ISSN 2663-1563 Vol. 5, Issue 6: 5-8, DOI: 10.25236/AJAGE.2023.050602

Study on Sequence Paleogeography of the Dameigou Formation in the Yuqia Area

Xin Li

School of Resources & Environment, Henan Polytechnic University, Jiaozuo, China

Abstract: *In order to study the evolution characteristics of lithofacies and sedimentary facies under the sequence framework, according to the field drilling core logging, the complete sequence framework of Dameigou Formation in Yuqia area was identified, the lithofacies paleogeography was restored, and the sequence stratigraphic evolution model and the coal accumulation law of Dameigou Formation were obtained.*

Keywords: *Yuqia area; Dameigou formation; Sequence; System tracts; Paleogeography*

1. Introduction

The Yuqia area is one of the important coal-rich belts in the Jurassic of the Qaidam Basin, and the main coal seams are developed in the Middle Jurassic Dameigou Formation. Sequence stratigraphy is now widely used in sedimentary analysis of coal-bearing basins, representing the latest progress in coal-bearing sedimentology. In this paper, the sequence stratigraphy method is used to analyze the lithofacies paleogeography of the Dameigou Formation in the Yuqia area, aiming to provide a theoretical reference for the study of coal accumulation and coalfield exploration in this area.

2. Geological overview

On the regional tectonic unit, the Qaidam Basin is in contact with the surrounding mountains by faults, including the southern margin fault of Altun, the piedmont fault zone on the southern slope of Zongwulong Mountain, the Ela Mountain fault and the Kunbei fault zone (Lv et al, 2011; Tang et al,2000; Dai et al,2003; Li et al,2012). According to the basement characteristics, current tectonic morphology, geomorphological characteristics, stratigraphic distribution, basin evolution and oil and gas field distribution, the Qaidam Basin is divided into the northern fault block belt in the west, the Mangya Depression and the Delingha Depression and the Sanhu Depression in the east. It is composed of multiple secondary structural belts, depressions and bulges. The northern margin of the Qaidam Basin includes seven depressions, including Yiliping Depression, Kunteyi Depression, Saishiteng Depression, Yibei Depression, Yuqia-Hongshan Depression, Tuosuhu Depression, Delingha Depression and Huobuxunhu Depression, and eight structural belt, including Dafengshan Structural Belt, Lenghu Structural Belt, Tuonan Structural Belt, Eboliang Structural Belt, Yanhu Structural Belt, Tuobei Structural Belt and Wulan Structural Belt, as well as two bulges, platform bulge and Dahonggou bulge (Dai et al,2003). This tectonic framework began in the Indosinian movement and developed in the late Himalayan strong tectonic deformation period. Therefore, the development and evolution of the geological structure of the Qaidam Basin is closely related to the above-mentioned regional faults and tectonic units. After the Caledonian, Hercynian, Indosinian, Yanshan, Himalayan and other multi-stage tectonic layers superimposed on each other and finally formed the current composite sedimentary basin[1-2].

Yuqia area is located in the west of Yuqia-Hongshan fault depression in the northern margin of Qaidam Basin. At the beginning of the Jurassic, the eastward compression of the Tarim plate led to the northward migration of the Qaidam block and the North China plate at different rates. At the same time, the Qaidam block rotated clockwise, resulting in a series of rift deposits in the northern margin of the Qaidam Basin (Zhao et al., 2000; Dang et al., 2003). The sedimentary basement of Yuqia-Hongshan fault depression is Proterozoic Dakendaban group biotite schist, Late Ordovician chlorite schist, Carboniferous Zongwulongshan group limestone and Late Paleozoic granodiorite. The Dameigou Formation is divided into the upper coal-bearing section and the lower glutenite section. The coal-bearing section is mainly siltstone, mudstone and thick coal seam, and the glutenite section is mainly medium-coarse sandstone with gravel coarse sandstone.

