Division and Evaluation of Carbonate Fracture-Cave Assemblages in Yingmaili Area, Northern Tarim Basin

Yong Xiao, Bingsong Yu

School of Earth Sciences and Resources, China University of Geosciences (Beijing), Beijing, China

E-mail: *x_y81@126.com, yubs@cugb.edu.cn*

Abstract

In recent years, Paleozoic carbonate reservoir is an important oil and gas exploration and Development Series in Tarim Basin. The classification and connectivity analysis of fracture vuggy system and large fracture vuggy aggregate in carbonate rocks are of great significance to the development of carbonate oil and gas. Fractures, pores and vugs are the main migration channels and reservoir space of oil and gas, and their combination and connectivity are one of the necessary conditions for hydrocarbon accumulation in carbonate rocks. The prediction of fractures and vugs in carbonate rocks, the evaluation of fracture and vuggy system and fracture and vuggy aggregate have always been the research focus and difficulty in this area. According to the development characteristics of fractures and dissolution pores in Paleozoic carbonate reservoirs in Tabei, Tarim Basin, and combined with sedimentary background and dissolution genesis, fracture cavity system and fracture cavity aggregate are divided step by step. Based on the division of fracture cavity system and fracture cavity aggregate, according to the structural position, carving volume and fracture cavity combination relationship of fracture cavity aggregate, the fracture cavity system and fracture cavity aggregate are reasonably evaluated and connectivity analysis is carried out, which provides important technical support for carbonate rock development and well location deployment.

Keywords: Carbonate Rock, Fracture Cavity System, Fracture Cavity Aggregate, Evaluation.

1. Introduction

The Paleozoic carbonate fractured vuggy reservoirs in Tarim Basin have various types of reservoir space, with obvious differences in size and grade. According to the shape and size, the reservoir space can be classified into three categories: vugs, pores and fractures. According to the different spatial combination characteristics of vugs, pores and fractures, fracture vuggy reservoirs can be classified into four types: vug type, pore type, fracture vuggy type and fracture type [1]. Referring to the previous studies on the distribution of karst fractures and vugs in this area, it is considered that the karstification in this area is mainly buried hill karst, which is affected by the important factors of structural faults and paleogeomorphology; according to the development characteristics of fractures and dissolution holes in carbonate reservoir, combined with the sedimentary background and dissolution causes, the fracture vuggy system and fracture vuggy aggregate in this area are statically divided.

In carbonate strata, the definition of fracture cavity system and fracture cavity aggregate is defined firstly. The fracture cave system is controlled by the same main controlling factors of karst fracture cave. According to the results of reservoir seismic prediction, it takes the dense area of fracture cave development as the boundary and consists of adjacent associated vugs, fractures and pores. Fracture vuggy aggregate is

a collection of multiple reservoir units connected by caves, faults and fractures in carbonate fracture vuggy reservoir, which is separated by relatively dense or poor permeability dissolution interface or closed fault.

2. Division of fracture cave system and fracture cave aggregate in Yingmaili area, northern Tarim Basin

The ideas and principles adopted in this paper are as follows: 1) with the same tectonic background, fault system and the same main controlling factors of fracture cave, it is composed of closely related holes, fractures and caves; 2) controlled by the main controlling factors of karst fracture cave, there are obvious differences in seismic attributes between fracture cave systems, with the relatively dense zone reflected as the boundary. The division ideas and principles of fracture cavity aggregate: taking seismic attribute cave prediction as the core to determine the geometric contour and location relationship of fracture cavity; in the stage of exploration understanding, quantitative carving of high angle fractures is used as the basis for determining the static connectivity of fracture cavity aggregate, and the reservoir prediction of the target interval is used as the basis for the relatively tight karst boundary of fracture cavity aggregate.

