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The recovery of the Middle-Late Triassic prototype basin in the western Tuha basin-eastern Junggar Basin

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Abstract: Based on the data of mud logging, well logging and seismic data, the erosion thickness and original sedimentary thickness of the Middle-Late Triassic prototype basin in the west of Turpan-Hami Basin-Zhundong area were restored and analyzed. The erosion thickness of the Middle-Upper Triassic was calculated by the seismic stratigraphic thickness trend method, and the prototype basin was analyzed by combining the original sedimentary thickness. The results show that the erosion thickness in the west of Turpan-Hami Basin is 0m-600 m, which decreases first and then increases from north to south and then decreases. The erosion thickness of the Middle-Upper Triassic strata in the Zhundong area is 0m-400m, which increases first and then decreases from south to north. The maximum original thickness of the Middle-Upper Triassic strata in the western Tuha Basin is 1400 m in the front of the Bogda Mountain, which is thickened from north to south. The original thickness of the Middle-Upper Triassic strata in the eastern Junggar Basin generally increases from north to south. Bogda Mountain and its adjacent areas show a quasi-plainization process of cutting high and filling low. The scope of Taibei depression and Tainan depression further expanded, the sedimentary center moved southward, the Pubei low uplift became the denudation area, and the Keyayi depression and the Toksun depression developed. Beisantai uplift and Shaqi uplift in the north of Zhundong area are developed and their scope is expanding, and Zhundong depression area is developed in the south.

Keywords: Tuha basin; Zhundong area; Calculation of erosion amount; Prototype basin; Middle Late Triassic.

1. Introduction

The prototype basin has not been affected by tectonic action and stratigraphic denudation after its formation. The untransformed prototype basin can maintain the original basin properties, basin properties and basin types when it is just formed [1]. After the formation of the basin, it will be affected by the later tectonic action, and the formation erosion will occur, resulting in the existing basin retaining only some prototype basin features. Therefore, when the prototype basin is restored, the amount of strata denudation should be restored to reshape the prototype basin. The idea of restoring the prototype basin is to remove the influence of later tectonic action, and to restore the thickness of the basin at that time by using the thickness of the residual strata and the thickness of denudation.

The prototype basin of the middle and late Triassic in the western-Jundong area of the Tuha Basin was reconstructed by tectonic movement. The prototype basin pattern is complex and the prototype basin boundary cannot be determined. Therefore, the study area is used as a boundary to restore the thickness of the prototype basin. Based on the study of the residual thickness and denudation thickness of the western-Jundong area of the Turpan-Hami Basin, the thickness of the middle-late Triassic prototype basin in the western-Jundong area of the Turpan-Hami Basin is analyzed by using the drilling, logging and seismic profile data in the western-Jundong area of the Turpan-Hami Basin, and then the tectonic framework of the middle-late Triassic basin in the western-Jundong area of the Turpan-Hami Basin is restored.

2. Regional geological survey

The western part of the Tuha Basin is located in the eastern part of Xinjiang, which is distributed east-west [2] It is adjacent to the Kalawucheng Mountain in the west, the Bogda Mountain in the north and the Jueluotage Mountain in the south. The basin has undergone multi-stage tectonic evolution. It is a composite superimposed hydrocarbon-bearing basin [3]. The western part of the basin is divided into two primary tectonic units from west to east: Turpan Depression and Ledun Uplift. Turpan Depression can be subdivided into seven secondary tectonic units, including Taibei Sag, Takquan Uplift, Tainan Sag, Luxi Uplift, Toksun Sag, Buerjia Uplift, and Keyayi Sag (Fig.1).

The Bogda Mountain is located on the northern side of the East Tianshan Mountains (Figure 1), from the Junggar Basin in the north to the Tuha Basin in the south, the western boundary is located in the Urumqi area, and the eastern boundary is located in the western part of Balikun County. The fault is connected with the Harlik Mountains. [4]; its east and west ends are wide and extend more than 250 kilometers. It is a north protruding arc mountain that divides the Junggar Basin and the Turpan-Hami Basin. It has the characteristics of multi-segment arc structure. The western section is the Fukang arc protruding northward, and the eastern section is the Shanshan arc protruding southward [5,6].