ISSN 2663-1563 Vol. 5, Issue 6: 5-8, DOI: 10.25236/AJAGE.2023.050602

The Middle Jurassic Dameigou Formation is exposed in Kesai, Wanggaxiu, Beidatan, Dameigou, Xidatan, Lvcaoshan, Datouyang, Yuqia, Tuanyushan, Lenghu, Huatugou and Mangya areas. It is divided into upper and lower sections. The lower section of the Dameigou Formation is mainly gray-white-grey yellow conglomerate, gravel-bearing coarse sandstone, with fine sandstone and mudstone, showing multiple upward thinning cycles. The gravel composition is mainly quartzite, potassium feldspar and granite. Stem fossils can be seen, and the formation thickness is generally 100-300 m. The lithology of the upper section of the Dameigou Formation is mainly composed of dark gray thick mudstone intercalated with light gray fine sandstone. The upper part of the Dameigou Formation develops a very thick coal group, containing siderite nodules, root fossils and bivalve fossils, with a thickness of 80-180 m.

3. Identification of key interfaces of sequence and system tract

(1) Sequence boundary

The bottom of the Dameigou Formation is a thick layer of gravel-bearing coarse sandstone or coarse sandstone. In the Yuqia area, the glutenite layer is mainly composed of multiple superimposed and upwardly thinned sandstone complexes. It is common to scour the bottom, large wedge-shaped cross-bedding or parallel bedding, representing meandering or braided river deposits; the Dameigou section is mainly gray conglomerate and gravel-bearing coarse sandstone. The gravel composition is mainly quartz sandstone and quartzite, with poor sorting, angular-subangular shape, matrix support or particle support, which is debris flow deposition on alluvial fan. This set of sandy gravel strata in the region is relatively stable and can be used as a regional comparison mark, which is the bottom interface of the third-order sequence.

The top boundary of the Dameigou Formation is a set of white, gray-white sandstone and gravel-bearing coarse sandstone at the bottom of the Shimengou Formation. It is thick in the Yuqia area, loose in lithology, soft in water, mainly composed of quartz, and high in kaolinized feldspar content. The Dameigou area is mainly composed of gravel river channel and cross-shore deposits beside the river channel. The lithology is gray-white fine conglomerate with a thickness of several meters or tens of meters, with large wedge-shaped cross bedding. It is a regionally comparable third-order sequence boundary[3-4].

(2) System domain interface

The maximum regression surface represents the interface from lake regression to lake transgression, dividing the lower progradational sequence and the upper retrograde sequence (Catuneanu, 2006). The maximum lake regression surface of the Dameigou Formation sequence in the Yuqia area is located at the bottom of a set of fine-grained clastic rocks. The lithofacies are mainly lacustrine mudstone, silty mudstone and siltstone with thin fluvial sandstone. The maximum flooding surface represents the end of lake transgression, indicating the change of lake shoreline trajectory from lake retreat to high normal lake retreat (Shanley and McCabe, 1993). The maximum flooding surface of the Dameigou Formation sequence in the Yuqia area appears at the bottom of a set of shore-shallow lacustrine mudstone and silty mudstone, which is a set of upward thinning normal sequence.

4. Paleogeographic characteristics of system tracts in sequence framework of Dameigou Formation

(1) Low system domain

The lowstand system tract is mainly composed of thick coarse sandstone, conglomerate with siltstone and mudstone. The sandstone and gravel are mainly composed of quartz and kaolinite feldspar, and the sorting is poor. The low system tract of the Dameigou Formation is mainly formed in the alluvial fan and braided river sedimentary system developed when the base level begins to rise. Based on drilling and seismic data, the lowstand system tracts are mainly developed in the exploration areas of Yangshuihe, Gaxiu, eastern Yuqia, Erjingtian and Beishan. The thickness of sandstone and conglomerate (code name ‘C’) is between 0-240 m, and the thickness of Yangshuihe and Beishan is the thickest, with an average thickness of more than 200 m.

Combined with the analysis of sedimentary facies and sedimentary system, the ‘dominant facies’ method was used to restore the lithofacies paleogeography of the low-stand system tract. The main lithofacies paleogeographic units in this sedimentary period are alluvial fan deposits ($C > 160m$), sandy and gravel braided channels ($160m > C > 50m$), and meandering channels ($C < 50m$). In the Yangshuihe

ISSN 2663-1563 Vol. 5, Issue 6: 5-8, DOI: 10.25236/AJAGE.2023.050602

exploration area, the thickness of sandstone and conglomerate gradually decreases from northwest to southeast. In the Beishan area, the thickness of glutenite decreases from east to west, which indicates that the northwest of Yuqia area and the eastern Dakendaban Mountain provide two directions of provenance. During this sedimentary period, shale is basically undeveloped.

