

Sedimentary Facies and Diagenesis of microbial Carbonate Rocks in Dengying Formation, Hujiaba Area, Northern Sichuan

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Abstract

On the basis of reading a large number of relevant literature and referring to previous studies, this paper collected and sorted out the relevant information of key strata in the work area, comprehensively analyzed the latest exploration research and development trend of the study area, and studied the sedimentary facies and diagenesis of microbial carbonate rocks in the Dengying Formation of Sichuan Basin, providing a summary and reference for the majority of scholars.

Keywords

Microbial carbonate; Dengying formation; Sedimentary facies; Diagenesis.

1. INTRODUCTION

Deep and ultra-deep microbial carbonate reservoirs have large reserves and high production. As of 2010, more than 200 oil-bearing basins with burial depths of more than 4,500 m and 1478 deep-ultra-deep oil and gas reservoirs have been discovered worldwide [1]. The latest oil and gas resource evaluation results show that deep and ultra-deep oil resources account for about 20% of the total oil resources in China. In China, the proportion of deep and ultra-deep natural gas resources is 50% [2]. Microbial carbonate reservoirs have gradually become the focus of deep-ultra-deep oil and gas exploration, and Sichuan Basin is a typical representative.

Microbial carbonate reservoirs with significant oil and gas discoveries are mainly distributed in Alabama, East Siberia, Santos Basin, Oman Salt Basin, Kazakhstan, Sichuan Basin and North China of China.

Sichuan basin is an important hydrocarbon superimposed basin in China, which is located between 28°00' N and 32°41' N, 102°31' E and 110°00' E, and covers an area of 19×104 km². The Sinian Dengying Formation in Sichuan Basin is the oldest oil and gas producing layer in China[3]. Previous studies in this field were mainly focused on weiyuan and Ziyang areas in southern Sichuan. Around 2011, multiple Wells deployed in the high part of gaoshidi structure of paleo-uplift yielded high industrial gas flow in the Sinian Dengying Formation, demonstrating the huge exploration potential of the Sinian Dengying Formation in this region. Group of the main lithology is microbial carbonate rock, microbial rock diagenesis is also one of the hot topics in the study of oil and gas geological workers in recent years, it has a very wide range of distribution, can be traced back to ancient archean era, and the Miocene Proterozoic, Cambrian and ordovician is the most development, much less since the middle ordovician and tend to form composite and epigenetic biological building common reef, In other words, microbial carbonate rocks are mainly developed in ancient strata and buried deeply[4]. Therefore, in view of the sinian system the group to carry out the types of sedimentary facies of the sichuan basin, phase sequence evolution and space-time distribution and diagenesis research, sinian system for sichuan basin group of favorable exploration zone of the evaluation and the risk of the next

step exploration and provide favorable support, and can further enrich the carbonate karst reservoir sedimentology and geology theory[5].

2. RESEARCH STATUS AND DEVELOPMENT TREND AT HOME AND ABROAD

2.1. Domestic Research Status

Domestic geological period and modern microbes and microbial calcium carbonate sedimentary study of relative lag, the sichuan basin since 2011, high stone well 1 set of 2 of the gas yield industrial air, Chinese scholars in the sichuan basin sinian system of the group has carried out a large number of oil and gas geological research work, and gradually realize the looking for microbial hill is looking for the key to reservoir[6], Therefore, more and more attention has been paid to the study of microbial carbonate rocks. Since 2013, microbial carbonate reservoirs have attracted attention in petroleum geology in China, mainly in sinian-Cambrian in Tarim Basin and Dengying Formation of Upper Sinian in Sichuan Basin. The research upsurge of microbial carbonate deposition in the world has gradually influenced the domestic geomorphology. Many research work involves microbial carbonate deposition in geological period, and it has been systematically studied, classified and described by the method of geological microbiology. At the macro level, some studies have focused on the relationship between calcareous microorganisms and microbial carbonate deposits in carbonate sediments and reefs and paleoclimate and paleoenvironment, but more studies have focused on the relationship between microbial carbonate deposits and Paleozoic extinctions, especially the Permian/Triassic transition. On the basis of the existing classification system of microbial carbonate deposits abroad, texture and nucleate stones are added to microbial carbonate rocks, and a six-point scheme of microbial carbonate rocks is established, that is, microbial carbonate rocks can be divided into stromatolites, tubules, nucleates, dendritic stones, texture stones and homogeneous stones[7].

Previous schemes for the division of sedimentary facies of Dengying Formation vary widely: Hongde Chen[8] defined it as restricted platform facies; The Dengying Formation is considered to be tidal flat facies and gentle slope facies[9]. However, Haitao Hong considered the Dengying Formation in Sichuan Basin as a restricted platform facies and divided it into intraplatform shoal, tidal flat and lagoon subfacies[10].

