shows a slow fall on the tectonic settlement curve; (4) J_3 uplift period: the regional basement shows a sharp uplift; (5) K-E subsidence period: the amplitude changes a little of the tectonic subsidence curve, which is similar to the characteristics of a thermal subsidence; (6) Late E uplift period: the subsidence mechanism changed between Paleogene and Neogene, and there is a slight uplift on the tectonic subsidence curve; and (7) N-Q subsidence period: the regional flexural subsidence occurred in the study area.

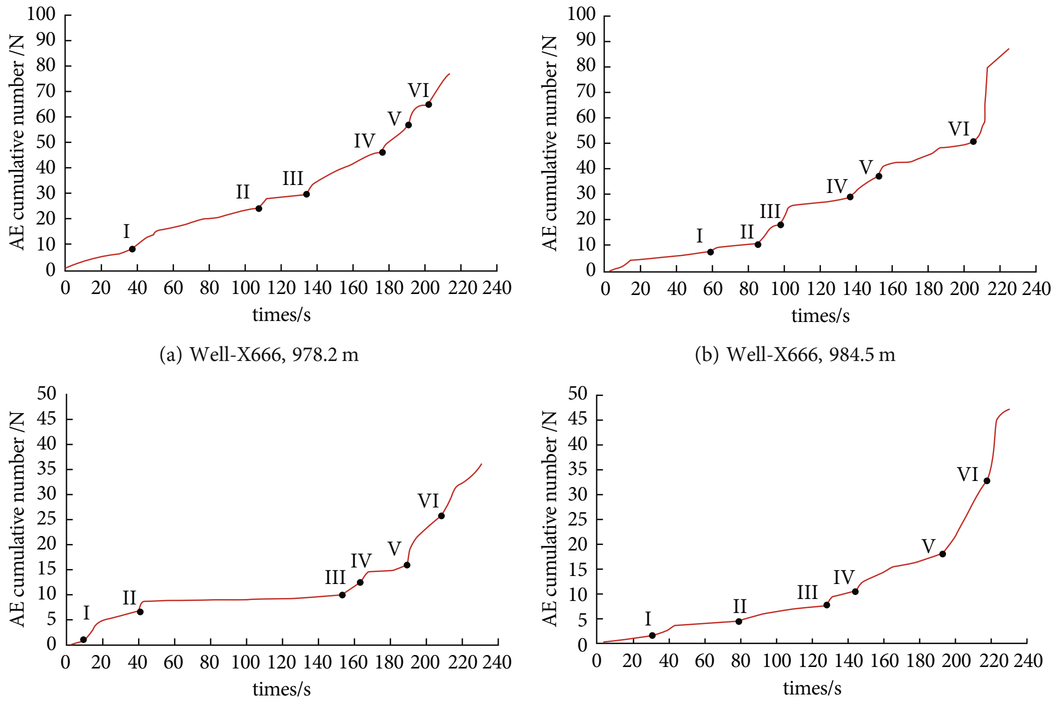
4.3. Tectonic Stratigraphic Sequence Analysis. From west to east, the section passes through Sikeshu Depression, Chepaizi Uplift, and the west slope of Shawan Depression. Upper Carboniferous, Permian, Mesozoic, and Paleogene are missing in the west of the Chepaizi Uplift, and the missing age of strata is about 310 Ma. Most of the strata of Upper Carboniferous, Permian, Mesozoic, and Paleogene are missing in the middle. The Cretaceous system is pinched out from the east of the bulge to the middle, and the top is eroded. The age of denudation is about 40 Ma, and the age of overlap missing is about 40 Ma. The Paleogene system overlaps from east to west, and the top is eroded, with a wider distribution range than the Cretaceous system. The age of erosion is about 30 Ma, and the age of overlap loss is about 15 Ma. A small amount of Jiamuhe Formation remains in the slope zone connecting the east of the bulge and Shawan Depression. The top of Permian is missing by the bottom of Jurassic and Cretaceous. The Lower Triassic and Middle Triassic are eroded from the depression to the west bulge. At the same time, the Upper Triassic is overlapped and the top is eroded. The Middle Jurassic and Upper Jurassic are missing as a whole, about 30 Ma, and the Lower Jurassic is eroded by the bottom of Cretaceous. The Cretaceous-Paleogene system overlapped and eroded from the depression to the bulge at the east slope. The overall thickness of Shawan Formation was stable, and the lithology at the bottom gradually became thinner from west to east.

