The Distribution of Rock Salt and Gypsum in Sequence Stratigraphic Framework—A Case in Jialingjiang Formation in Chongqing

To cite this article: Gao Caixa et al 2017 IOP Conf. Ser.: Earth Environ. Sci. 63 012040

View the article online for updates and enhancements.

Related content
- Understanding sea level change over the last half century and its implications for the future
  John Church, N White, C Domingues et al.

- Measurement of Attenuation Length for Radio Wave in Natural Rock Salt and Performance of Detecting Ultra High-Energy Neutrinos
  M Chiba, T Kamijo, Y Watanabe et al.

- Research to lessen the amounts of curing agents in processed meat through use of rock salt and carbon monoxide
  R Sakata, S Takeda, Y Kinoshita et al.
The Distribution of Rock Salt and Gypsum in Sequence Stratigraphic Framework—A Case in Jialingjiang Formation in Chongqing

Caixa Gao 1, 2, a, Jun Yi 1, b, Junjiang Su 1, c, Yongqin Zhang 1, d, Bo Li 1, e
1 Chongqing Vocational Institute of Engineering, Chongqing, 402260, China;
2 State Key Laboratory of Coal Resources and Safety Mining and Department of Resources and Earth Sciences, China University of Mining and Technology, Beijing, 100083, China

Abstract. The Jialingjiang Formation of the Lower Triassic in the eastern Sichuan Basin is subdivided into four members. The first and third members are featured with limestone, while the second and forth members which are clipped with gypsum and halite are characterized by dolomite and limy dolomite. At the same time, the second and forth members are the main geothermal reservoir in Chongqing area. Two sequence boundaries represented by regional unconformities and the lithology-lithofacies transition surface are recognized in the Jialingjiang formation based on outcrop and borehole data analysis. A total of two third-order sequences are subdivided in the Jialingjiang formation, and they are subcorrelated to the intervals of Member 1 to Member 2, Member 3 to Member 4, respectively. Each sequence is further subdivided into lacustrine transgressive system tract (TST) and highstand system tract (HST) according to variation in lithology and lithofacies. The sea level change is the main factor to control the sequence development. With the sea level change, the middle and late periods of HST in sequence are the favorable periods of the development of rock salt and gypsum.

1. Introduction
There was rich natural gas developed with Jialingjiang formation in the Lower Triassic in the east of Sichuan basin. At the same time, the Jialingjiang formation was rich of halite and gypsum and was important reservoir for geotherm in Chongqing in the east of Sichuan basin. Now, the predecessors have made a lot of achievements about sedimentary facies[1,7], gas accumulation
mode[2], hydrocarbon sources[3], gypsum-salt rock[4], dolomite reservoir prediction[5], geochemistry characteristic[6], ichnofabric[7], lithofacies paleogeography[8-10], sequence stratigraphy[9,10], and so on. On the base of detailed sedimentary facies and accurate stratigraphic classification, the sequence framework has been established including sequence and system boundaries based on outcrop and borehole data analysis for early Triassic in the east of Sichuan basin, so that discussing the distribution of halite and gypsum in the sequence framework.

2. Regional geological background

Sichuan basin is located in the east of Longmen mountains nappe zone, by the northern boundary of Chengba fault zone and Daba mountains obduction zone, the eastern boundary of Qiyaoshan fault and passive boundary fold belt in the south of Yangzi plate (Fig 1). The studied area was located in the east of Huayingshan fault. In the late Triassic, the study area had been developed into inland sea basin and the Jialingjiang formation featured by carbonatite had been sedimented. The Jialingjiang formation was subdivided into four members. The first and the third members were mainly filled with limestone, while the second and the forth members mainly filled with dolomite rock and limy dolomite and being the important reservoir for geotherm in Chongqing.

![Figure 1. Sketch map showing structural outlines of Sichuan Basin](image)

3. Sequence and system boundaries identification

Based on the Vail’s theory from EXXEN Company, the distribution of sequence and system tract with Jialingjiang formation has been studied. The key sequence and system tract boundaries were as follows.

3.1. Sequence boundaries

A. Regional unconformity surface

At the end of the Feixianguan stage in early Triassic in Yangtze area, there was a massive regressive and regional exposed caused by corrosion function. It had been deposited until the stage of early Jialingjiang. The unconformity surface had been present in the study area, even larger area.
B. The top of Jialingjiang formation was the interface between Jialingjiang formation and Leikoupo formation.

