

Analysis on Tectonic Style and Forming Mechanism of the Cambrian System in the Central Uplift Belt, Tarim Basin

W. Yin

CNPC Research Institute of Petroleum Exploration & Development, PetroChina
Beijing, China

T. L. Fan

China University of Geosciences
Beijing, China

Abstract—Based on the theory and method of structural geology, through the systemic analysis on seismic data, the author researched on characteristics of structure geometry and kinematics, and its dynamics mechanism: There are a series of half-grabens in the Lower-Middle Cambrian Series of the Central Uplift Belt, and they are located in Bachu uplift and the southwestern area of Tazhong uplift. Based on the special basement, tectonic movements, including extension and compression are the main factors of forming half-grabens. The residual gravity anomaly high is accord with the distribution of half-grabens, the strike of buried fault and half-graben is concordant.

Keywords—half-graben; tectonic style; forming mechanism; cambrian; central uplift belt; tarim basin

I. REGIONAL GEOLOGY

Tarim Basin consists of eight first-order tectonic units and Central Uplift Belt is located in the central part of Tarim Basin. From west to east, it is Bachu Uplift, Tazhong Uplift and Tadong Uplift orderly. Bachu Uplift and Tazhong Uplift are both neighbouring second-order structural units of Central Uplift Belt, but there are obvious differences in tectonic evolution between them. Bachu uplift formed in Hercynian period, and finalized in Himalayan period. Tazhong Uplift formed in the middle Caledonian period, and finalized in the early Hercynian period (Figure 1).

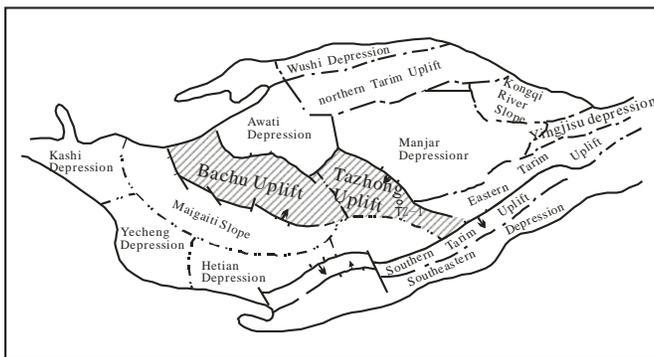


FIGURE 1. LOCATION MAP OF WORK AREA.

II. CAMBRIAN TECTONIC STYLE

Tectonic style refers to the total tectonic deformations controlled by the same tectonic movement or the same stress, and it is one of the important contents of the structure research of oil and gas fields. In this paper, target zones is middle and lower Cambrian (the top surface of middle Cambrian is T81, the top surface of lower Cambrian is T82, and the bottom surface of lower Cambrian is T90). The faults of this period have the typical wedge shapes — half-grabens. In half-grabens, not only formation thickness changes obviously, but also does seismic reflection characteristic. Generally, in the deepest location of half-grabens, the amplitude is weak, and continuity is poor. In the slope and the top of half-grabens, the amplitude is high, and continuity is better (Figure 2).

The scale of single half-graben is small, but so many half-grabens develop in the same belt, and consist of a large scale half-graben, which develops highland, slope and sag at the same time. A large scale half-graben controls regional depositional landform structure and restricts regional strata development and sedimentary facies distribution. In seismic profile, the expression of a large scale half-graben is not obvious, while, the top boundary of T81 was leveled, the tectonic framework of a large scale half-graben is distinct (Figure 3).

Half-grabens experienced 2 periods of tectonic movements: ① in early and middle Cambrian, it mainly experienced extensional movement and block tilt movement, accompanied by a short minor local compressional movement, and local compressional movement did not change the extensional structural framework of lower and middle Cambrian system. ② it mainly experienced compressional and flexing action and formed thrust folds after early and middle Cambrian. Both actions reshaped the half-grabens (Figure 4) [1-2]. In the planar, the trend of half-grabens is mainly northwest-southeast, and strike of half-grabens is mainly northeast-southwest. Half-grabens mainly distribute western Bachu uplift, western Hetianhe block and southern tazhong uplift (Figure 5).