According to the identified tectonic activity periods, regional unconformities, and the established chronostratigraphic framework in the study area, the Chepaizi uplift can be divided into the following 5 structural layers (see Figure 5):

(1) Carboniferous-Early Permian structural layer

From Carboniferous to early Permian, the Chepaizi area experienced the evolution process from ocean basin subduction and accretion, multi-island arc collage to postcollision extension tectonic environment. The Carboniferous strata are volcanic sedimentary rock assemblages, which are widely distributed in the whole uplift. In the Early Carboniferous, it was mainly semideep sea shore shallow marine facies, with basalt, andesite, siliceous rock, tuff, pyroclastic rock, mudstone, and argillaceous siltstone developed. The Late Carboniferous is mainly littoral and shallow marine sediments, mainly developing volcanic lava, pyroclastic rock, glutenite, sandstone, argillaceous siltstone, and mudstone.

(2) Middle Permian-Triassic structural layer



(a) Well-X666, 978.2 m

(b) Well-X666, 984.5 m

(c) Well-X666, 1118.1 m

(d) Well-X666, 1227.5 m

Figure 3: The cumulative number-time curves of the AE experiment of Carboniferous volcanic rocks in the Chepaizi Uplift.

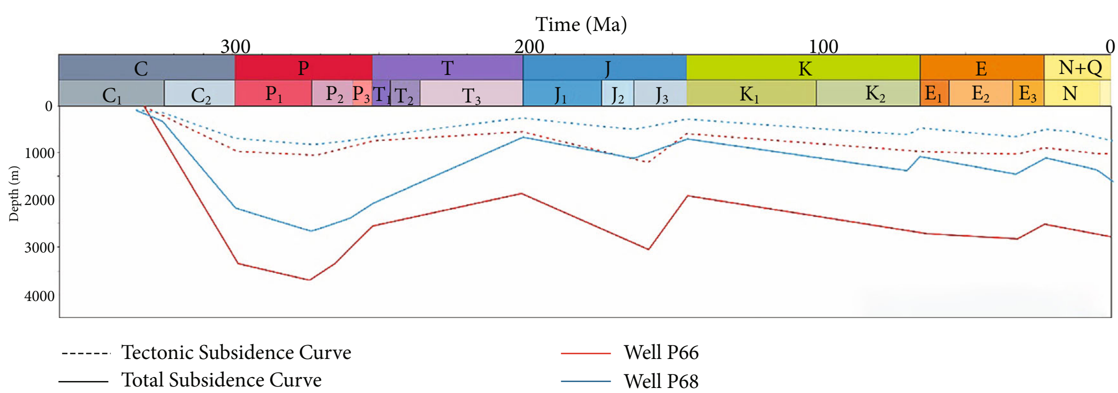


Figure 4: Tectonic subsidence curve and total subsidence curve of well-P66 and well-X68.

The Chepaizi Uplift experienced strong compression from late Hercynian to Indosinian. The main body of the uplift lacks Permian and Triassic system. A small number of coarse clastic deposits of Upper Wuerhe Formation (P_3) are left near well-C25 in the hanging wall of the Hongche fault zone. A small amount of Middle and Upper Triassic is distributed near well-HS4 in the northeast of the uplift, of which Karamay Formation is fan delta plain facies; Baijiantan Formation is mainly dominated by braided river delta front facies and shore shallow lake facies.

(3) Jurassic structural layer

Jurassic system is largely absent in the main part of the uplift, which is mainly distributed near the Hongche fault zone in the east of the uplift and scattered in the Carboniferous trench in the part and the south of the uplift. Badaowan Formation of Lower Jurassic is the most widely distributed, mainly delta front and shore shallow lake facies; Sangonghe Formation is locally distributed, mainly delta front facies and braided river delta plain facies. A small amount of Middle Jurassic is distributed over the hanging wall of the Hongche fault zone, and the Upper Jurassic is missing as a whole

(4) Cretaceous-Paleogene structural layer

From the Cretaceous, Junggar Basin as a whole entered a unified and stable subsidence stage, and the lacustrine deposits in the Chepaizi Uplift expanded rapidly. Under