3.2. The initial flooding surface and the maximum flooding surface

The Jialingjiang formation was continuous deposited. The sedimentary facies reversal surface was developed in the Jialingjiang formation, usually being the initial flooding surface and the maximum flooding surface.

4. Sequence division and lateral throughgoing

According to regional unconformities, sedimentary facies reversal surface, we have subdivided the Jialingjiang formation into 2 third-order sequences, and they are subcorrelated to the intervals of Member 1 to Member 2, Member 3 to Member 4. But, Jialingjiang formation had been developed differently in different areas influenced by later structures. Two comparison figures of the sedimentary facies and sequence stratigraphy from northeast to southwest were studied in order to understand the characteristics of the sequence stratigraphic framework (Fig 2).

4.1. Sequence I

Sequence I corresponds to the intervals of Member 1 to Member 2. The basal sequence boundary is the bottom of Jialingjiang formation and is a lithology reversal surface. This sequence includes transgressive and highstand system tract. The transgressive system tract is developed basically in the whole region, and composed by limestone in open platform. The deposition range of TST is wide and deposition thickness is large. There are abundant fossils, such as mussel-shrimp, lamellibranch, proleg, cephalopoda and ammonite. On the whole, the sea water is continuous increasing and the rest of accommodation space is gradually increasing. This is the filling process of basal level rising and basin retrogradation.

The highstand system tract is also developed comparatively, and composed by dolomite rock, evaporite solution breccia, gypse in restricted platform and limestone in open platform. The halite and gypse are developed very well and thickly, such as the points at ZK5 and ZK12. In the middle and late of this system tract, the sea level descented and the accommodation space decrease progressively and slowly. When the rate of accommodation space decreasing was close to the rate of carbonate productivity and accumulation, the aggradation was dominant. The depositional sequences of shallowing-upward and shallow face were built, representing the dolomitization and gypsification of carbonate.

4.2. Sequence II

Sequence II corresponds to the intervals of Member 3 to Member 4. The basal sequence boundary is a lithology reversal surface between Member 2 and Member 3. This sequence includes transgressive and highstand system tract. The transgressive system tract is developed basically in the whole region too, mainly composed of limestone in open platform and dolomite rock, argillaceous dolomite in restricted platform. The deposition range of TST is wide and deposition thickness is large. There are also abundant fossils, such as mussel-shrimp, lamellibranch, proleg, cephalopoda and ammonite, and
On the whole, the sea water is continuous increasing and the rest of accommodation space is gradually increasing. This is the filling process of basal level rising and basin retrogradation.

The highstand system tract was also developed comparatively, but the thickness is nonuniform. The lithologic association of this system tract is gyspe, dolomite, evaporite solution breccias, argillaceous dolomite, and limy dolomite, cryptite in restricted platform and limestone in open platform. The halite and gypse are developed very well and thicker, such as the points at ZK5 and ZK12. In the middle and late of this system tract, the sea level descented and the accommodation space decreased progressively and slowly. When the rate of accommodation space decreasing was close to the rate of carbonate productivity and accumulation, the aggradation was dominant. The depositional sequences of shallowing-upward and shallow face were built, representing the dolomitization and gypsification of carbonate.

5. The distribution of halite and gypse in sequence framework
The distribution and system tract type of carbonate sequence are controlled by the change of relative sea level. The global eustasy and tectonic descent together control the change of relative sea level and accommodation space; further influence the type and distribution of system tract. Each sequence includes TST and HST in study area.

In the stage of TST sea level fast ascends, the open platform is mainly developed, followed by restricted platform. The sediment scope is wide and thicker in restricted platform. There are abundant fossil organism, such as mussel-shrimp, bivalve, gastropod, cephalopoda and ammonite. On the whole, the sea water is continuous increasing and the rest of accommodation space is gradually increasing. This is the filling process of basal level rising and basin retrogradation.

![Figure 2. Columnar section showing sedimentary facies and sequence stratigraphy of the Early Triassic Jialingjiang Formation in Chongqing](image-url)
In the stage of HST sea level fast descends, the restricted platform is mainly developed. Because the water in restricted platform is shallower in open platform and flat, the evaporation makes the water salty. As the relative sea level lightly fluctuates, large areas tableland will appear at the up and down of sea level, while tidal flat is developed well in restricted platform. The penecontemporaneous dolomitization will happen between carbonate mud and particle in the surface water which salinity is high and magnesium is rich. So, one of lithology characteristics is dolomite rock develops widely.