The spatial distribution of carbonate fracture cave system is mainly controlled by faults, fractures, paleogeomorphology and paleo water system. In Yingmaili area, North Tarim Basin, according to the differences of stratigraphic distribution, structural characteristics and seismic attributes, with the same structural form and reservoir boundary clarity, 16 fracture cave systems are identified. As shown in figure 1, the total area of fracture cave system is 251.03km^2.
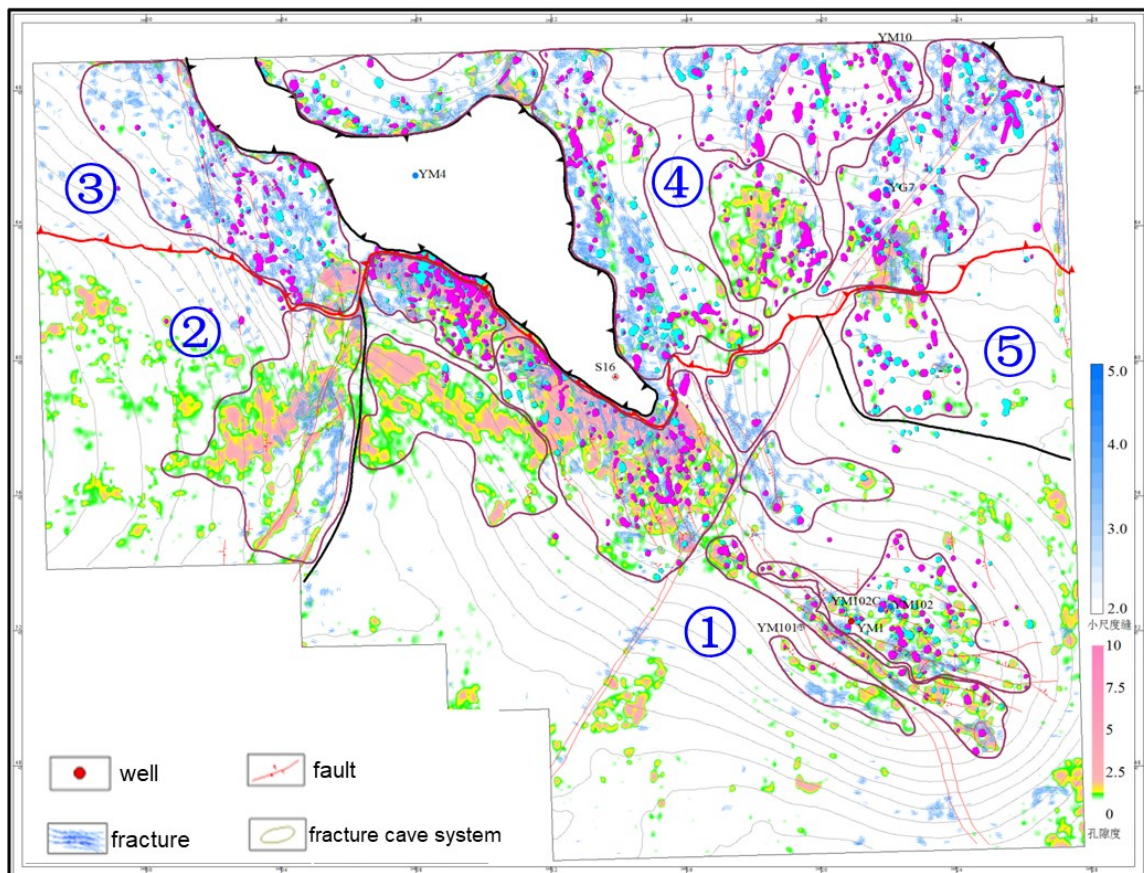

Fig. 1 division plan of Ordovician carbonate fracture cave system in Yingmaili area