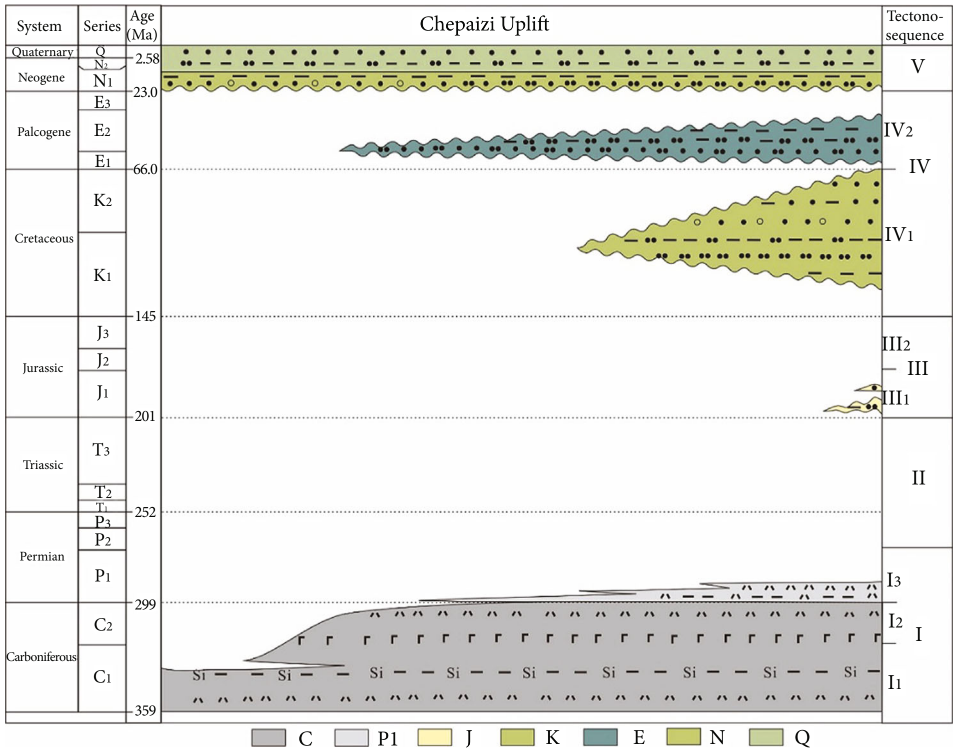


FIGURE 5: Tectonic stratigraphic sequence analysis of the Chepaizi Uplift.

the influence of Yanshan phase II movement, the sedimentary range of the Tugulu group expanded in the Early Cretaceous, and fan delta and shore shallow lake facies deposits were developed. In the Late Cretaceous, the basin was uplifted under the influence of the Yanshan phase III movement. The sedimentary range of the Upper Cretaceous is reduced, the main body of the uplift is basically missing, and it is locally distributed in the southern central part of the Hongche fault zone. At the end of the Late Cretaceous, the Chepaizi Uplift had tectonic "fluctuation" activities, and the Cretaceous system uplifted and suffered denudation, which showed a large-scale denudation unconformity between Paleogene and Cretaceous. The Paleogene inherited the tectonic pattern of the Late Cretaceous. The Chepaizi Uplift continued to subside in the east and south, forming a stratum dominated by fan delta plain and delta front facies. On the whole, the late Yanshan tectonic movement is obviously weakened in this area. The differential subsidence of Cretaceous and Paleogene formed the stratigraphic characteristics of thick in the east and thin in the west. The Paleogene system was uplifted and denuded by the tectonic movement at the end of Paleogene, which showed the truncated unconformity between Neogene and overlying Paleogene system.

(5) Neogene-Quaternary structural layer

Since Neogene, under the background of the uplift of the North Tianshan orogenic belt, the southern margin of the basin has been subjected to compression, resulting in flexural subsidence of the Chepaizi area as a whole. The Neogene-Quaternary system with thick sedimentation is basically distributed in the whole area, in which Shawan Formation is mainly braided river delta, fan delta, and shore shallow lake facies.

4.4. The Characteristics of Tectonic Regime Changes. Through the analysis of tectonic movement stages, tectonic subsidence, and tectonic stratigraphic sequence, four tectonic regime changes were comprehensively identified, which occurred at the end of Early Permian, Triassic, Jurassic, and Paleogene, respectively, and five tectonic evolution stages are divided accordingly (see Figure 6).

