Triassic in the eastern Sichuan basin ray slope and badong group strata division and correlation

Zhen Liu [1, 2], Ruigang Zhang [1, 2], Dan Zhou [1, 2], Fei Chen [1, 2], Wei Li [1, 2], Yang Chen [1, 2], Zhengda Zhou [1, 2], Lei Nie [1, 2]

[1] Chongqing Key Laboratory of exogenetic mineralization and mining environment (Chongqing Institute of Geology and mineral resources), Chongqing 401120 China
[2] Key Laboratory of Shale Gas Exploration, Ministry of Natural Resources (Chongqing Institute of Geology and Mineral Resources), 401120. China

Abstract: Triassic strata are widely developed in the eastern part of Sichuan Basin. The Mingyuexia anticline and Huangnitang anticline located in the eastern Sichuan structural belt develop Triassic Jialingjiang Formation to Xujiahe Formation. The middle Triassic Leikoupo Formation and Badong Formation on both sides of the anticline are synchronous and heterogeneous strata. They are distinguished regionally according to their different sedimentary environments and lithologic characteristics, and the phase transition boundary between Leikoupo Formation and Badong Formation is determined.

Keywords: Leikoupo Formation; badong Formation; sedimentary environment; phase transition boundary.

1. Introduction

A series of parallel folds developed in the eastern part of the Sichuan Basin, forming an arc-shaped structural belt mainly extending in the north-east direction. A series of Jurassic folds alternated with anticlines and synclines developed in the structural belt. Divided into two categories, one is a trough-type fold with a wide anticline and a tight syncline, and the other is a block-type fold with a tightly closed anticline and a wide syncline [1-2]. The Jura Mountain-type folds in the study area are mainly barrier folds, which are mainly characterized by the tight closure of the Mingyuexia anticline on the north side and the Huangnitang anticline on the south side, and the Liangping syncline between the two anticlines is gentle and open. It is a typical high and steep anticline structure in eastern Sichuan.

Dianjiang and Mingyuexia anticline in the north of Liangping are located in this structural belt, which is characterized by asymmetric wings, steep south-east wing and gentle north-west wing. In the core of Mingyuexia anticline, there are early Triassic Jialingjiang Formation, Leikoupo Formation and Xujiahe Formation developed in both wings, and Badong Formation developed in Huangnitang anticline, in which Leikoupo Formation and Badong Formation are heterogeneous strata in the same period. Previous studies on oil, gas and rock salt in Triassic Leikoupo Formation in the study area have been more, while comparative studies on Leikoupo Formation and Badong Formation have been less. The study area is in the transition of Badong Formation and Leikoupo Formation transition area, therefore this in-depth research.

2. Group condition

2.1 Leikoupo Formation of Middle Triassic

2.1.1 Stratigraphic division of Leikoupo Formation

The Leikoupo Formation was named for Xu Deyou at Leikoupo near Xinchang, Weiyuan County, Sichuan, and was formerly known as the "Leikoupo System". Before the 1950s, the next group of this group was divided by "mung bean rock"; after the 1960s, some scholars raised the next group of the Leikoupo Formation to the bottom boundary of the variegated mud and shale section in the lower part of the group, which is higher than the bottom boundary of "mung bean rock". dozens of meters. There is no mung bean rock exposed at the bottom of the Leikoupo Formation in the study area, and the bottom variegated mudstone and shale are used as the geological boundary with the Jialingjiang Formation.

The Leikoupo Formation in the study area is divided mainly by the bottom gray-green hydromica clay rock, namely "mung bean rock", which is generally about 0.5~3m thick. Leikoupo Formation is in integrated contact with the underlying Jialingjiang Formation; Parallel unconformity contact with overlying Xujiahe Formation.

Leikoupo Formation in the study area is divided into three sections. The first section is mainly gray and light gray argillaceous limestone, argillaceous dolomite with

yellow-green hydromica clay rock at the bottom, the second section is yellow-green and dark gray argillaceous dolomite, argillaceous limestone mixed with silty mudstone, and the third section is gray and off-white argillaceous dolomite, argillaceous limestone and limestone.

The Leikoupo Formation in the study area has the highest content of dolomite, argillaceous dolomite and microcrystalline limestone, followed by mudstone shale, with gypsum rock and rock salt crystals locally. The color of dolomite is mainly light gray and gray-white, of which the content of dolomite is more than 90%, including quartz, mica, iron, etc., and there are micro-cut patterns on the surface. The color of microcrystalline limestone is mainly gray and dark gray. The rock is mainly calcite, and the rest can be seen in quartz, mud, iron and debris. Mudstone and shale have mixed colors, mainly gray-green, gray-white, light gray, gray-black, etc. The mudstone at the bottom is clay-like.

