Sedimentation Model of the Upper Triassic Xujiahe Formation in Eastern Sichuan Basin

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Keywords: Easter sichuan basin, upper triassic, xujiahe formation, sedimentation model.

Abstract: The upper triassic xujiahe Formation which is divided into seven members in eastern Sichuan Basin deposits a set of clastic rocks with black mudstone, siltstone, fine sandstone, sandstone, gritstone and coal. The first, third, fifth and seventh members are coal-bearing intervals, while the second, fourth and sixth members are sandstone-rich intervals. According to the rock types, the supply of source, formation mechanism and sedimentary sequences, and combined with regional geological features, Xujiahe Formation is identified three sedimentary types of lake face, delta face and fluvial face. At last, the sedimentary model of fluvial plain-delta-shallow lake is established.

1. Introduction

The study area is located in the east of Sichuan Basin, as an area of about 82400 km2. The upper Triassic Xujiahe Formation are mainly coal, oil and gas formation in the study area and hot spot areas of people's concern. The predecessor studied depositional systems and coal accumulation of the Upper Triassic Xujiahe Formation in Sichuan Basin and obtained the results of attract people's attention[1, 2]. Recently, I have been studied sedimentary facies, sequence stratigraphy, depositional model, coal accumulation and the paleogeographic evolution of Xujiahe Formation. This paper focuses on the sedimentary system characteristics of the Xujiahe Formation.

2. Regional Geological Background

Sichuan Basin is located in the east of Long Men mountain nappe belt, and south of Chenba fracture zone and Micangshan-DaBashan obduction zone, west of Giyaoshan fault and north of passive edge fold belt of the south Yangtze blocks (Figure 1).

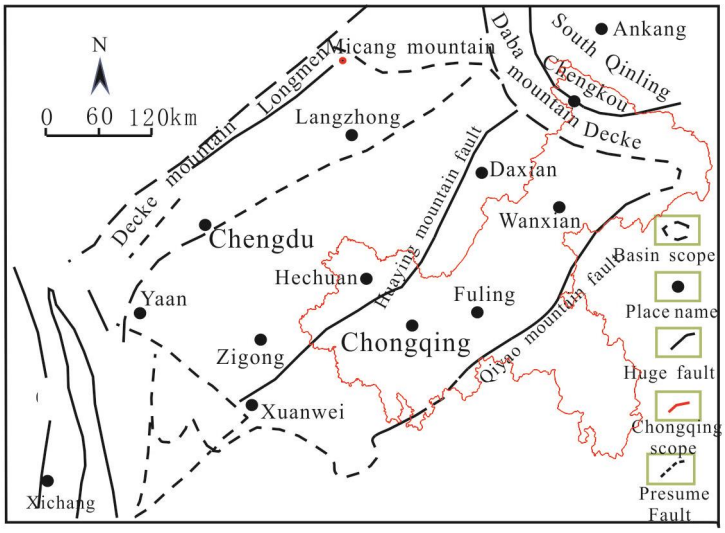

Figure 1: Sketch map showing structural outlines of sichuan basin (dotted line indicates the study area chongqing city)(modified after tong chongguang and hu shouquan, 1997).

The study area is in the east of Huayingshan fault. The study area became the inland basin of the half closed in the late Early Triassic. Influenced by the indosinian movement, the Sichuan basin generally uplifted in the Middle Triassic, and suffered denudation and planation of different degrees, forming an half graben-like depression basin that the east is high and slow, while the west is low and slope. With the bay in the west of Longquanshan was aggradated, DaBa mountain and Jiangnan mountain gradually uplifted, rivers began to develop, and inland lake was developed in the early Late Triassic[3]. In the late Triassic, remain influenced by indosinian movement, the mountains and the old lands around study area further uplifted and suffered denudation, river very developed and erode seriously. That lead to the seventh member lost in local areas of the East and North, while the face belt is not preserved. Over the years, the scholars adopt different methods to divide Xujiahe formation. For the convenience of the study, the Upper Triassic Xujiahe Formation is divided into seven members by contrast. The first, third, fifth and seventh members are coal-bearing intervals, while the second, fourth and sixth members are sandstone-rich intervals (Figure 2).