Based on the comprehensive analysis of the previous data, it is preliminarily concluded that the Sinian Dengying Formation in Sichuan Basin has obvious continental platform sedimentary characteristics. The Dengying Formation can be divided into two sedimentary facies zones: restricted platform and platform margin. It can be divided into six subfacies: microbial mound beach complex, microbial mound, grain beach, platform flat, lagoon and mixed platform.

After the end of the Nanhua ice Age, the climate became warm and the Sichuan Basin entered rapid transgression. The Sinian Dengying Formation began to deposit carbonate platform. The Dengying Formation can be divided into four sub-members: Deng1 Member, Deng2 member, Deng3 member and Deng4 member. Microbial carbonate rocks in the group of the two main development period and the group of four, Shu gen Liu to study the whole basin[11], such as the group of the summary after lamp 2 microbes found rock with laminated stromatolite, stone is given priority to, also develop foam layer of stone, like a pellet rock and oncolite, light particles rocks, four main development peperite and thrombolites, followed by layers of grain stone and stromatolite. Wenzhi Wang studied the sedimentary characteristics of microbial dolomite of sinian Dengying Formation in Gaoshiti-Moxi area[12], Sichuan Basin, and concluded that algae-poor layer was usually formed in the early and middle period of a sedimentary cycle, while algae-rich layer was formed in the middle and late period of a sedimentary cycle. Ling Li study of sichuan basin lamp and lamp four plaster hill found that plaster by coagulation stone hill[13], stromatolite and oncolite and microbial communities related to build, is formed by the capture

of the microbial community and adhesive plaster, plaster hill nuclear part is the good reservoir space, development have different size of holes, so it can be used as a favorable exploration objects for research. International research on microbial carbonate rocks.

The development of microbial carbonate reservoir of Sinian Dengying Formation in Sichuan Basin was influenced by tongwan movement. There were two acts of Tongwan movement in Dengying period, one of which formed unconformity in Deng2 and Deng3 member, and the other one formed unconformity in Deng4 member and Overlying Maidiping Formation. A large number of scholars have studied the controlling effect of two-act Tongwan movement on dengying Formation reservoir in various oil-gas distribution areas of Sichuan Basin. During the supergene period, the Dengying Formation was exposed to the surface and atmospheric fresh water entered into microbial carbonate rocks, which corroded them and improved the reservoir capacity of microbial rocks, which was an important reason for the reservoir development of The Dengying Formation[14]. With the discovery of late Sinian to Early Cambrian extension trough[15, 16], controlling the intensity of supergene karstification, hydrocarbon charging and sedimentary environment to transform the microbial reservoir of Dengying Formation, the closer to the tension trough, the stronger karstification and the more developed reservoir pores. Han lin Peng to Jinshi- Weiyuan-Ziyang area and upper region of the siltstones group reservoir found in contrast[17], reservoir property upper region > siltstones vying > > from ziyang area stone area, confirm the mianyang a changning tension tank to control the group table of the karstification, hydrothermal process, development of hydrocarbon filling effect, strength, so as to affect the reservoir property.

Since the 1990s, Scholars at home and abroad research history and developing trend of microbial carbonate[18], microbial carbonate rock classification and forming process[19, 20], the microorganism of the stone formation mechanism[21], the seats in carbonate precipitation process[22], microbial carbonate deposition and the research significance[23], microbial carbonate reservoir types, characterization, and its significance in oil and gas exploration prospect do a lot of beneficial exploration, etc[4, 11, 24].

2.2. International Research on Microbial Carbonate Rocks

(1) the microbial induced carbonate mineral deposits: microbes mainly through their metabolic activities promote cells surrounding the change of the carbonate ions, pH value and water to make it up, carbonate minerals in water saturated began to precipitation, and the existence of extracellular polymers (EPS) can be fixed, the carbonate crystals settle, make its surrounding the particle growth.

(2) Sedimentary structure of microbialites: The study and description of the internal structure of microbialites began in the early 20th century with the description and study of lacustrine stromatolites in the Early Triassic greywacke of the Harz Mountains in northern Germany (Kalkowsky, 1908), but no in-depth research has been conducted. Until 70-90 - s of the 20th century, the research of microbial rock heats up, only this time the main research content of microbial rock concept, classification and morphology, more focus on the occurrence, the identification characteristics of descriptive content, further enrich the forms of microbial rock type, the initial set up the concept of microbial rock system and classification system. At the beginning of 21 century, the study of microbialites was further improved. Driven by the long-term continuous research of different geologists, the study of microbialites attracted more and more geologists' interest, and the study of microbialites was carried out in breadth and depth. At present, researches on microbialites are mainly carried out on the basis of preserved microbial structures or sedimentary structures. Some scholars divide microbialites into four scales, namely, micro scale, mesoscale, macro scale and macro scale. According to their internal structure, macroscopic structure and microbial sedimentation mode and characteristics, microbialites can be divided into five types: stromatolites, dendrites, tubelites, travertine

