Abstract. The Carboniferous Karashayi Formation in Tahe Oilfield is one of the most promising formations in the field of clastic rocks in Tahe Oilfield, which is rich in hydrocarbon resources, but the stratigraphic framework is unclear, which restricts the exploration of hydrocarbon formation. The stratigraphic features and seismic section analysis of the area combined with oil and gas distribution are used to analyze the stratigraphic framework and reservoir control factors of the Karashayi Formation. The results show that the lower part of the Carboniferous sedimentary strata is overburdened and the top part is denuded. The Karashayi Formation can be divided into four tertiary sequences and seven system domains. The oil and gas reservoirs are mainly developed near the interface of the sequences. Good transport conditions and stratigraphic unconformity cusp blocking can also make the marine intrusion system domain a favorable location for oil and gas accumulation. The Carboniferous Karashayi Formation is located on a convex overburden background and is a composite reservoir controlled by a stratigraphic unconformity and stratigraphic sharp extinction, which is influenced by tectonics, fractures, and lithology.

Keywords: Stratigraphic Framework, Reservoir-forming Principal Control Factors, Carboniferous, Tahe oil field

1. Introduction

Large stratigraphic reservoirs have been the mainstay of China's oil and gas reserves growth in recent years, with proven reserves accounting for 78% of China's new oil and gas discoveries in the same period, and have become an important area for increasing oil and gas reserves and production [1-2]. The Karashayi Formation of the Carboniferous System in the Tahe Oilfield is one of the most promising formations in the field of clastic rocks in the Tahe Oilfield and is rich in hydrocarbon resources. Exploration practice shows that the formation conditions of the Karashayi Formation lithology-stratigraphic reservoir group are complex, and the lack of understanding of its formation conditions and oil and gas enrichment laws has seriously restricted the next oil and gas exploration deployment and planning decisions in the basin. Based on the comprehensive analysis of the basic reservoir formation conditions of the Upper Karashayi Formation, the stratigraphic stratigraphic and reservoir seismic stratigraphic theories are used as the guidance, and the stratigraphic stratigraphic framework is constructed by combining the previous research results and geological and logging data; and under the control of the stratigraphic framework, three levels of stratigraphic sequences are delineated, the stratigraphic characteristics are analyzed, and the reservoir formation characteristics are summarized. The research understanding is of great significance for the exploration of oil and gas reservoirs in the Carboniferous clastic lithology-stratigraphy of Tarim Land.

2. Regional Geological Overview

The Tarim Basin is a large composite basin formed by the superposition of the Paleozoic Craton Basin and the Middle Cenozoic Foreland Basin, which has been developed for a long time on a shallow metamorphic crystalline basement in the Pre-Earthquake period in western China. During its long geological history, it has undergone many complex tectonic movements, forming seven primary tectonic units: the Tarbei Uplift, the Central Uplift, the Tanan Uplift, and the Kucha Depression, the Northern Depression, the Southwest Depression, and the Southeast Depression. The study area is located in the Tahe oil field. The study area, the Tahe oil field, is located in the south-central part of the Akkul Bulge of the Shaya Uplift within the Tabei Uplift. The study area is located in the middle-south part of the Akkul Bulge, within the Shaya Uplift of the Tabei Uplift, with

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the Ruta Fault to the north, the Halahatang Depression to the west, the Caohu Depression to the east, and the Manager Depression to the south. (Figure 1-a).

The Akkul Bulge was a stable carbonate platform in the Cambrian-Middle Ordovician; the base was formed in the Pre-Auranian; the Late Ordovician-Devonian basin was uplifted; the basin was strongly uplifted in the Carboniferous-Permian, resulting in the absence of the Upper Carboniferous and Permian in most of the basin; the Triassic-Cretaceous stable The Tarim Basin was controlled by the collision of the Indian and Eurasian continental plates during the Himalayan (Cenozoic), and several foreland basins, foreland rebellions, and large strike-slip fracture activities developed, while the northern part was strongly subsided under the influence of the Kucha foreland basin, forming the Akkul Bulge. The main oil-bearing systems in the study area are the Carboniferous, Triassic, and Jurassic systems, which have all been denuded to different degrees during the geological and historical periods by multiple phases of tectonic uplift The study area is the Santa Woodworking Zone. The study area of this paper is the most abundant block of clastic oil and gas reservoirs in the Tahe Oilfield, and a variety of reservoir type's development, including lithologic reservoirs, stratigraphic reservoirs, and stratigraphic-lithologic composite reservoirs. The Karashayi Formation in the Santa woodworking area is integrated with the underlying Bachu Formation bimodal tuffs and has an unconformable contact with the overlying Permian volcanic rocks (Figure 1b). Previous studies have pointed out two sedimentary phases in the study area, the deltaic and tidal ping, and the source system is mainly NNE oriented source.