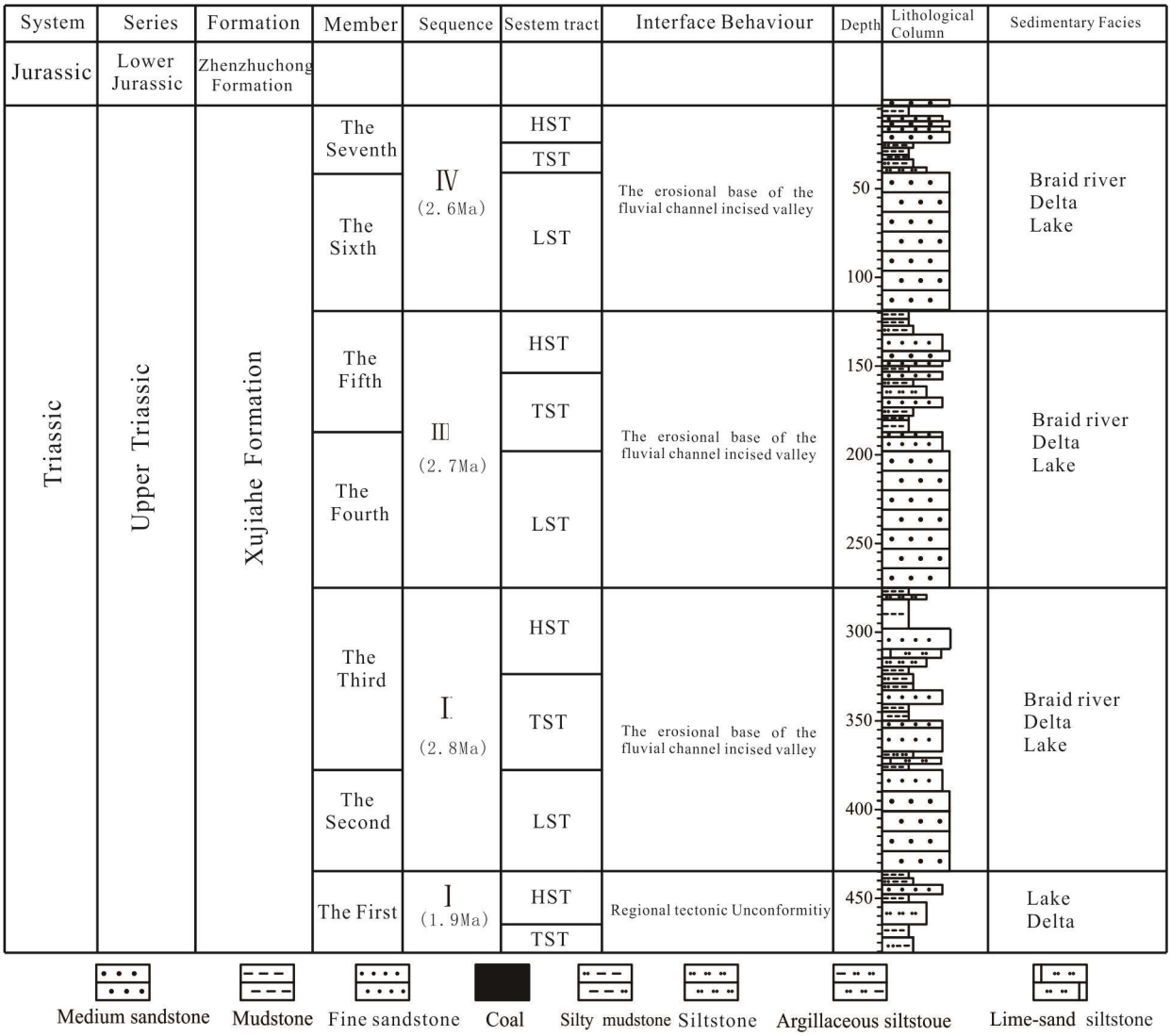

Figure 2: Columnar section showing sedimentary facies of the Late Triassic Xujiahe Formation in eastern Sichuan Basin.

3. The Characteristics of Sedimentary Facies

According to the analysis of macroscopic sedimentary facies in outcrop, drilling core and the basis of summarizing in rock facies types, and combing with the analysis of section structure and regional data, the Xujiahe formation can be divided into 3 kinds of sedimentary system and 10 types of sedimentary facies in the study area (Table 1).

Table 1: Sedimentary System and Sedimentary Facies of Later Triassic in Eastern Sichuan Basin.

Sedimentary system		Sedimentary facies	Sedimentary units
River sedimentary system	Meandering river	Riverbed subface	Riverbed retention sediment, Sediment bar
		Bank subface	Natural levee, Crevasse splay
		Flood basin subface	Alluvial flat, Overbank lake, Overbank swamp
	Braid river	Riverbed subface	Riverbed retention sediment, Piont bat
		Flood basin subface	Alluvial flat
Delta sedimentary system		Lower delta plain	Distributary channel, Distributary bay, Natural levee, Bay swamp
		Delta front face	River mouth bar, Distal bar
		Predelta face	Predelta mud
Lake sedimentary system		Shoreland subface	Longshore bar, Shoreland swamp
		Meare subface	

3.1.River Sedimentary System

River developed well in Xujiahe formation, the characteristics were obvious and sedimentary types were more. According to the degree of development of flood basin, river sedimentary system can be divided into meandering river and braided river.