The tectonic regime change I occurred at the end of Early Permian, which represented the end of the postorogenic stage and opened the intraplate nonorogenic stage. After the change I, the tectonic evolution of the Chepaizi Uplift really entered the intracontinental environment and formed continental sedimentation. The change I changed the tectonic stress environment from postorogenic extension environment to intraplate compression environment. Under the joint action of Zaire mountain in the northwest and North Tianshan mountain in the southeast, the Chepaizi Uplift experienced strong eastward compression pushover, resulting in a large number of reverse faults distributed among the Carboniferous system with steep dip angle. The tectonic regime change II occurred at the end of Triassic, which ended the tectonic uplift of Triassic, and made the structural evolution of the Chepaizi Uplift enter the stage of fault-depression basin evolution. This tectonic regime change made the tectonic stress environment change from

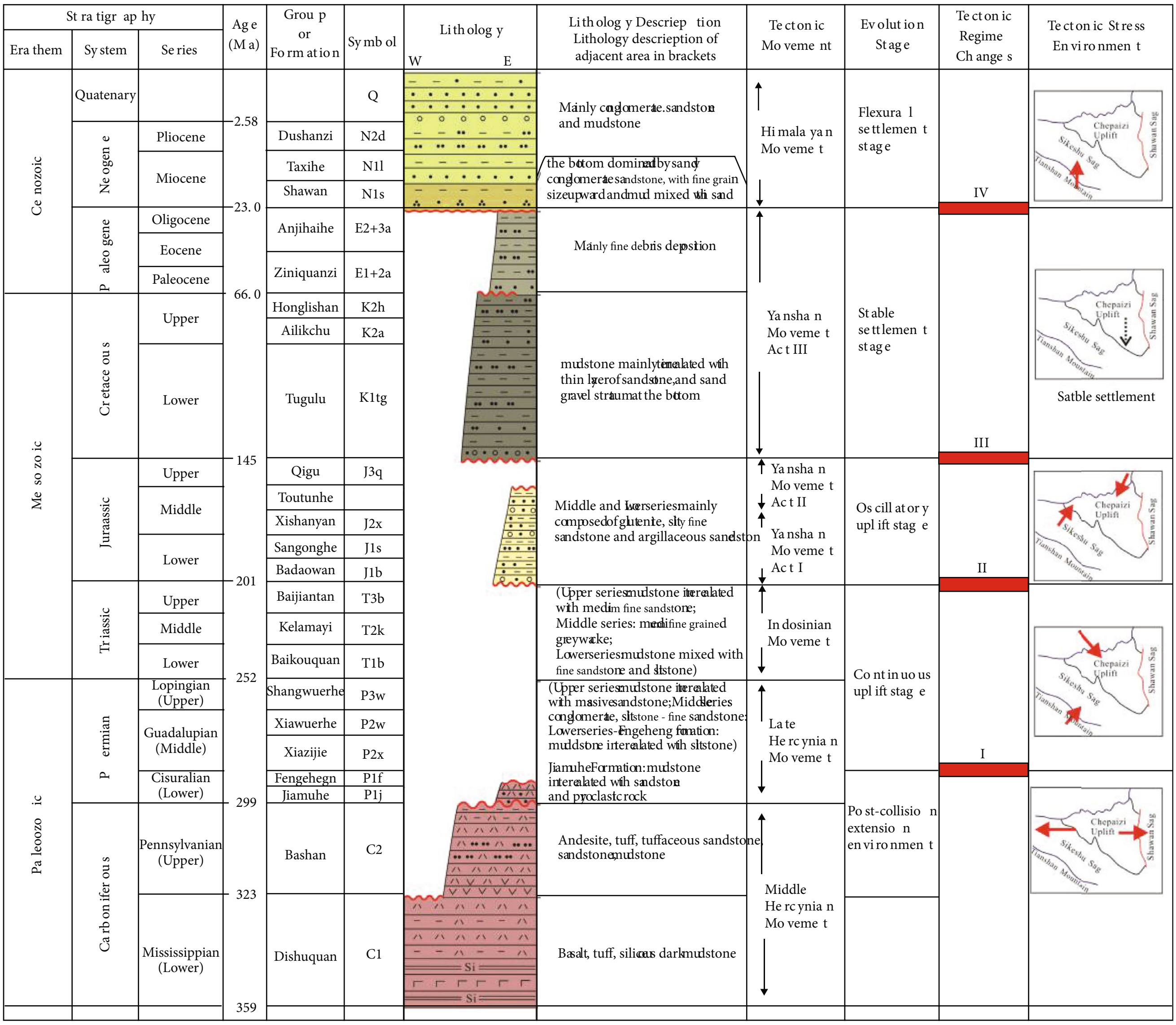


Figure 6: The characteristic of tectonic regime changes in the Chepaizi Uplift.