As the sea level descents, the accommodation space decreases progressively and slowly. When the rate of accommodation space decreasing is close to the rate of carbonate productivity and accumulation, the aggradation is dominant. The depositional sequences of shallowing-upward and shallow face are built, representing the dolomitization and gypsification of carbonate.

In a word, the sea level change is the most important influencing the sequence development and lithofacies paleogeography. As the sea level goes up and down, it is the favorable period for halite and gypse development in the middle and late of HST.

6. Summary
1) The regional unconformities and the lithology- lithofacies transition surface are recognized in the Jialingjiang Formation. A total of two third-order sequences are subdivided and they are subcorrelated to the intervals of Member 1 to Member 2, Member 3 to Member 4, respectively. Each sequence is further subdivided into lacustrine transgressive system tract (TST) and highstand system tract (HST) according to Variation in lithology and lithofacies.
2) The sea level change is the main factor to control the sequence development. With the sea level change, the middle and late periods of HST in sequence are the favorable periods of the development of rock salt and gypsum.

7. Acknowledgements
This study was supported by the National Natural Science Foundation of China (41030213), Land and Resources Survey, China (1212010633901), Chongqing Education Commission, Chongqing (2015ZX011) and Chongqing Vocational Institute of Engineering, Chongqing (KJB14).

8. References
[1]Zhong Yijiang, Chen Hongde, Zhu Lidong, etc, 2008, Sedimentary microfacies of the Lower Triassic Jialingjiang Formation in Shizhu, Chongqing, China [J]. Journal of Chengdu University of technology (Science & Technology Edition).35(6): 655–662
[2]Lu Zhengyuan, Luan Haibo, Lu Zonggang, etc, 2009, Study on the distal gas accumulation model of the Lower Triassic Jialingjiang Formation in the south of Sichuan Basin, China[J]. Journal of Chengdu University of technology (Science & Technology Edition). 36(6): 617–620
[3]Lu Zhengyuan, Zhao Luzi, etc, 2004, Study on hydrocarbon sources of Lower Triassic Jialingjiang Formation in south of Sichuan Basin, China[J]. Journal of Chengdu University of technology (Science & Technology Edition). 31(6): 720–722
[4] Zhangqi, Xuliang, Jin Xiaolin, etc, 2009, Sedimentary Environment Analysis on Tj4 Gypsum 2 salt Rock in Eastern Sichuan Basin[J]. Journal of Salt Lake research. 17(4): 1~5
[5] Ji Yuxin, Wei Xiucheng, Liu Chunyuan, etc, 2008, Dolomite Reservoir Prediction in the Jialingjiang No. 2 Member of the Tongnanba Area, Northeast of the Sichuan Basin, China[J]. Acta Geologica Sinica. 82(3): 353~359
[6] Li Yanjun, Li Qirong, Wang Yandong, etc, 2006, Geochemical research of hydrocarbon reservoir in Lower Triassic Jialingjiang Formation in Luzhou palaeohigh[J]. Oil and Gas Geology. 27(3): 363~369
[7] Wangkun, 2010, Ichnofabrics and Their Sedimentary Significance from the Jialingjiang Formation in Longmendong Section, Mount Emei, Sichuan Province, China[D]. Henan Polytechnic University
[8] Tian Ruixiao, Wei Lingchen, 1985, Paleogeography and Facies of Jialingjiang period, Early Triassic in Sichuan Basin[J]. Experimental Petroleum Geology. 7(3): 218~226
[9] Lin Liangbiao, Chen Hongde, Zhu Lidong, etc, 2010, The sequence-based lithofacies-paleogeography of Jialingjiang Formation and Leikoupo Formation in eastern Sichuan Basin, China[J]. Journal of Chengdu University of Technology (Science and Technology Edition). 37(4): 446~451
[10] Hu Mingyi, Wei Guoqi, Li Sitian, etc, 2010, Characteristics of Sequence-based Lithofacies and Paleogeography and Reservoir Prediction of the Jialingjiang Formation in Sichuan basin[J]. Acta Sedimentologica Sinica. 28(6): 1145~1152