(2) Lake transgressive system tract

The lake transgressive system tract are mainly composed of mudstone carbonaceous mudstone, siltstone and coal seam, with thin layers of fine sandstone and coarse sandstone locally. The distribution range is consistent with the low system tract, and its thickness is between 10-240 m, mainly between 20-80 m. The sedimentary center is located in the Beishan area, and the formation thickness is 100-200 m. During the deposition period, Dakendaban Mountain continued to provide the main clastic sediments. With the beginning of lake transgression, the main body of the study area was covered by meandering and delta sedimentary systems. The main paleogeographic units were meandering river floodplain with sand-mud ratio (code name 'S / N') greater than 0.7, upper delta interdistributary bay (0.7 > S / N > 0.5), and lower delta underwater interdistributary bay (S / N < 0.5).

(3) High system domain

The high-stand system tract represents the stratigraphic sequence formed after the largest lake transgression in the sequence. The thickness of the high-stand system tract is mainly between 10-280 m on the plane. The thickness of the high-stand system tract is between 40-100 m in the eastern part of Yuqia, Yijingtian and Erjingtian exploration area. The Beishan exploration area is the sedimentary center of the system tract, with a thickness of 120-280 m. The main lithological paleogeographic units in this sedimentary period are the upper delta interdistributary bay (0.7 > S / N > 0.5), the lower delta underwater interdistributary bay (0.5 > S / N > 0.3) and the underwater delta and shore-shallow lake (S / N < 0.3).

In summary, the main paleogeographic units in the sedimentary period of the Dameigou Formation include braided river alluvial plain, delta plain delta front, shore-shallow lake and paleo-uplift. The coal-bearing deposits are mainly delta plain deposits. The Lvliangshan delta and the Yangshuihe delta are developed in the area. The sediments are mainly from the Lvliangshan paleo-uplift in the southeastern part of the basin. The Yangshuihe river has secondary source supply from the Dakendaban mountain in the northern part of the basin. The delta front sedimentary system is developed on the outside of the delta plain, which is widely developed around the lower delta plain. The delta front transitions to the center of the basin as a shallow lake environment with deep water[5-6].

5. Sequence stratigraphic evolution model

The first stage began when the base level began to rise to the maximum lake regression surface, and the accommodation space was lower than the sediment supply rate, resulting in an active terrestrial clastic sedimentary system. Sediments such as conglomerate and sandstone are first deposited in the incised valley. After the filling of the valley is completed, the excess sediment is deposited on the edge of the river or delta distributary channel and lateral migration occurs.

The second stage corresponds to the early stage of the transgressive system tract. The base level rise rate and the sediment supply rate can basically reach a balance. The continuous increase of the accommodation space leads to the weakening of the lateral migration deposition of the river channel, while a set of aggradation and progradation river alluvial plain-delta interdistributary bay deposition is formed. During this period, peat swamps are widely developed on delta plains, interdelta bays and river alluvial plains. The relatively low accommodation space increase rate can be balanced with the peat generation rate during this period. This widely developed peat swamp environment can be sustained and thick layers of coal and carbonaceous mudstone are formed[7-8].

The third stage is equivalent to the late stage of the transgressive system tract. With the accelerated rise of the base level, the increase rate of the accommodation space is increasing, which leads to the continuous break of the balance between the peat accumulation rate and the accommodation space. The river-delta deposition continues to retreat to the upward direction of the basin, while the downward direction of the basin is gradually occupied by the deep-water underwater delta and the shore-shallow lake environment, and the scope of the swamp environment is reduced. The fourth stage begins with the maximum flooding surface, which is equivalent to the early stage of the highstand system tract. The large and wide range of lake transgression leads to the maximum water cover area of the lake basin, and the increase rate of the accommodation space increases sharply. The main body of the lake basin is dominated by deep lake, semi-deep lake, shore-shallow lake and underwater delta environment of deep water facies.