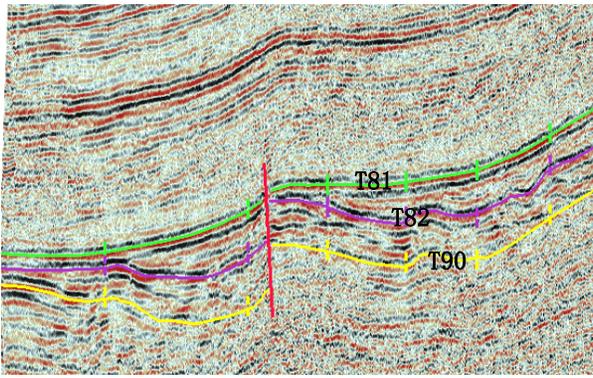


FIGURE II. STRUCTURAL STYLE OF HALF-GRABEN IN HETIANHE BLOCK OF BACHU UPLIFT (HTH-TZ03-244.6SN).

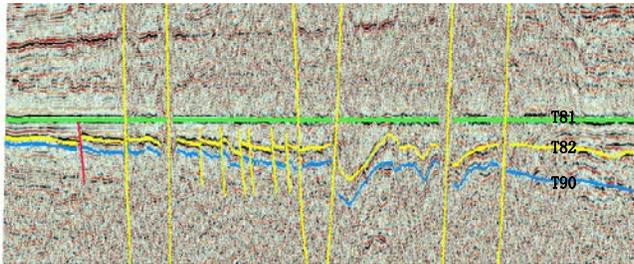


FIGURE III. SECTION STYLE BEFORE THE UPPER CAMBRIAN SEDIMENTATION IN BACHU UPLIFT (BC04-L1).

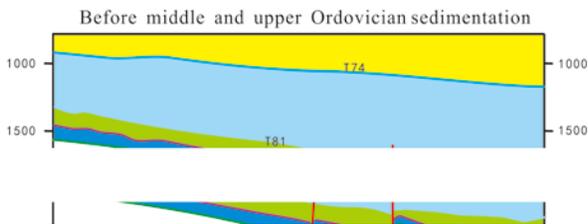


FIGURE IV. EVOLUTION SECTION OF HTH-TZ03-256.6SN.

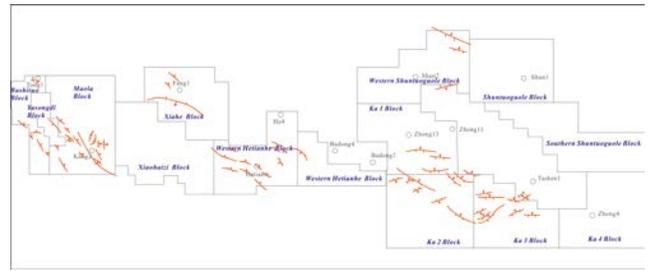


FIGURE V. PLANAR DISTRIBUTION OF HALF-GRABENS ON THE BOUNDARY T82 IN CENTRAL UPLIFT BELT.