compressive tectonic environment to extensional tectonic environment. The tectonic regime change III occurred at the end of Jurassic, which opened the evolution stage of stable intracontinental depression characterized by lake facies. The tectonic regime change forms a wide range of regional unconformity structures, and a set of glutenite with good porosity and permeability is developed at the bottom of the overlying Cretaceous system. This tectonic regime change made the tectonic stress environment change from compressive tectonic environment to extensional tectonic environment. The tectonic regime change IV occurred at the end of Paleogene, which ended the stable subsidence evolution stage of the Chepaizi Uplift. In Neogene, the Chepaizi Uplift entered the stage of foreland basin evolution under the strong collision and continuous pushing of Indian plate on Eurasian plate . This tectonic regime change made the tectonic stress environment change from extensional tectonic environment to compressive tectonic environment.

5. Discussion

Tectonic regime change represents the change of the evolution stages of the basin and basin structures. It plays an important role in the reconstruction of the basin [5] and forms fault and fold structures that are convenient for the adjustment and distribution of material and energy in the basin. Tectonic regime change affects the changes of basin sedimentary system and energy field to control the generation, migration, accumulation, and distribution of oil and gas [6]. The stratigraphic response product of tectonic regime change is the formation of the unconformity structure. Unconformity is the manifestation of discontinuous contact between strata. Regional unconformity often reflects an important regional tectonic movement event. In the Chepaizi Uplift, the unconformity structure is widely distributed, which controls oil and gas migration and accumulation.

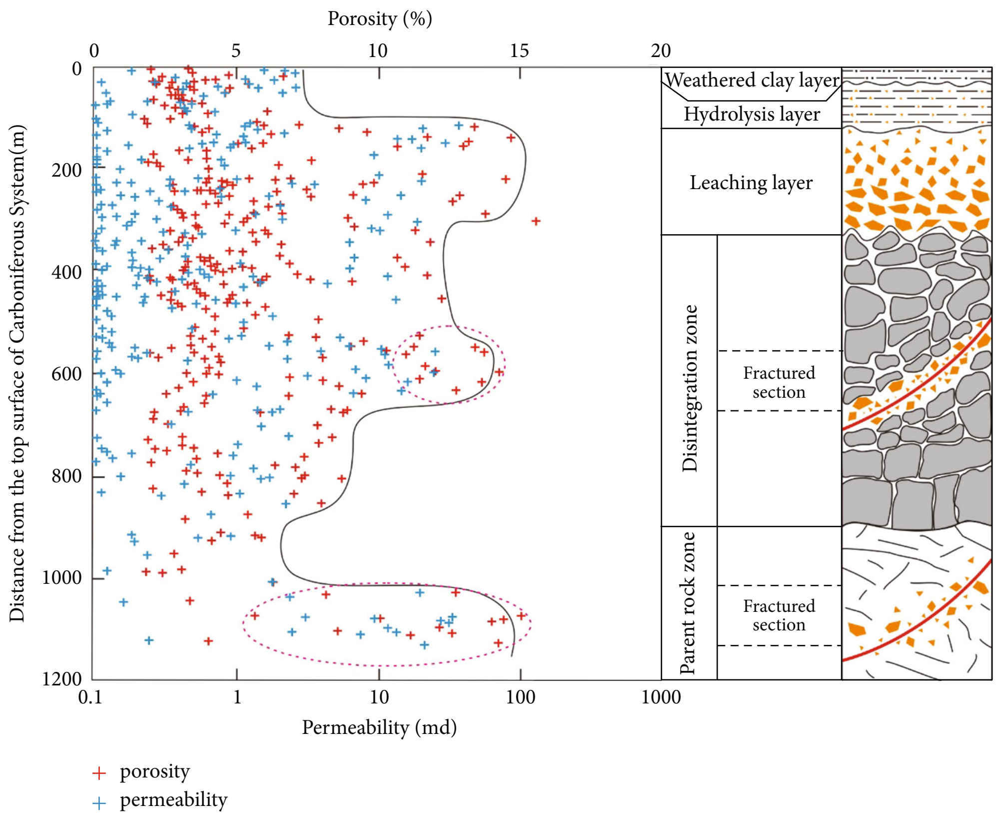


Figure 7: The structure characteristics of the Carboniferous system top weathering crust.