2.1.2 Formation environment analysis

The predecessors inferred that the Middle Triassic Sichuan Basin developed a sedimentary environment of barrier-type carbonate salt platforms due to the influence of paleostructure[3,8]. The barrier platform developed in the study area, and the hydrodynamic conditions were weak, which provided the basis for the deposition of carbonate salt in the Leikoupo Formation. Due to favorable conditions, the lithology of the Leikoupo Formation in the study area is mainly marl, dolomite, argillaceous dolomite, halite, gypsum, mudstone, shale, etc. Mainly dolomite and shale, the sedimentary environment is the lagoon edge flat, the second member of the Leikoupo Formation is mainly composed of mudstone, shale, and argillaceous dolomite, which is characterized by the decline of sea level and strong evaporation. Terrigenous clastic sediments, the sedimentary environment is lagoon edge facies, the rocks of the third member of the Leikoupo Formation are mainly microcrystalline limestone, which is characterized by the rapid rise of sea level and the increase of water depth. Limestone flat deposits on the edge of the lagoon. Based on previous research results, it can be seen that the sedimentary environment of the Leikoupo Formation in the study area is mainly characterized by lagoon-tidal flat facies deposition in limited platform.

2.2 Badong Formation of Middle Triassic

2.2.1 Stratigraphic division of Badong Formation

Badong Formation in the study area is divided into hydromica clay rock, gray deep stucco rock and dolomitic limestone mixed with shale as marker layers. Chongqing Regional Geological Records defines the bottom boundary of Badong Formation as the bottom of "Mung Bean Rock", which is the same as Leikoupo Formation. However, the muddy dolomite and muddy limestone at the bottom of Leikoupo Formation are mixed with mud shale, which is easily confused with "Mung Bean Rock" in the field. Therefore, this time, purple clastic rock is used as the auxiliary identification mark of Badong Formation in the field. Badong Formation is in integrated contact with the underlying Jialingjiang Formation, and the overlying Xujiahe Formation is a parallel unconformity stratum, which is completely equivalent to the stratification sign of Leikoupo Formation.

Badong Formation in the study area is divided into three sections, the first section is gray, grayish yellow marl and dolomitic limestone mixed with shale, the second section is purplish red, yellow green shale mixed with argillaceous siltstone and marl, and the third section is gray and light gray argillaceous limestone.

The Badong Formation in the study area has the highest content of mudstone and shale, followed by siltstone and fine sandstone, with the least carbonate salt content. The main characteristics of mudstone and shale are purple-red, gray-green, and reddish-brown. Among them, clay minerals generally account for more than 50%, and non-clay minerals include quartz and calcite. The color of the sandstone is mainly purple-red and gray-brown, and the sandstone is mainly silt-fine sand lithic sandstone, and the lithic composition is mainly quartz. Carbonate rock salt is basically dolomite, with a small amount of limestone intercalated. The color is mainly dark gray, gray, and taupe. There are terrigenous clastic materials in the limestone.

2.2.2 Formation environment analysis

The Badong Formation mainly develops mudstone, siltstone and marl. The first member of the Badong Formation has well-developed rock bedding, thin-to-medium-layered dolomite at the bottom, and well-developed shale shales. siltstone, reflecting the weak hydrodynamic environment during the deposition of the Badong Member. In the second member of the Badong Formation, cross-bedding is developed, and small corrugated bedding is developed in the argillaceous siltstone, indicating that the formation was deposited in a low-energy environment. The third member of the Badong Formation mainly develops mudstone and marl, and the bedding is homogeneous bedding, which also shows the characteristics of weak hydrodynamics. From the stratigraphic lithology of the Badong Formation, it can be seen that the first member of the Badong Formation and the third member of the Badong Formation show sea level rise, and the sedimentary materials are rich in calcareous sediments, while the second member of the Badong Formation shows the sea level decline, mainly terrigenous debris deposition. Based on previous research results, it can be seen that the depositional environment of the Badong Formation in the study area is dominated by low-energy tidal flats and lagoons under the barrier coast[4-6].

3. Stratigraphic correlation and its thickness distribution characteristics

A series of Jura-type folds are developed in the study area, which are dominated by high and steep anticlines of NE and NNE, and the occurrence of strata changes obviously, which is not conducive to stratigraphic correlation. Therefore, it is particularly important to choose a suitable location for profile survey, and then to make regional stratigraphic correlation.

Mingyuexia anticline in the north of the study area is the main exposed area of Leikoupo Formation, Mingyuexia anticline is an obvious knee fold, and Leikoupo Formation is exposed on both wings of the anticline. The stratum on the south-east wing of the anticline is exposed completely, the marker bed is obvious, and the occurrence is stable. Therefore, the south-east wing of the anticline is selected for typical profile survey of Leikoupo Formation. The southern Huangnitang anticline is the main exposed area of Badong Formation. The two wings of Huangnitang anticline are exposed to Badong Formation. The two wings of this anticline are asymmetrical, the northwest wing is gentle and the south wing is steep, and it is a linear sharp-edged to half-box anticline, and the indicator layer of Badong Formation exposed to the northwest wing is obvious. Therefore, this wing is selected for typical profile survey of Badong Formation.