III. FORMATION MECHANISM OF HALF-GRABENS

A. Dynamic Mechanism of Half-Grabens[3-4]

A series of important geological events were happened during Sinian-Early Ordovician passive continental margin, where aulacogen was developed in the northeast margin of Tarim Basin during Early Sinian[5]. The development of aulacogen played an important role in the formation of Early-Middle Cambrian half-graben in central uplift belt. Regional seismic line (TLM-Z90) of Tarim Basin, regional seismic line (TZ01-448SN) in Tazhong uplift, and regional seismic line (BC04-L1) of Bachu uplift were selected to analyze the structure features of the depression and its plane changes. Obvious difference of strength were found in the above three lines: TLS-Z90 was closely close to the aulacogen, where the affection by the aulacogen was the greatest, fault-throw can be reached up to 1700ms (Figure 6.); The distance from TZ01-448SN to the aulacogen became larger, where affection became smaller, fault-throw was about 500-800ms (Figure 7.); BC04-L1 in Bachu uplift was the farthest one from the aulacogen, where the affection by the aulacogen was the minimum, leading the smallest fault-throw, about 20-200ms (Figure 8.). According to the changes of fault-throw, it can be concluded that the development of depression was mainly controlled by the aulacogen that was developed in the northeast margin of Tarim Basin, and the affection towards the faulted-sag became weakened from east to west. Therefore, a reasonable explanation was gained for the development of half-graben under the regional dynamic background.

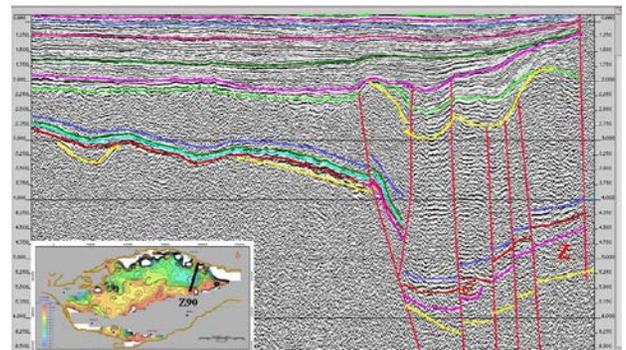


FIGURE VI. REGIONAL SEISMIC PROFILE TLM-Z90 OF TARIM BASIN.

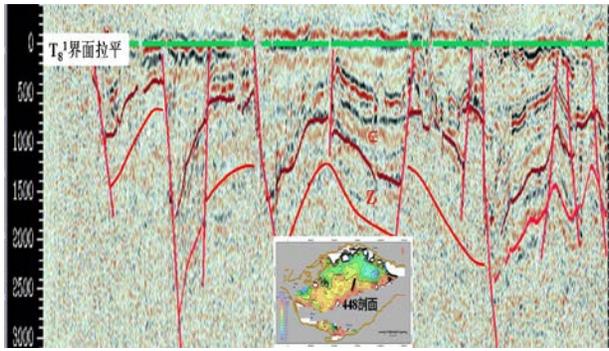


FIGURE VII. REGIONAL SEISMIC PROFILE TZ01-448SN IN TAZHONG UPLIFT OF TARIM BASIN.

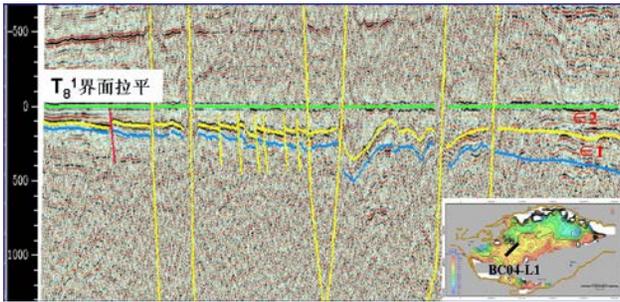


FIGURE VIII. REGIONAL SEISMIC PROFILE BC04-L1 IN BACHU UPLIFT OF TARIM BASIN.

Based on the above analysis, it can be concluded that the development of aulacogen was the dynamic mechanism for the formation of half-graben. However, which factor controlled the distribution and strike of the half-graben? According to the analysis of gravity-magnetic data of the basement in Tarim Basin, the distribution and strike of the half-graben was controlled by the characteristics of the basement of Tarim Basin.

B. Gravity Field Controls Planar Distribution of Half-Grabens

In the residual gravity anomaly map of Tarim Basin, the work area was located in the high-value zone, which was corresponding to upper-mantle uplift of Bachu and upper-mantle uplift of Tazhong. The high-value zones of residual gravity anomaly were easy to form half-graben by the regional horizontal extensional stress in Early-Middle Cambrian [5].