Figure 1. Tectonic Location Map and Paleozoic Integrated Stratigraphic Column Map of Tarhe Oil Field in Tarim Basin

3. Carboniferous Clastic Rocks Thin Reservoir Sequence Frame Delineation

3.1 Stratigraphic Feature
The Carboniferous strata were severely denuded by the uplift of tectonic activities such as Haixi and Indo-Yanshan, and the study area as a whole was denuded in the northern part by regional tectonic activities and sea-level rise and fall, while the southern part was relatively well preserved. Longitudinally, the lower and top lithologic sections of the Carboniferous are partially missing, with the depositional characteristics of overburdened lower and denuded top. The lower part of the Carboniferous is partially missing and has the characteristics of deposition of the overburdened lower part and denuded top part. The overall Tahe Oilfield Carboniferous Karashayi Formation can be divided into the lower mudstone section and the upper sand mudstone section: the upper mudstone section is mainly dark gray, brownish-gray, and tan mudstone with stable thickness in the plan; the sand mudstone section is a large set of brown mudstone, tan mudstone interbedded with sandstone and conglomerate bearing sandstone (Figure 1). Based on the internal lithological characteristics, they are divided into four subsections from CK1 to CK4. Figure 2 shows a comprehensive column diagram of a single well in study area B. The unconformity surface and the important water recession surface are used as the interface for stratigraphic division, and four tertiary stratigraphic sequences were divided in this time: SQ1 (middle mudstone section-upper mudstone section), SQ2 (CK4), SQ3 (CK3-CK2), and SQ4 (CK1) (Fig. 2), and seven system domains (Fig. 2).

The SQ1 sequence is mainly mudstone sediments with a small amount of chert, and the sand content gradually increases from the bottom to the top, which is a set of stable mudstone stratigraphy, and there is no oil and gas display in this sequence. The resistivity curve at the boundary between the HST and TST system domains has increased significantly, and the natural gamma curve value has decreased significantly. The SQ3 sequence as a whole is characterized by thin sand-mud interbeds, the TST system domain is mainly a deltaic foreland deposit, and the lithology is mainly grey medium sandstone, conglomerate sandstone with mudstone and siltstone interbeds, with thin sand layers at the bottom and increasing mudstone upwards. The HST system domain is a deltaic plain deposit, and the lithology is a grey conglomerate, conglomerate sandstone and sandstone with grey mudstone interbeds. The conglomerate is lenticular in shape. The SQ4 sequence succeeds the SQ3 sand-mud thin interbedded sedimentary features, mainly yellow fine sandstone, siltstone, and mudstone interbedded. The logging curve has obvious abrupt change characteristics, upward resistivity value decreases, natural gamma curve value increases, this sequence contains a large amount of oil and gas display around the unconformity surface.

The various tertiary sequences of the Karashayi Formation, consisting of the HST controlled by fluvial action and the TST controlled by tidal action, lack the LST, several layers of the S60-1 well contain significant hydrocarbon resources, and the hydrocarbons are mainly distributed around the interface of the sequence and the unconformity.
4. Comparative Stratigraphy of Continuous Wells

Based on a single well stratigraphic delineation, a continuous well comparison of stratigraphic stratigraphy was conducted to establish a north-south (pro-source) and east-west (pro-source) stratigraphic grid in the study area to provide a framework for studying the distribution of reservoir sands.