Meandering river

The meandering river distributed widely in the study area, and mainly developed thick sandstone in the second member, fourth member, sixth members in Xujiahe Formation, while the sandstone of beach was typical. Diadactic sequence is the representative in meandering river.

The channel lag

The lithology was mainly composed of conglomerate, pebbly sandstone or gravel-bearing sandstone, and gradually transited to beach deposition. The erosion surface was generally developed in the bottom of channel lag. Moreover festoon cross-bedding and large tabular cross bedding were common. The sand with the thickness about 0.5~1m presented small lens, and the distribution of sand was extremely unstable.

The point bar

The sediment has a large number of sandstone, the granularity became fine from bottom to top. The large cross bedding was developed well, such as tabular cross bedding, festoon cross-bedding and concordant bedding. But tabular cross bedding was the most developed. Beside ripple bedding appeared occasionally in the upper part. The scale of bedding decreased from bottom to up, showing that hydrodynamic force changed from strong to weak.

The natural levee

The lithology was composed of thin interbeds of siltstone and argillaceous rocks, and have commonly small sand ripple bedding, small inclined bedding and irregular horizontal bedding, and contain more plant debris fossils and insect trace that generally appear in the upper of the beach sand body.

The crevasse splay

The lithology was composed of fine sandstone and some silt material, and mainly developed various small cross-bedding, part of medium cross-stratification. More plant debris and mud gravel were developed in the bottom of erosion surface and vanished from the river to the flood river. So the plane was often shown lobate form or fan.

The flood basin

The lithology was composed of mudstone, silty mudstone and siltstone, and developed level or horizontal wavy bedding, containing plant fossil fragments and fossils of root, and has siderite concretions or pellet that contains worm trail. According to the characteristics of sediment, the flood basin can be divided into the floodplain of mainly sandy sediments, river diffuse lake and river flood swamp of mainly muddy sediments. In general, coal or coal seam was formed in the peat swamp.

Braided river

The lithology was composed of coarse clastic sediments of the conglomerate, pebbly sandstone and sandstone, and developed plate, groove, wedge cross bedding and parallel bedding. Especially tabular cross-bedding is common and its internal scoured frequently. River edge deposition and flood basin were composed of mainly siltstone and mudstone, and had horizontal bedding and small-scale cross-bedding, and contained small amount of plant fossils or fossil fragments. While the thickness of river edge deposition and flood basin were thin and scoured with the overlying strata, and significantly contacted or sharply transited with underlying stratum.

3.2.Delta Sedimentary System

The study area was located gentle slope zone in the eastern Sichuan Basin. Delta system scale was more small, and mainly developed the shallow water delta. While the delta plain was not developed, so delta sedimentary system mainly developed lower delta plain, delta front and predelta.

Lower delta plain

The lower delta plain mainly included sedimentary units of distributary channel and inter distributary bay.

Distributary channel

The distributary channel mainly composed of coarse sandstone, fine sandstone and siltstone which were mainly apperared in scour surface, large tabular cross-bedding and large trough cross-bedding. The cross section of sand present lenticular and become fine-grained sediments in the lateral. The scour surface contained trunk fossils and boulder clay, but its scale turn smaller.

The distributary bay

The distributary bay was mainly composed of deep and dark mudstone, carbonaceous mudstone and muddy siltstone. Wavy bedding and horizontal bedding were common, while plants fossil and siderite concretions were rich. It got along with symbiosis of distributary channel and estuary dam. Because the current involvement of lake, the brackish and freshwater animal fossils were often saw.

Delta front

The sediments of delta front were distributed in the edge of the lake with a ring shape.

River mouth bar

The lithology was mainly composed of sand and silt which were better graded and with pure quality. The wedge-shaped cross-bedding, foreset laminae of " S " and horizontal lamination were mainly developed, while the water current ripples and wave ripples were appeared. The fossils of the sandstone were scarce, only shell appeared which was transported from the adjacent environment.

Distal bar

The lithology was mainly composed of silty sand and a little mud. Usually, the horizontal bedding, wavy cross-bedding, veined - wave - lenticular composite bedding were developed. Occasionally, the graded bedding was appeared.