The Chepaizi Uplift experienced multistage tectonic regime changes and formed multiple sets of unconformities, including Carboniferous top unconformity, Cretaceous bottom unconformity, Paleogene bottom unconformity, and Neogene Shawan Formation bottom unconformity. The unconformity types mainly include truncated, overlap, and parallel unconformity. The truncated unconformity is mainly caused by tectonic genesis. The strata formed in the early stage are uplifted and eroded under the action of large-scale tectonic movement and then subsided to accept new sediments to form truncated unconformity, which represents regional tectonic uplift and long-term sedimentary interruption and erosion. The overlap and parallel unconformity are mainly sedimentary genesis, which are related to the rise and fall of sea (lake) level.

At the end of Late Paleozoic, the Chepaizi Uplift was strongly uplifted under the action of Hercynian movement, and the Carboniferous system was in angular unconformity contact with the overlying strata, with a wide range of unconformity on the plane. Jiamuhe Formation of Lower Permian was found near the Hongche fault zone in the study area. It can be inferred that the strata were obviously uplifted and deformed at the end of Early Permian, eroded to the Carboniferous system, forming unconformity at this stage. Since the Jurassic system only exists in a few areas, the distribution range of angular unconformity between the Cretaceous system and the Jurassic system is limited. However, as far as the Junggar Basin is concerned, this unconformity is the most widely distributed regional unconformity. In addition, the Cretaceous system and the Carboniferous system are truncated unconformity, which indicates that the Yanshan movement from the end of Jurassic to the early Cretaceous is strong, which makes the Chepaizi Uplift obviously uplifted, deformed, and eroded again. The truncated unconformity at the bottom of the Neogene Shawan Formation was formed by the deflection and tilting of the Chepaizi Uplift of the Himalayan movement from the end of Paleogene to the beginning of Neogene.

From the above tectonic regime change analysis, it can be seen that the study area is an inherited paleouplift developed from Early Permian. Until Jurassic, under the influence of regional extension, there were alluvial fans and river deposits in some parts. The Carboniferous system suffered a long-term weathering and erosion, forming a widely developed unconformity structure. This paper takes the unconformity structure at the top of Carboniferous system as an example to explain in detail. The unconformity structure has an obvious three-stage type, that is, the upper section is the bottom conglomerate, the middle section is the weathered clay layer, and the lower section is the semi-weathered rock layer [14]. In addition, the Carboniferous parent rocks are mainly basalt, andesite, rhyolite, tuff, and mudstone, which provide material conditions for the formation of the top weathering crust. Therefore, the weathering crust at the top of Carboniferous system is widely developed.