The whole Bachu uplift was located in upper-mantle uplift zone and with large uplift amplitude, so the half-graben was well developed; The south part of Tazhong uplift was located in upper-mantle uplift zone, while the basement of the north part was flat, so the half-graben was well developed in the south part. Based on the above analysis, it can be concluded that the distribution of half-graben was consisted with the high residual gravity anomaly zone, In other words, the high residual gravity anomaly controlled the distribution of half-graben (Figure 9.).

C. Influence of Insidious Basement Faults Over Half-Grabens

Buried basement faults were developed in the basin basement. 41 larger buried basement faults were found in Tarim Basin, some of which promoted the development of Middle-Lower Cambrian half-graben, including ① AF7 and BF8 (buried basement fault) in the central uplift and ② AF1 and AF2 (latitudinal basement fault) in the central (Figure 10.).

The controlling of buried basement faults towards the half-graben was shown in the strike of half-graben. Strike of buried basement fault in Tarim Basin was NW-SE, while half-graben was also NW-SE. Different buried basement faults played the major role in different areas. AF7 and BF8 played the major role in Bachu uplift while AF7 and AF2 played the major role in Tazhong uplift. According to the above analysis, buried basement fault played a relatively strong controlling over the strike of half-graben in overburden [5-6] (Figure 10.).

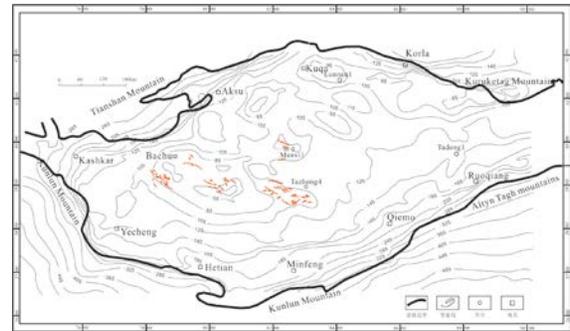


FIGURE IX. CORRESPONDING DIAGRAMS BETWEEN RESIDUAL GRAVITY ANOMALY AND HALF-GRABENS DISTRIBUTION OF TARIM BASIN (ACCORDING TO JIA CHENGZAO, 1997).

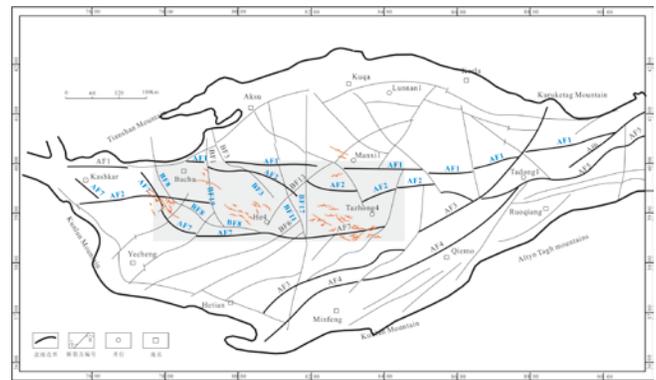


FIGURE X. CORRESPONDING DIAGRAMS BETWEEN INSIDIOUS BASEMENT FAULTS AND HALF-GRABENS DISTRIBUTION OF TARIM BASIN.

IV. CONCLUSION

The extensional background of the Central uplift in Tarim Basin during Early-Middle Cambrian was the major controlling factor for the development of half-graben. The formation of aulacogen in northeast margin of the basin was the dynamic mechanism for the developing of half-graben. The upper-mantle uplift zones controlled the distribution of half-graben, and buried basement faults controlled the strike of half-graben. Therefore, the development of half-graben in the

Central uplift was the result of joint-action by the extensional and compression stress in the later stage under the specific basement background.

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