More plant debris and charcoal were distributed in the surface of laminate, while bioturbation structure and burrow were developed well. But shell was scarce.

Predelta

Predelta is located in the front of delta front. The distribution of predelta is the most wide and the deposition of predelta is the most thick. The front delta mud was only developed in the study area.

3.3.Lake Sedimentary System

The lake and swamp facies were well developed in the first, third, fifth and seventh members in the study area, and the lake was mainly developed in the first and fifth members.

The shoreland

Facies could be divided into two types. One was sandy shore which was mainly detrital sediment. The psephicity was better and the maturity was high. The small cross-stratification was usually appeared. Another was muddy shore which was dominated by mudstone. The wavy bedding, horizontal bedding and massive bedding were developed well. The rain imprint, desiccation crack, burrow, bioturbation structure, plant fragment and so on were common.

The meare

The lithology mainly composed of gray thin-bedded mudstone, silty mudstone and muddy siltstone, containing siderite concretions. The horizontal bedding and small ripple bedding were saw clearly. While the fossils were more abundant, such as plant fragment, lamellibranch, gastropods, conchostraca and fish.

4. Sedimentary Model

If Sichuan Basin was an half graben-like depression basin that the east was high and slow, while the west was low and slope. The study area was located in a gentle slope zone in eastern Sichuan Basin and the provenance was form the Daba Mountains and the Jiangnan old land (also called Xuefeng old land). But the Jiangnan old land was the main source area. The longshore bar and shoreland swamp were developed in the delta, so the delta and the shoreland were conjunctive symbiotic and called by Lake-delta in the study area. The River filled with sandstone was mainly developed in the east and the area of Qijiang-Fuling-Fengdu in the study area. A great quantity of detritus were transported from Jiangnan moutain to the lake-delta and shallow lake facies. Through the analysis of the sedimentary facies and regional geological data in the study area, the sedimentary model of Xujiahe formation was built with river alluvial plain-lake delta-shallow lake. The ratio of sand and mud was decreased gradually from southeast to northwest (Figure 3).

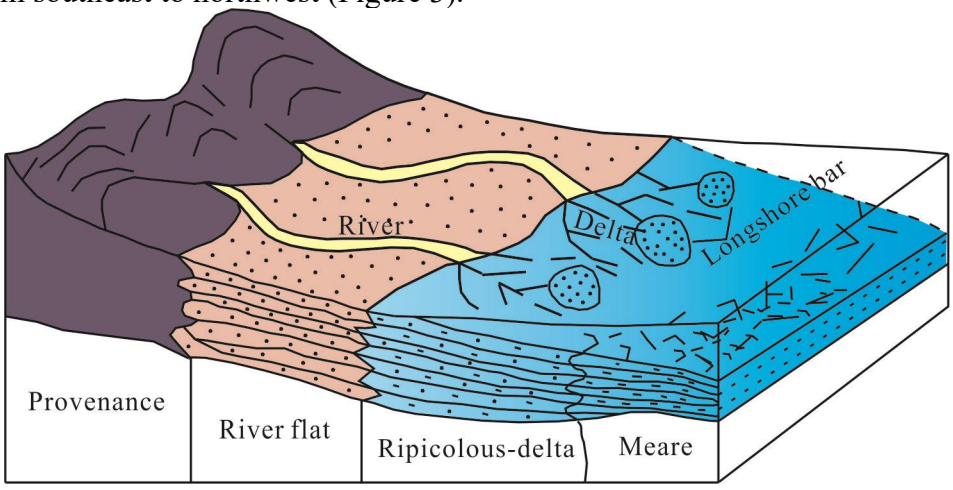

Figure 3: Sedimentary mode of xujiahe formation in eastern sichuan basin.

5. Conclusions

(1) By contrast, the Upper Triassic Xujiahe Formation was divided into seven members in the study area. The first, third, fifth and seventh members were coal-bearing intervals, while the second, fourth and sixth members were sandstone-rich intervals.

(2) According to the analysis of macroscopic sedimentary facies in outcrop, drilling core and the basis of summarizing in rock facies types, and combing with the analysis of section structure and regional data, the Xujiahe formation can be divided into 3 kinds of sedimentary system and 10 types of sedimentary facies in the study area. Through the analysis of the sedimentary facies and regional geological data in the study area, the sedimentary model of Xujiahe formation was built with river alluvial plain-lake delta-shallow lake.

Acknowledgments

This study was supported by Chongqing Education Commission, Chongqing (2015ZX011) and Chongqing Vocationan Institiute of Angineering, Chongqing (KJB14).

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