The eastern part of the Junggar Basin is from the Kelameili Mountain in the north to the Bogda Mountain in the south, and the western part is in a transitional relationship with the central depression of the Junggar Basin. From the Triassic to the present, it has experienced a long stage of intracontinental depression evolution, and has experienced the superposition and transformation of the basin by the Indosinian movement, Yanshan movement and Himalayan movement [7]. From west to east, the Zhundong area is divided into nine secondary tectonic units: Shaqi uplift, Wutongwozi sag, Beisantai uplift, Jimsar sag, Fukang fault zone, Guxi uplift, Gucheng sag, Gudong uplift and Mulei sag (Fig.1).

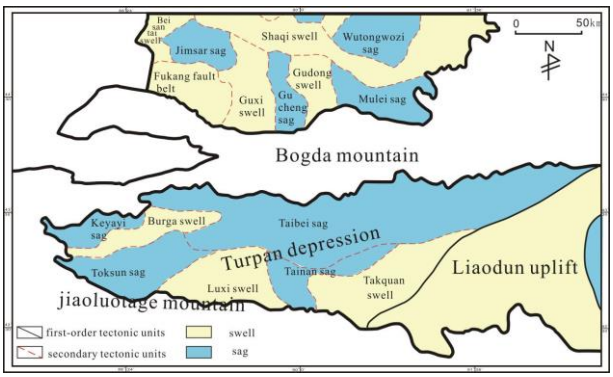


Fig.1 Division of tectonic units in the western Tuha Basin and the eastern Junggar Basin (according to Yuan Mingsheng et al. [8]; there are modifications)

3. Restoration of Middle-Upper Triassic denudation thickness

Strata denudation is common in multi-stage sedimentary basins and often accompanied by tectonic movement. The tectonic uplift during the main inversion period of the basin has the strongest erosion on the filling sequence of the original basin. Therefore, restoring the amount of strata denudation is an important basic work for sedimentary basin analysis.

3.1. Calculation of erosion amount by seismic stratigraphic trend thickness method

In order to accurately restore the erosion thickness of the Permian and Triassic strata in the western-Jundong area of the Turpan-Hami Basin, according to the geological characteristics and existing data of the study area, the seismic stratigraphic trend thickness method is used to calculate the erosion amount, and then restore the erosion thickness.

Any basin always has one or several subsidence centers in a specific geological history. The strata in these sedimentary centers are always thicker than those in adjacent areas, and thinned until the thickness of the sedimentary layers at the edge of the basin is pinched out [9]. Under certain conditions, the subsidence zone on one side of the basin is developed, and it will always become thinner to the edge of the basin, except that some of the basin fault edges are sometimes abruptly cut off [10].

The method of thickness trend of seismic strata is based on the characteristics of uniform or uniform thickness of the strata before the ideal state denudation, and according to the geophysical imaging characteristics of the strata in the regional seismic data, the strata that are easy to track and stable in thickness are found in the regional section. Starting from the strata that have not been denuded, the initial denudation points are traced and the thinning rate of the strata is calculated according to the sedimentary principle of the basin, and then the variation trend of the formation thickness is calculated to calculate the original formation thickness. The erosion surface formed by the Indosinian movement in the western-Jundong area of the Turpan-Hami Basin is clear and reliable. It is easy to identify on the seismic profile. The thickness of the strata in each era changes evenly and the dip angle of the strata is small, which provides the conditions for using this method to restore the amount of erosion.

In this study, three seismic profiles were selected in the western and Zhundong areas of the Tuha Basin to track the unconformity, identify and compare the erosion points and erosion characteristics of the unconformity interface (Figure 2). Based on the above principles, the erosion amount of the Upper Triassic in each section is calculated on the basis of 6 seismic sections (Fig.3-Fig.14).