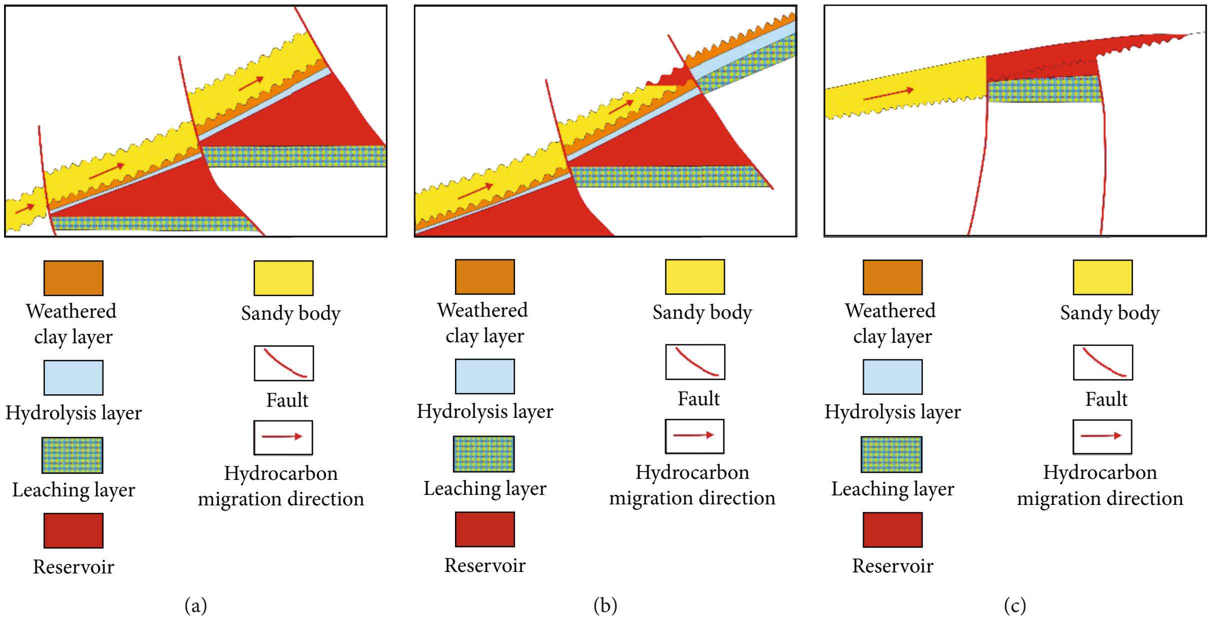


FIGURE 8: Schematic diagram of oil and gas reservoir related to the unconformity structure.

5.1. *The Unconformity Structure*

5.1.1. The Bottom Conglomerate Layer. The rock types above the top unconformity of the Carboniferous system are mainly conglomerate, including pebbly sandstone, breccia, pebbly fine sandstone, and pebbly mudstone. The gravel of pebbly sandstone is mainly composed of quartz, with coarse particles, which is good physical properties for reservoir. The lithology of this layer is quite different from that of volcanic rock under the unconformity surface, and an obvious step is formed at the unconformity surface on the logging curve. The logging response characteristics of this layer are mainly low resistivity, low density, and low neutron porosity. The lateral thickness of this layer varies greatly, and the thickness variation range is 15~50 m.

5.1.2. The Weathered Clay Layer. The weathered clay layer has poor physical properties (porosity < 8%; permeability < 10 md). Under the strong weathering, the volcanic rock structure is destroyed, and obvious clayization can be observed in the core. This layer shows medium high resistivity, high natural gamma, high acoustic moveout, and high neutron porosity on the logging curve. Affected by volcanic rock lithology, paleoclimate, sedimentary discontinuity time, and paleotopographic characteristics, the layer has varying degrees of development in the plane distribution range, and the thickness variation range is 0~20 m.

5.1.3. The Semiweathered Rock Layer. The semiweathered rock zone is located under the weathered clay layer, and the rock structure and physical properties are better than those of the weathered clay layer. On the logging curve, it shows lower density, lower gamma, higher acoustic wave, and higher neutron. This zone is developed with large thickness and various rock types, mainly including basalt, andesite, andesite basalt, basaltic breccia lava, basaltic breccia, tuff, and other volcanic rocks. Analysis of core, thin section, and imaging logging data shows that pores and fractures are developed in this zone. According to the degree of alteration and weathering of volcanic rocks, the zone is further divided into the hydrolysis layer, the leaching layer, and the disintegration zone (Figure 7).

The hydrolysis layer is the product of strong alteration of Carboniferous volcanic rocks. It is mainly composed of fine particles of volcanic rocks, most of which are chloritized and carbonated. This layer belongs to ineffective reservoir or poor reservoir, with a development thickness of 25~100 m. The leaching layer is the product of relatively strong alteration of Carboniferous volcanic rocks. The volcanic rocks are semibroken and have strong weathering, leaching, and tectonism. Therefore, the dissolution holes and fractures are developed and the reservoir physical properties are good. This layer is a high-yield oil layer with a thickness of 100~250 m. The disintegration zone is the product of medium alteration of Carboniferous volcanic rocks, mainly volcanic fragments of large blocks. The fractures in this layer are relatively developed, with occasional dissolution pores and fractures, with large thickness. On the whole, the reservoir physical properties of the leaching layer and the disintegration zone in the semiweathered zone are the best, and the hydrolysis layer is slightly worse.

