

## Some Theories of Carbonate Rock Diagenesis——Chaohu for Example

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**Abstract:** In order to do more study in Marine carbonate reservoirs in China, this article described the evolution of the carbonate diagenetic, mainly introduced the mud crystallization, compaction, pressolution, recrystallization and cementation of four mainly kinds of carbonate diagenesis The protection of porosity in the process of diagenesis is another point of this artical, some conclusions were put out. By analyzing the degree of different regions, it is showed that different pore filling on the compaction effect of porosity. It is very meaningful for the study of Marine carbonate reservoir in our country.

**Key words:** carbonate rocks; diagenesis; dolomitization

### I. CARBONATE DIAGENETIC EVOLUTION

In terms of the evolution of the carbonate reservoir diagenetic, different scholars have different opinions, the following two views are widely accepted

One is called pure carbonate diagenesis. Firstly, because of the mechanical compaction from the overlying strata Original intergranular pore, biological framework hole in acid salt rocks or microcrystalline carbonate mud is gradually reduced or even disappear, neary all the remained biological suffer from serious damage. For the cooperation of pressure and fluid interaction, some acid salt rocks dissolved, scattered, moved to another place and crystallized again. After that, rock experienced cementation, dissolution, recrystallization and partial dolomitization, forming solution pores, intergranular pores and so on.

The other diagenesis, does not have big differences, which contains not only bioclastic but also epicontinental clastic and intraclast. The presence of these substances not only affects the rock structure, internal components, but also makes something special during the process of diagenetic chemistry, and these would be showed by the characteristics of dolomite. A certain amount of grain limestone is the sign.

### II. STUDY OF DIAGENESIS

According to the study of The carbonate formation of lower Permian in the Chaohu lake of Anhui province, the main diagenetic evolutions are listed as followed.

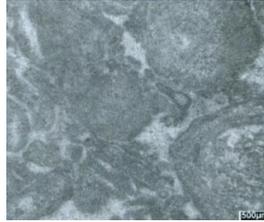
#### (1) Mud Crystallization

Mud crystallization mainly effect the biological remains in carbonate formation. Containing a lot of pieces of Marine creatures and even whole body is one of the most important characteristics of carbonate rocks. The essence of mud crystallization is a compound substitution between small crystal particles and organic remains. According to the degree of biological particles displacement, mud crystallization effect can be divided into two kinds, one is internal filling, the other is outer packing.

Internal refers to the internal grain filling completely or more than half the mud crystallization, and oolitic or organism internal structure still has a certain degree of retention. This way of filling the core part of most

particles to crystallization is no mud, the degree of mud crystallization is not high, most of internal structures are filled by sparry calcite.

Outer filling, a micritic shell along the grain of the external, is similar to the structure characteristics of complex oolite of transverse section. In this case, the degree of the mud crystallization of mollusks or inner cavity is very low.

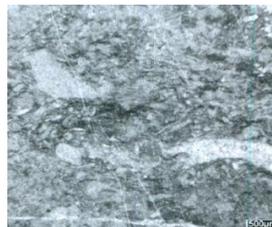


**Fig.1 internal mud crystallization**

### **(2) Compaction and Pressure-solution**

Compaction and Pressure-solution are two different reactions at two stages under the same force. Compaction is mostly in the early stage of the diagenesis, material experiences the state from a loose accumulation to a compacted state during this period. The elongated particles will arrange in the form of fixed direction, as well as the spheroidal ones will change in shape. Compaction is one of the biggest effects in reducing the porosity, so it is called "pore killer".

Pressure-solution, the crystal will dissolve when the pressure is pretty high due to the lattice deformation. However, the edge of the different particles contact and granule interior are two places where the particles are dissolved. The development of suture line is an obvious feature, it could cut through the original particles and substrate. With the increasing pressure degree, the suture line is widen. At the early step of the suture line is fine with sharp dentates and short, filled with black organic matter; later it is smooth, strong continuity fillings are diverse, even less visible calcite crystals.



**Fig.2 compaction effort**

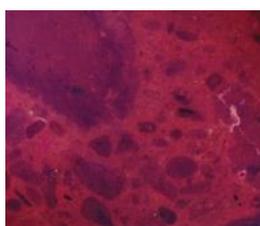
### **(3) Dolomitization**

The essence of dolomitization is the stratum gradually replaced by dolomite. The principle of this replacement is that the insertion of a large number of magnesium ions results in the change of the structure of crystals and eventually lead to the change of the nature of the compounds. At early time, in 1998, geologists had put it that after the dolomitization, the porosity of the rock will increase. Compared with calcite, dolomite is more bulky, and has a unique structure characteristic of fog heart bright side, which is usually formed in deep burial depth and the hot temperature.

### **(4) Recrystallization**

Recrystallization is divided into two kinds by evolutionary stages. Early recrystallization is the translation from aragonite and high-magnesian calcite to calcite for the rapid change of diagenetic environment and poor stability themselves. The lity one under the condition of deep burial depth, tiny crystals had

recrystallization formed larger ones.



**Fig.3 recrystallization**

### III. PART OF THE WEAK LIGHT RED-BROWN IS RECRYSTALLIZED CALCITE.

#### (5) Cementation

There are many kinds of cementations in Marine carbonate, it is similar with clastic rock, not only the type but also the mechanism of action. Cementation is controlled by the fluid pore, aiming at making the rocks to adapt to the environmental changing. Here are several kinds of carbonate cementation in the area of research area.