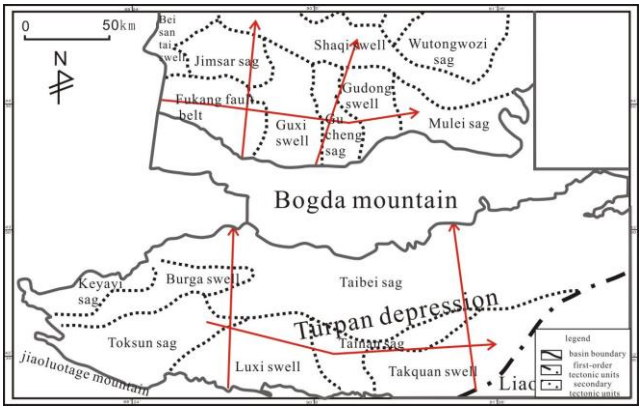


Fig. 2 Seismic profile location map

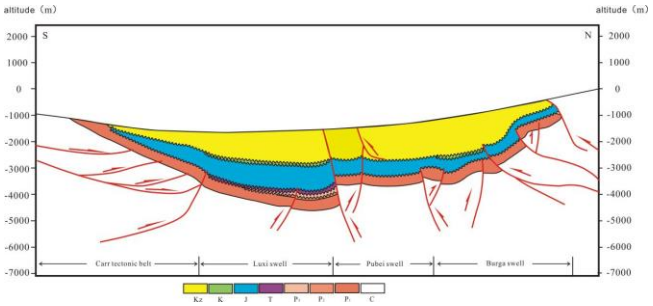


Fig. 3 North-south structural-stratigraphic interpretation profile on the west side of the western Tuha Basin

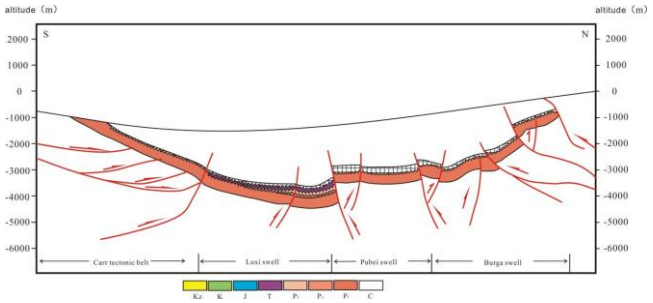


Fig.4 The north-south Middle-Upper Triassic denudation interpretation profile in the west of Turpan-Hami Basin

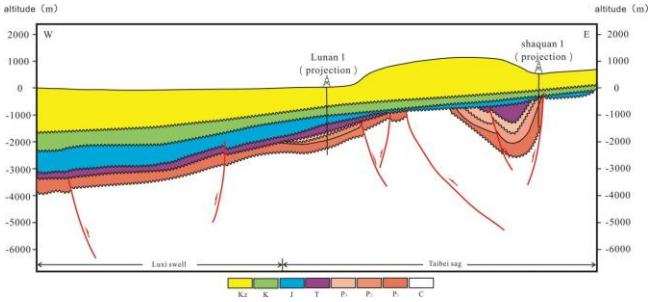


Fig. 5 East-West structural-stratigraphic interpretation profile in western Tuha Basin

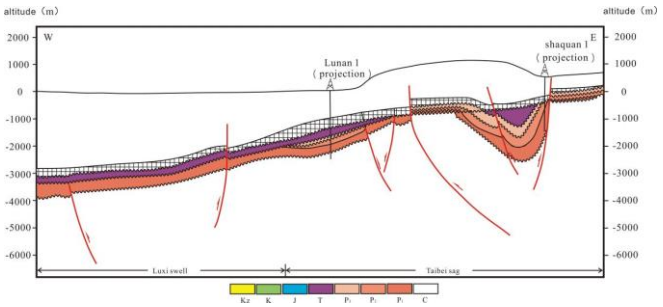


Fig. 6 E-W-trending Middle-Upper Triassic denudation interpretation profile in Tuha Basin

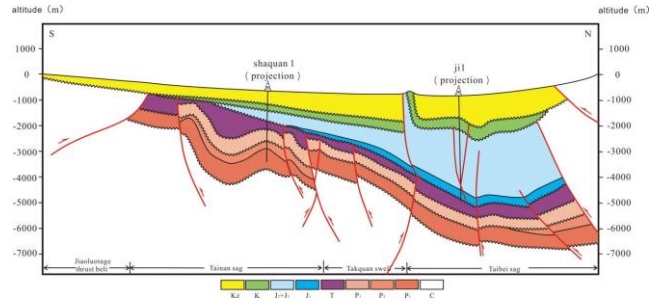


Fig. 7 North-South tectonic-stratigraphic interpretation section on the east side of the western Tuha Basin