Comparing the two typical sections in the study area with other strata sections of Leikoupo Formation and Badong Formation in the area (Figure 1), it is found that the strata thickness of Badong Formation gradually becomes thinner from Yunyang through Kaizhou to Liangping area, and the strata thickness of Leikoupo Formation changes obviously from Nanchuan to Dianjiang area, the Leikoupo Formation in Nanchuan to Yubei area is not fully exposed, and the thickness of Leikoupo Formation in Dianjiang area is stable. From Dianjiang to Liangping to the west, the content of mudstone in Leikoupo Formation gradually decreases, while dolomite, dolomitic mudstone and limestone gradually increase. The content of red clastic rocks in the East Badong Formation gradually increased. Therefore, it can be found that the boundary line of phase change between Leikoupo Formation and Badong Formation in the study area is from Dianjiang to Liangping.

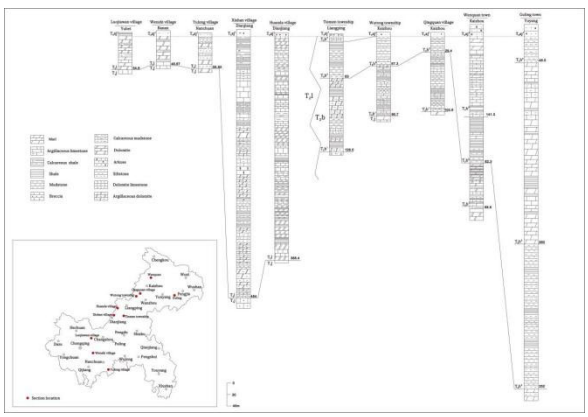

Fig. 1 Comparison of stratigraphic sections between Leikoupo Formation and Badong Formation

Chongqing Regional Geology takes the Chengkou-Wanzhou-Nanchuan line as the boundary line between Leikoupo Formation and Badong Formation[7], with Leikoupo Formation in the west of the boundary line and Badong Formation in the east of the boundary line. From east to west, the content of purplish red clastic rocks in Badong Formation gradually decreases, the dolomite and dolomitic mudstone in mudstone gradually increases, and the argillaceous components in limestone also gradually decrease, and gradually transition to Leikoupo Formation, on the contrary. The comprehensive comparison between Leikoupo Formation and Badong Formation in the study area is the same as that in Chongqing Regional Geology, so the phase transition boundary between Leikoupo Formation and Badong Formation in the study area is redefined as Dianjiang-Liangping area.

4. Conclusion

(1) Leikoupo Formation and Badong Formation are sedimentary facies strata in the same period.

(2) The stratigraphic depositional environment of the Leikoupo Formation is a lagoon-tidal flat depositional environment with limited platform, and the depositional environment of the Badong Formation is a low-energy tidal flat and lagoon-based depositional environment under the barrier coast.

(3) The phase transition zone between the Leikoupo Formation and the Badong Formation in the study area is the Dianjiang-Liangping area.

Acknowledgements

Foundation：Chongqing 1:50000 Xinsheng, Yuanbayi, Shiqiaopu, Pingjinpu, Zhoujiachang, Dianjiang County regional geological Survey project.

References

1. Yan Danping, Wang Xinwen, Liu Youyuan. Structural style and genetic mechanism analysis of folds in Sichuan-Hubei-Hunan border region [J]. Modern Geology, 2000(1).
2. Feng Xiangyang, Meng Xiangang, Shao Zhaogang, et al. Preliminary study on ordered deformation and its dynamics in South China and its adjacent areas [J]. Acta Geologica Sinica, 2003,24(2):115-120.
3. Lin Liangbiao, Chen Hongde, Zhu Lidong, et al. Sequence lithofacies palaeogeography of Jialingjiang Formation-Leikoupo Formation in eastern Sichuan [J]. Journal of Chengdu University of Technology (Natural Science Edition), 2010,37(4):446-451.
4. He Naishuo. Sedimentary environment analysis of Triassic Badong Formation in Shizhu area, eastern Chongqing [J]. World Nonferrous Metals, 2016 (October): 33-36.
5. Xu Shenglin, Chen Hongde, Zhu Lidong, et al. Study on sedimentary facies of Middle Triassic Badong

Formation in Shizhu, Chongqing [J]. Sedimentology and Tethys Geology, 2007,27(1):44-49.

6. Li Hualiang, Yi Shunhua, Deng Qinglu. Development characteristics and spatial variation law of Badong Formation in Three Gorges Reservoir Area [J].
7. Journal of Engineering Geology, 2006,14(5):577-581. Yang Hongzhong, Li Deliang, Qin Qin, et al. Regional Geology of Chongqing [Z]. Chongqing Geological Survey Institute .2020.