Table 1 Cementation types

Type	Developed places	Granular size	Characteristic
granular cementation	between particles	Spar 0.02~0.10mm, poikilitic 0.5mm	Clearly geopetal structure
gravity type	Under particles	0.1~ 0.12mm	Divided into two generations, suspension type cement and granular cement
Coaxial accretion	particle surface	Acanthosis structure 1.0~1.5mm, single-crystal structure 1.5~2.0 mm	Contain bubbles, vacuole, crystal stale, clouds shaped
meniscus	Below particles	Depend on the size of the void space	crescent-shaped and the lower bending outward

### IV. RETENTION PROCESS

At first, retention process which mainly discusses the preservation of the pore during the diagenetic process was presented in the study of continental strata. In this regard, Marine strata and continental strata are similar<sup>[1]</sup>.

In the process of diagenetic of carbonate rock, there are three main ways of reducing the porosity<sup>[2-4]</sup>, which are called “Pore killers”. They are Compaction, Pressure Solution and Excessive Cementation.

It is not good news for the workers who work in petroleum geological because of the reduction of porosity leading to the decline of oil reserves. However, there is also a kind of diagenesis process, whose name is retention process, protecting the porosity of the rock during the long geological processes. There are four main kinds of diagenesis protecting the porosity in the study area as followed.

#### (1) Micrite envelope

When the particles are at the bottom of the sea, the environment contributes to the formation of micritic or microcrystalline limestone, which grow along with the appearance or edge of the grains. Due to the pressure of the deep sea and special chemical environment, it is likely to form a particle shell by the micritic or microcrystalline limestones, and it is called the micrite envelope. The micrite envelope has three important characteristics as followed:

First, the micrite envelope has strong ability to work under pressure, therefore, in the overlying pressure function, which can effect on the applied force to reduce to a certain extent, thus keep the pore volume into the largest possible. Second, the micrite envelope is very difficult to be dissolved, as well as it has strong ability of resistance to weathering. Last but not least, the micrite envelope has the nature of magnesium ion affinity and the function of the molecular sieve, so it could result in selective dolomization of particles<sup>[5-6]</sup>.

### **(2) Early atmospheric fresh-water cementation**

There are two main effects belong to the early atmospheric fresh-water cementation, on the one hand the affect is aiming at mineral grains, on the other hand it is aiming at pores. This kind of cementation could form a thick rim in the particle surface, and the rim has a strong ability to work under pressure. Another representation of this cementation is the formation of cement on the edge of the pore inside, that could protect the pore during the compaction at the beginning of the deposition.

### **(3) Early dolomization**

The early dolomization is the process of the transformation from calcite to dolomite as well as the change of the limestone. Great changes have taken place in the structure of the rock during the process, after that the capability of resistance to compaction would remarkably enhanced, therefore the reservoir property was maintained well<sup>[7-9]</sup>.

### **(4) Recrystallization**

When the recrystallization is at the appropriate stage, the effective porosity and permeability of the rock would improved because of the changing of the crystal habit, at the same time it might also contribute to building the environment of dissolution, however the advantage will disappeared if the recrystallization is not at the right time, only harmful remained<sup>[10]</sup>.

## **V. CONCLUSION**

In the process of the diagenesis and evolution of the carbonate, all the diageneses can be divided into two kinds, the one reduces the porosity of the rock, and the function of the other one just on the contrary, protecting the pores from the pressure. These two kinds of effects can lead to different results. All in all, learning the two kinds of diageneses play an important part in the futher reaserch.

## **REFERENCE**

- [1]. Huang J S, Huang P P, Wang Q D, Liu H N, Wu M, Zou M L. Cementation in the deeply buried sandstone pore preservation. *Lithologic Reservoirs*. 2007, 19(3):7-13.
- [2]. Zhu R K, Guo H L, Gao Z Y, Wang X S, Zhang X Y. China's Marine reservoir distribution characteristics and form the main controlling factors. *Chinese Science Bulletin*, 2007, 52(A01):40-45.
- [3]. Heydari E. Porosity loss, fluid flow, and mass transfer in limestone reservoirs: Application to the Upper Jurassic Smackover Formation, Mississippi[J]. *AAPG Bulletin*, 2000, 84(1):100-118.
- [4]. Ehrenberg S N, Nadeau P H, Steen Φ. Petroleum reservoir porosity versus depth: Influence of geological age[J]. *AAPG Bulletin*, 2009, 93(10):1281-1296.
- [5]. Melzer S E, Budd D A. Retention of high permeability during shallow burial(300 to 500 m) of carbonate grainstones[J]. *Journal of Sedimentary Research*, 2008, 78:548-561.
- [6]. Bi Y Q, Tian H Q, Zhao Y S. Theory of micritic set of secondary dolomite and the recovery of the original rock structure characteristics and significance. *Acta Petrologica Sinica*, 2001, 17(3):491-496.
- [7]. Warren J. Dolomite: Occurrence, evolution and economically important associations[J]. *Earth-Science*

- Review, 2000, 52: 1-81.
- [8]. Lucia F J. Dolomitization: A porosity-destructive process[J]. AAPG Bulletin, 2000, 84(11): 32-40.
- [9]. Ehrenberg S N, Eberli G P, Keramati M, et al. Porosity-permeability relationships in interlayered limestone-dolostone reservoirs[J]. AAPG Bulletin, 2006, 90(1): 91-114.
- [10]. Jiang Z B, Wang D X, Zeng D M. Northwest sichuan qixia group of lower Permian favorable diagenesis and pore evolution. *Geology In China*, 2009, 36(1): 101-109.
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