5.2. *Geological Significance of Oil and Gas*

5.2.1. Sealing or Shielding of Oil and Gas. The weathered clay layer and hydrolysis layer are affected by water-rock interaction to form an effective caprock with the regional distribution [15]. Through the measurement and calculation, combined with the oil and gas density in the study area, the oil and gas plugging height of the weathered clay layer and hydrolysis layer is about 1200 m, and the measured reservoir height is generally less than 550 m. The measured caprock (the weathered clay layer or the hydrolysis layer) plugging capacity is much greater than the oil column height of the actual reservoir, which can effectively block the reservoir and form a trap caprock. According to the actual drilling data, there is no oil and gas display in the weathered clay layer and hydrolysis layer in the Carboniferous reservoir in the study area, while the oil and gas display is found in the leaching layer, which proves that the weathered clay layer and hydrolysis zone can seal oil and gas and control the type and distribution of oil and gas reservoir. When there are the weathered clay layer and the hydrolysis layer, it can form weathered crust inner reservoir; on the contrary, it can form sand body edge reservoir and composite lithologic reservoir (Figure 8).

5.2.2. Weathered Crust Reservoir. The Carboniferous system suffered from weathering and leaching for a long time and developed secondary pores, which played a positive role in improving the volcanic reservoir and formed a favorable weathering crust reservoir [16]. The physical properties of the extremely thick weathered crust will change greatly in the whole process of reburied diagenesis, which mainly depends on the two factors: the degree of weathering of the original rock in the early stage and the diagenesis in the later stage. At present, reservoir physical properties are the final result of the above actions. Among them, the early weathering degree of the original rock is the premise, and the later diagenesis is the key. Tectonism will also significantly improve the permeability of the reservoir. The Chepaizi Uplift has experienced multistage tectonic regime changes, and faults and fractures are relatively developed. Due to the relatively low degree of clayization and good brittleness of the leaching layer, the fractures are developed and can be well preserved. Coupled with the late dissolution, a large number of fracture dissolution reservoir spaces are formed, which greatly improves the physical properties of the reservoir. The extremely thick weathering crust leaching layer becomes a large reservoir in the study area (Figure 8).

5.2.3. Lateral Hydrocarbon Transport Capacity. The top leaching layer of the Carboniferous system is generally developed in the study area, with a thickness of tens of meters to hundreds of meters. It has good permeability and transverse connection and forms a good oil and gas transportation system with Carboniferous roof sand bodies and faults [17]. Under the condition of the hydrolysis layer or the weathered clay layer, when the sand body at the bottom of Shawan Formation of Jurassic and Neogene is connected with the leaching layer of weathered crust, oil and gas can migrate to the leaching layer and accumulate in the leaching layer. When the sand body is connected with the weathered clay layer and the hydrolysis layer, oil and gas cannot migrate to the sand body to form a stratigraphic reservoir (Figure 8). When there is no hydrolysis layer or weathered clay layer, oil and gas will flow up or down to form a composite lithologic or sand body edge reservoir.

6. Conclusion

(1) Tectonic regime change is a common phenomenon in oil and gas basins. Tectonic regime change plays an important role in controlling the formation, development, and reconstruction of basins, as well as the migration and accumulation of oil and gas

(2) Since Late Paleozoic, the Chepaizi Uplift in Junggar Basin has experienced four tectonic regime changes, namely, the end of Early Permian, the end of Triassic, the end of Jurassic, and the end of Paleogene

(3) The tectonic regime change at the end of Early Permian represents the opening of intraplate nonorogenic stage. The tectonic regime change at the end of Triassic shows that the structural evolution of the Chepaizi Uplift has entered the evolution stage of fault depression basin. The tectonic regime change at the end of Jurassic opened the evolution stage of the Chepaizi Uplift stable intracontinental depression. The tectonic regime change at the end of Paleogene brought the Chepaizi Uplift into the evolution stage of foreland basin

(4) The main sedimentary product of tectonic regime change is the unconformity structure. The unconformity structure has stratification and can be divided into the bottom conglomerate layer, the weathered clay layer, and the semiweathered rock layer. The semiweathered rock layer can be further divided into the hydrolysis layer, the leaching layer, and the disintegration zone

(5) The unconformity structure produced by tectonic regime change controls oil and gas migration and accumulation in the study area. The weathered clay layer and the hydrolytic layer have a sealing and shielding effect on oil and gas; the leaching layer can become the effective reservoir and provide a place for oil and gas accumulation; at the same time, the leaching layer can provide a channel for the lateral transportation of oil and gas

Data Availability

All data included in this study are available upon request by contact with the corresponding author.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

This study was supported by the China Geological Survey Project (DD20160170).

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