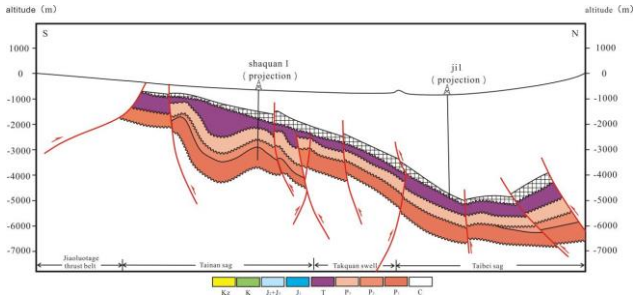


Fig. 8 The north-south Middle-Upper Triassic denudation interpretation profile on the east side of the western Tuha Basin

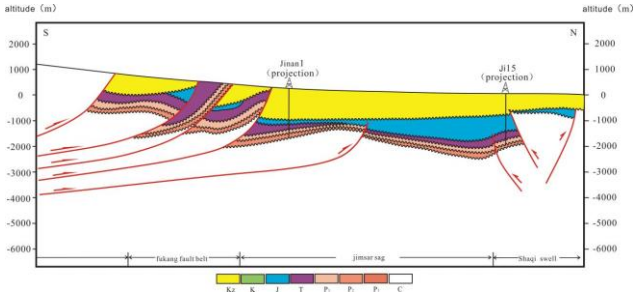


Fig. 9 The north-south structure-strata interpretation section on the west side of Zhundong area

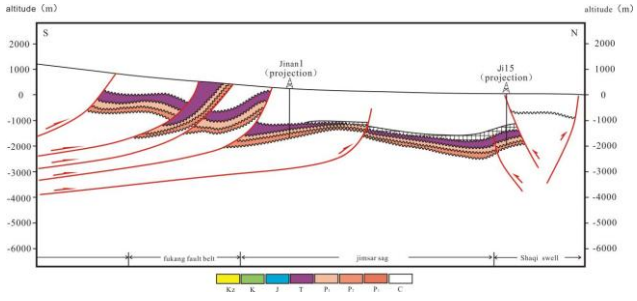


Fig. 10 The north-south Middle-Upper Triassic denudation interpretation profile on the west side of Zhundong area

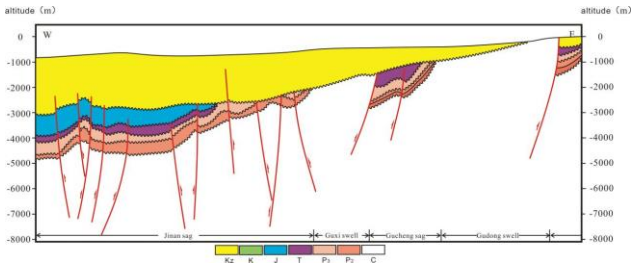


Fig. 11 East-West structural-stratigraphic interpretation profile in Zhundong area

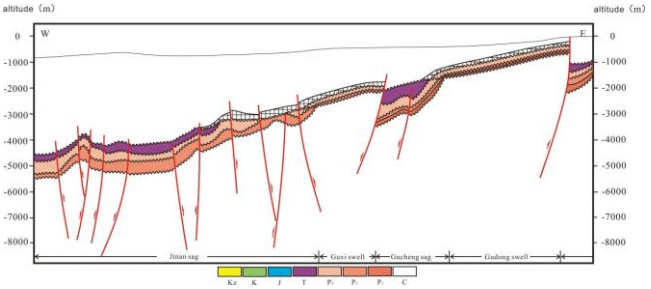


Fig. 12 E-W-trending Middle-Upper Triassic denudation interpretation profile in Zhundong area