4.1 Cis-source Continuous Well Profile.
The subsections have good continuity from the cis-source continuous well profile. Among them, the CK1 formation is gradually thinned from south to north and the northern CK1 formation is denuded. Clear stratigraphic cusps of extinction can be seen on the seismic profile (Figure 4). The longitudinal sands are stacked on top of each other, and have short lateral extension distances and poor connectivity; among them, the CK4-CK3 sands are developed and the CK2-CK1 sands are relatively undeveloped. There is little inter-well variation and strong contrast, indicating relatively stable deposition in this area during the depositional period of the Karashayi Formation. From the seismic profile, T50 (thick mudstone of the Triassic Ke Tul Formation), and T56 (bimodal tuff of the underlying Carboniferous Batu Formation) have a clear reflection interface. The upper mudstone section on the seismic profile is characterized by strong amplitude parallel continuous reflections, and the top of CK1 is characterized by continuous strong axes (Figure 6). Overall, the gas reservoir is developed in the western oil region and underdeveloped in the eastern oil and gas reservoir.

4.2 Vertical Source Continuous Good Profile.
From the vertical source continuous well profile, the continuity of each small layer in the western part of the study area is relatively good, while the continuity in the eastern part is poor, and the continuity of each small layer in the vertical source direction is good, and the thickness of the stratum does not change much. The sand body in the study area changes from west to east in a clear pattern, and from west to east the sand body gradually does not develop; vertically the western CK4-CK sand body is developed, and multiple sets of sand bodies are superimposed on each other, and the CK2-CK1 sand gradually thins; the eastern part of the work area is dominated by mudstone deposits, occasionally interspersed with thin sand bodies (Figure 5). The upper mudstone section on the seismic profile is characterized by strong amplitude parallel continuous reflections, and the top of CK1 is characterized by continuous strong axes (Figure 6). Overall, the gas reservoir is developed in the western oil region and underdeveloped in the eastern oil and gas reservoir.
5. Main Control Factors of Oil and Gas Formation

The Taher oil field is located in the south-central part of the Akkul Bulge of the Shaya Uplift. Under the influence of multi-phase tectonic movements, the strata have been stripped and overburdened many times, and multiple phases of unconformity and fractures have been developed. Meanwhile, the Cambrian-upper Ordovician marine hydrocarbon source rocks in the Manage depression, which produce hydrocarbons under large burial depth and high-pressure conditions, continuously supply hydrocarbons to the Carboniferous Karashayi Formation through deep and large fractures [17]. It has favorable conditions for the formation of stratigraphic oil and gas reservoirs. The multi-phase stratigraphic unconformity of the Carboniferous Karashayi Formation plays a dominant role in the formation of stratigraphic traps and hydrocarbon reservoirs, and combined with tectonic and lithologic factors, it forms a complex situation of the formation characteristics of the Carboniferous hydrocarbon reservoirs.

5.1 Reservoir Formation Control Factors

5.1.1 Stratigraphical Ringwork.

The Carboniferous Karashayi Formation reservoirs are mainly braided river deltaic sands, river and small deltaic phase estuarine dams, and branch river sands, which are thin in a single layer thickness and interbedded with mudstones in a lenticular form. The upper part of the clastic rocks of the Karashayi Formation is eroded (the stripping line is shown in Figure 7), and the capping layer that plays a major role in capping the Carboniferous reservoirs is a large set of dense mudstone of the overlying Lower Triassic Kotur Formation, while its reservoir development is mostly lenticular and interbedded with mudstone, and the mudstone developed between the sands also plays a good capping role, forming a multiple oil and gas system of thin reservoirs of the Carboniferous clastic rocks. The lower sandstone section of the Carboniferous Batu Formation is distributed in the southwest of the work area and extinguished to the northeast, forming a better reservoir-cover combination with the mudstone of the lower mudstone section overlying it. At the same time, the salt body of the Batu Formation also seals the oil and gas to a certain extent.

5.1.2 Fracture-disintegration Three-dimensional Transport System.

Carboniferous oil and gas distribution is closely related to fractures, which are the main channel for the upward transport of oil and gas in the Lower Ordovician. During the Carboniferous-Permian period, the intense uplift of the basin caused the denudation of most of the Silurian-Devonian strata, and the Carboniferous system was unconformable above the Ordovician system, forming unconformable surfaces. Oil and gas were transported upward through such unconformities and deep major fractures. Multiple phases of tectonic movements have occurred since the Permian, and the resulting multi-phase fractures are the conduits for the diffusion of hydrocarbons within the Carboniferous, which eventually accumulate in tectonic traps and closures to form reservoirs (Figure 7).