ISSN 2663-1563 Vol. 5, Issue 6: 5-8, DOI: 10.25236/AJAGE.2023.050602

The fifth stage corresponds to the high-stand system tract. During this period, the base level is still rising, but the rate of rise is gradually decreasing, until it stops rising, and the accommodation space continues to decrease. This makes the previously abandoned river delta sedimentary system gradually resurrected, and the aggradated to progradated strata deposited in various environments such as peat swamps, bay lakes, rivers, and alluvial plains. As the base level stops rising, the high-level system domain ends.

The sixth stage corresponds to the period when the lake base level began to decline. In the onshore part of the basin margin, because the accommodation space is zero (or even ‘negative’), the river incision is mainly occurred, and the early formed strata may be eroded by the river. Most of the area is basically a ‘sediment bypass’ area, which is basically an incised valley for filling from the profile. There is an accommodation space in the catchment area of the lake basin, and the sediments transported by rivers over long distances are deposited in the delta front and lake environments.

6. Conclusion

Combined with the analysis of sedimentary facies and sedimentary system, the lithofacies paleogeography of the sub-system tract was restored by the ' dominant facies ' method. The main lithofacies paleogeographic units of the lowstand system tract include alluvial fan deposits, sandy and gravelly braided channels, and meandering channels. The main paleogeographic units of the transgressive system tract are meandering river floodplain, upper delta interdistributary bay and lower delta underwater interdistributary bay. The main lithological paleogeographic units of the highstand system tract include the upper delta interdistributary bay, the lower delta underwater interdistributary bay, the underwater delta and the shore-shallow lake.

According to the distribution of coal seams under the sequence framework of the Middle Jurassic Dameigou Formation in the northern margin of Qaidam Basin, the coal seams are mainly developed in the transgressive system tract, and there are few coal seams in the high system tract and low system tract. The accumulation of peat requires sufficient accommodation space to protect it from oxidation or erosion, while the water level cannot be too high to ensure that coal-forming plants are not drowned. This requires a dynamic balance between the rate of peat accumulation and the rate of increase in accommodation space within a certain range. The increase of accommodation space in continental environment is closely related to the rise of lake level. The lowstand system tract often has low accommodation space and develops channel deposition, which is not conducive to the continuous accumulation of peat. With the rise of base level, the increase rate of accommodation space and the accumulation rate of peat tend to be balanced, and the transgressive system tract becomes a favorable coal-forming period. However, too high base level will also terminate the development of peat swamps, so the phenomenon of lacustrine fine-grained sediments replacing coal seams often occurs in highstand system tracts.

References

[1] Catuneanu O., 2006, Principles of sequence stratigraphy: Amsterdam, Elsevier, 375 p.
[2] Shanley K. W., and P. J. McCabe, 1994, Perspectives on the sequence stratigraphy of continental strata: AAPG Bulletin, v. 78, p. 544–568.
[3] Wang W, Zhao R, Muir L A, et al. Darriwilian (Middle Ordovician) chitinozoans from the Qaidam Paleoplate, northwest China[J]. Review of Palaeobotany and Palynology, 2018. DOI: 10.1016/j. revpalbo.2018.09.016.
[4] Zhao Wenzhi, Jin Yongqiang, Xue Liangqing, et al. Formation and evolution of Jurassic prototype basins in Northwest China [M]. Beijing: Geological Publishing House, 2000.
[5] Lv Baofeng, Zhang Yueqing, Yang Shuyi. Characteristics of Structural System and Its Implication for Formation Dynamics in Qaidam Basin [J]. Geological Review, 2011, 57(2):167-174.
[6] Tang Lingjie, Jin Zhijun, Zhang Mingli, et al. An analysis on tectono-paleogeography of the Qaidam Basin, NW China[J]. Earth Science Frontiers, 2000(04): 421-429.
[7] Dai Junsheng, Ye Xingshu, Tang Liangjie, et al. Tectonic units and oil-gas Potential of the Qaidam Basin [J]. Chinese Journal of Geology, 2003, 38(3): 291-296.
[8] Li Mingyi, Yue Xiangan, Jiang Qingchun, et al. Relationship between hydrocarbon accumulation and tectonic evolution in main structural belt of the Northern border of Qaidam Basin[J]. Natural Gas Geoscience, 2012, 23(3): 461–468.