(travertine) and cryptic microbial carbonate rocks. Then, they are simplified into four classical groups: stromatolites, tubelites, dendritic stones and homogeneous stones[19], and the genesis, occurrence and structural identification characteristics of each microbiolite type are described respectively. Ahr(2009) proposed six types of microbial carbonate "buildingblocks" : Peloids and mesoclots, Shrubs, Stromatoids, Filaments, Radial calcite Cements), calcareous microorganisms (e.g. Gorvania, nephroforms, epiphysis), which further enrich the identification of microbiolites.

(3) Microbial carbonate oil and gas reservoir research: This research direction was developed from 2000 to 2008, mainly focusing on the prediction of microbiolite sedimentary environment, reservoir space, reservoir formation mechanism and distribution, mainly focusing on the Upper Jurassic Smackover Formation in the northeastern and northern Gulf of Mexico of the United States and the Lower Cretaceous Barra Velha Formation in the pre-salt basin of the Offshore Brazil. Internationally in recent years, each big about microbial carbonate meeting, for example, in 2012 in Houston, Texas, USA, June AAPG microbial carbonate "representation" of the meeting, held in June 2013, geological society of London "time and space distribution of microbial carbonate: enlightenment to the global oil and gas exploration and production" meeting.

3. MAIN RESEARCH CONTENTS AND KEY TECHNOLOGIES TO BE SOLVED

3.1. Research Contents

Characteristics of microbiolites: on the basis of outcrop profile measurement and core observation, microstructural and petrological analysis of microbial carbonate rocks in dengying Formation are carried out in detail. By means of thin section observation and scanning electron microscope, the characteristics of microbial structure, petrology and reservoir space of dengying Formation microbial reservoir were analyzed.

Stratigraphic and sedimentary facies research: on the basis of detailed outcrop profile measurement, core observation, thin section identification of rock, combined with previous research on sedimentary facies belt in northern Sichuan, the comprehensive column map of sedimentary facies was prepared. Based on the study of sedimentary facies and geochemical analysis, the relationship between microbiolites morphology and environment is discussed.

Diagenesis studies: On the basis of petrology characteristics, based on the detailed identification of wafer, auxiliary cathodoluminescence analysis, scanning electron microscopy (sem) analysis, C - O isotopes and the main and trace element analysis method, clear rock in sedimentary - diagenetic process of diagenesis types and diagenetic evolution sequence, microbial calcification analysis of early diagenesis on reservoir, The differences between the pore characteristics of microbial dolomite and the pore development of common carbonate rocks were found out, the relationship between microbial dolomite formation period and dolomitization process and microorganism was discussed, and the influence of various diagenesis on microbial dolomite reservoir in the study area was clarified.

Reservoir pore evolution research: on the basis of the research of sedimentary, diagenesis, pore structure, division of microbial reservoir rock types, analysis of different types of microbial rock reservoir pore structure characteristics analysis of microbial rock quality, chuanbei area development and space distribution of reservoir formation mechanism of sedimentary rock - structure, clear the high-quality reservoir pore formation and evolution, formation conditions and main control factors for the development of reservoir.

3.2. Problems to Be Solved

On the one hand, it is necessary to accurately identify the types of microorganisms in the rocks and the sedimentary environment of microbial carbonate rocks, especially the

sedimentary microfacies, by observing and identifying microscopic sections when making the sedimentary facies of microbial carbonate rocks.

Made rock action research, on the other hand is to through scanning electron microscopy (sem), carbon and oxygen isotopes, the main elements, trace elements analysis, find out the relationship between microbial rock and dolomitization, clear study the effect of all kinds of diagenesis on reservoir in the area, clear the sinian system in sichuan basin microbial rock development of favorable facies belt.

4. MAIN RESEARCH METHODS

On the basis of reading a lot of relevant literature and referring to previous studies, the relevant data of key strata in the work area were collected and sorted out, and the latest exploration research and development trend in the study area were comprehensively analyzed, and the comprehensive lithofacies histogram of dengying Formation was compiled. On this basis, microbiolites were divided into microbiolites by thin section identification, cathodoluminescence analysis and scanning electron microscope analysis. The favorable environment and diagenetic mechanism of different types of microbiolites were determined by the analysis of trace elements. On the basis of the analysis of characteristics of petrology, conjointly characteristics research, to investigate the relationship between the rock dolomitization and microbes and its diagenetic evolution sequence, clear microbial quality the main controlling factors of the reservoir rock, microbial rock distribution of favorable reservoir area, the microbes to the influence of carbonate diagenesis and reservoir.

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