5.1.3 Deep Supply.

There are no hydrocarbon source rocks in the Carboniferous System of the Tahe Oilfield, and hydrocarbons come from the Cambrian-Superior Ordovician marine hydrocarbon source rocks in the Manage Depression. The marine hydrocarbon source rocks produce hydrocarbons under the conditions of large burial depth and high pressure, and continuously supply hydrocarbons to the Carboniferous Karashayi Formation through deep and large fractures, which is one of the conditions for the enrichment of Carboniferous hydrocarbons in the Tahe area.
5.2 Hydrocarbon formation model

The hydrocarbon formation mode of the Carboniferous Karashayi Formation is source-storage separation type-overburden-truncation composite formation mode (Figure 8).

1) The stratigraphic cusp extinguishes upper dip masking and forms a trap background. The Carboniferous strata were subjected to multiple stages of denudation, and the clastic-based Karashayi Formation is integrated with the underlying Bachu Formation bimodal tuff and is in unconformable contact with the dense mudstone of the overlying Lower Triassic Kotur Formation. The resulting numerous stratigraphic unconformities provide good trap conditions for the oil reservoir. In addition, the upper part of the clastic rocks of the Carboniferous Karashayi Group is eroded, and when the overlying Triassic volcanic rocks are covered by poorly permeable strata, good trap conditions are formed. From the north-south direction, the Karashayi Formation is cut off to the north and makes unconformable contact with the Triassic volcanic rocks. well S47 CK1 oil group is cut off from the Triassic unconformable contact with the Triassic volcanic rocks and the oil and gas are blocked by the Triassic volcanic rocks.

2) Lower growth and upper storage, long-distance cross-layer transport, and aggregation. Carboniferous hydrocarbons are supplied from the lower Ordovician suture hole reservoir, transported into the Carboniferous strata through deep and large fractures and unconformities, and formed into Carboniferous clastic thin reservoir strata hydrocarbon reservoirs through the multi-phase fracture transport formed at a later stage and the occlusion of the stratigraphic sharp extinction zone trap background.

The comprehensive analysis concludes that the Carboniferous Karashayi Formation is located in a complex stratigraphic reservoir controlled by a stratigraphic unconformity and stratigraphic sharp extinction, which is influenced by tectonics, fractures, and lithology, on a convex overburden background.

![Figure 8. Map of the Carboniferous Formation Model in the Tahe Oilfield](image-url)

6. Conclusion

(1) The lower and top lithologic sections of the Carboniferous are partially missing due to regional tectonic activity and sea-level rise. On the whole, Carboniferous sedimentation is characterized by overburden in the lower part and denudation in the top part. The interface between the unconformity and the important water recession surface is used as the interface for stratigraphic division, and four tertiary stratigraphic sequences are divided: SQ1, SQ2, SQ3, and SQ4.

(2) The distribution of stratigraphic sequences in the study area has a certain pattern, which is generally characterized by thinness in the middle and thickness from the north to the south, and strip-like spreading from the east to the west. The CK1 stratum in the northern part of the work area is stripped, and the stratigraphic sharp extinction feature is clear on the seismic.

(3) The Carboniferous Karashayi Formation is located on the overburdened background of convexity and is a composite reservoir controlled by a stratigraphic unconformity and stratigraphic extinction that is influenced by tectonics, fractures, and lithology.

References

10. Genetic relationship between tensor-torsional fracture zone and basin margin orogenic zone in the basin hinterland and control of hydrocarbon formation—a Jurassic system in the East Rim of the West Depression of 1 well in Junggar Basin as an
example[J]. Fracture Block Oil and Gas Field, 2021,28(6):805-809,822


12. Zhao Linfeng. Identification and distribution characteristics of faults in the Rotai and Sentamu oil fields [D]. China University of Petroleum (East China), 2018