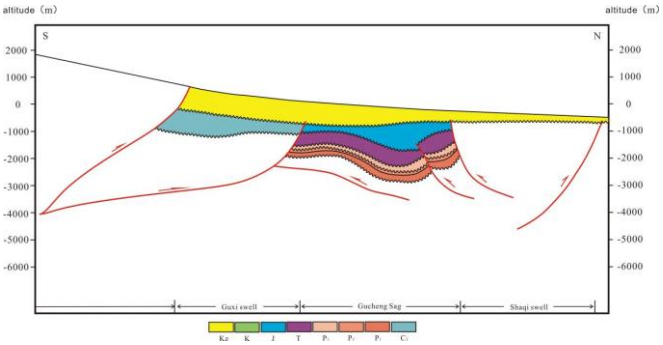


Fig. 13 The north-south structure-strata interpretation section in the east of Zhundong area

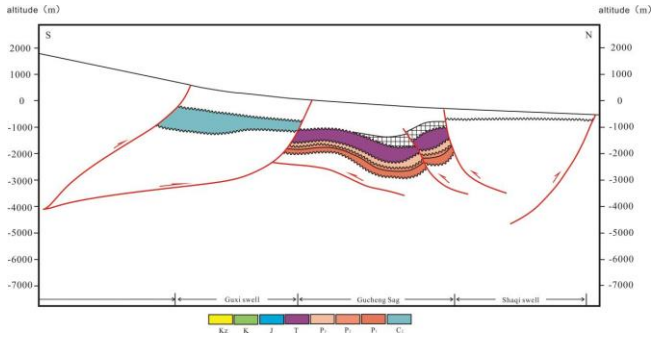


Fig. 14 The north-south Middle-Upper Triassic denudation interpretation profile in the east of Zhundong area

3.2. Strata erosion thickness recovery

In this study, the erosion amount of the middle and upper Triassic on the profile was calculated according to the seismic stratigraphic trend thickness method, and a plane distribution map of erosion amount was formed (Fig.15).

It can be seen from Fig.15 that the Indosinian movement at the end of the Late Triassic made the western part of the Turpan-Hami Basin-the eastern part of the Junggar Basin once again subjected to near north-south compression, and the strata in the northern and southern margins of the basin were uplifted and eroded. In the western region of Tuha Basin, the erosion range of the Middle-Upper Triassic strata is larger than that of the Upper Permian, which is distributed in Taibei

Sag, Tainan Sag, Keyayi Sag, Toksun Sag, Buerjia Uplift, Luxi Uplift and Takquan Uplift. The erosion thickness is 0m-400m; the erosion thickness on the east side of the western Tuha Basin gradually increased from Dongtan 1 well to Dongshen 2S to the north to 400 m, and the erosion thickness to the south increased first and then decreased, reaching the maximum at the slope and decreasing southward (Fig.15).

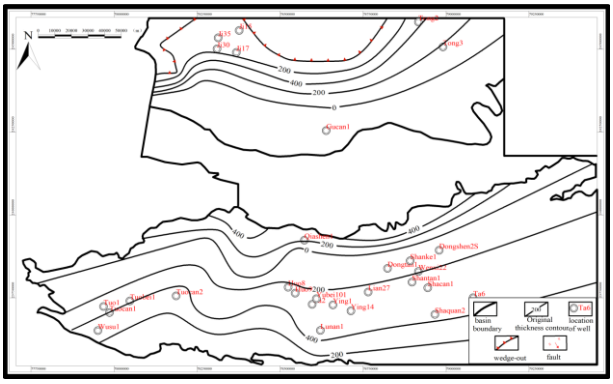


Fig. 15 Erosion thickness contour map of Middle-Upper Triassic in western Tuha Basin-eastern Junggar Basin

4. Prototype basin thickness recovery

It can be seen from Fig.3.36 that the original strata of the Middle-Upper Triassic are mainly distributed in Taibei sag, Tainan sag, Keyayi sag, Toksun sag, Buerjia uplift, Luxi uplift and Takequan uplift. The original thickness is 200m-1200m. The sedimentary center is located in the front of Bogda Mountain and Shaquan 2 well. The sedimentary thickness of Bogda Mountain is 1200 m, and the sedimentary thickness of Shaquan 2 well is 1000 m. The thickness of the original strata in the western Tuha Basin gradually increases from south to north, reaching the maximum in the front of the Bogda Mountains.

In the Zhundong area, the thickness of the original strata in the southern part of Beisantai uplift and Shaqi uplift is thickened from north to south, and the sedimentary thickness is 0m-600m. In the Jimsar sag, the thickness of the original strata is thickened northward, and the thickest is 400m (Figure 16).

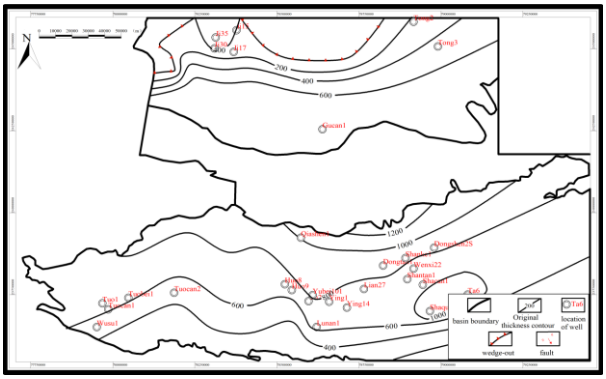


Fig.16 Original thickness contour map of Middle-Upper Triassic in western Turpan-Hami Basin-eastern Junggar Basin

5. Prototype basin framework

The results were calculated by denudation. Combined with the residual formation thickness of each layer, the original formation thickness of each layer can be obtained by calculation. On this basis, combined with the current tectonic characteristics and tectonic evolution process, the prototype basin is restored, and compared with the current structure, the ancient tectonic pattern and basin prototype evolution can be further analyzed.

In the Middle-Upper Triassic sedimentary period, Bogda Mountain belongs to the sedimentary product of stable depression type, and Bogda Mountain and its adjacent areas show a quasi-plainization process of cutting high and filling low [4]. The western part of the Tuha Basin is a depression-type basin. The Taibei and Tainan depressions are further expanded, the sedimentary center moves southward, the Pubei low uplift becomes an erosion area, and the Keyayi and Tuokexun depressions are developed on the west side. The tectonic framework of the Triassic in the eastern Junggar Basin is consistent with that of the Upper Permian. The Beisantai uplift and Shaqi uplift in the north continue to develop and expand. The southern side is still the Zhundong depression area (Figure 17).

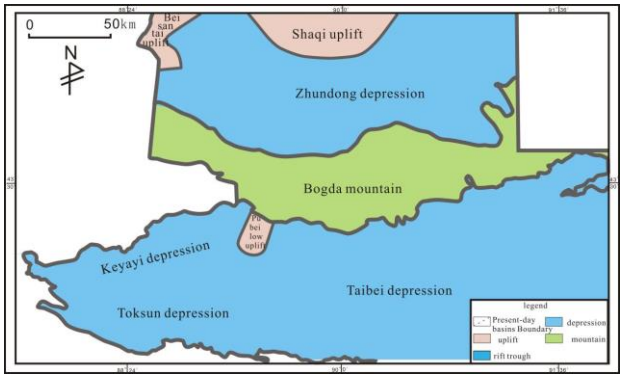


Fig. 17 Middle-Late Triassic tectonic framework

6. Conclusion

According to the calculation of denudation amount, the denudation thickness of the middle and upper Triassic strata in the western Turpan-Hami Basin is 0m-600m, which has a trend of decreasing first, then increasing and then decreasing from north to south. The erosion thickness of the Middle-Upper Triassic strata in the Zhundong area is 0m-400m, which increases first and then decreases from south to north.

The maximum original thickness of the Middle-Upper Triassic strata in the western Tuha Basin is 1400 m in the front of the Bogda Mountain, which is thickened from north to south. The original thickness of the Middle-Upper Triassic strata in the eastern Junggar Basin generally increases from north to south.

During the Middle-Upper Triassic sedimentary period, Bogda Mountain and its adjacent areas showed a quasi-plainization process of cutting high and filling low. The scope of Taibei depression and Tainan depression further expanded, the sedimentary center moved southward, the Pubei low uplift became the denudation area, and the Keyayi depression and the Toksun depression developed. During the Middle-Upper Triassic sedimentary period, the Beisantai uplift and Shaqi uplift in the north of the Zhundong area were developed and the range was expanding, and the Zhundong depression area was developed in the south.

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