Based on the division of fracture cavity system, different levels of fracture cavity aggregates are identified in each fracture cavity system. In Yingmaili area, 55 fracture cavity aggregates are identified by using the static division method, with a total area of 108.83km2. Fracture cavity aggregates are mainly distributed in the anticline area of the top structure of carbonate rock, the surrounding area of buried hill and the slope zone, as shown in Figure 2.
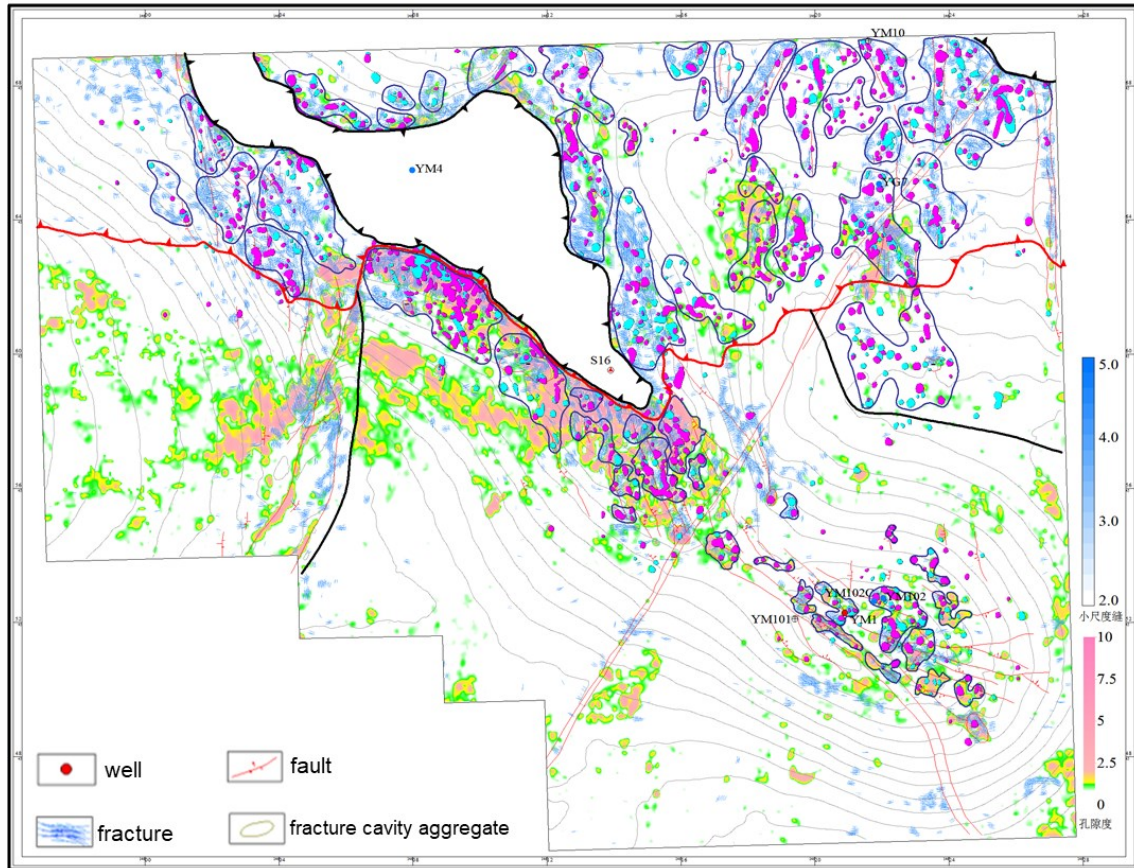

Fig. 2 division plan of Ordovician carbonate fracture cavity aggregate in Yingmaili area

Based on the identification and division of carbonate fracture cave system and fracture cave aggregate in Yingmaili area, it is considered that the development characteristics of carbonate reservoir in this block are as follows: fractures are mainly developed in Yingmai 4 buried hill surrounding area, near the Western fault zone, the axis of Yingmai 1 anticline area and the slope zone; karst caves are controlled by the distribution range of buried hill under the action of buried hill karst, and are mainly developed in Yingmai 4 surrounding area Yingmai-1 anticline and yinggu-7 slope zone have strong interlayer karstification. Therefore, the fracture cave assemblages are concentrated in Yingmai 4 anticline, Yingmai 1 anticline and yinggu 7 slope zone. The distribution of reservoirs in this area is strongly controlled by buried hill karst and interlayer karst, and concentrated in the structural position with strong dissolution.

3. Evaluation of fracture cave system and fracture cave aggregate in Yingmaili area, northern Tarim Basin

Based on the static division of fracture cavity system and fracture cavity aggregate, the fracture cavity system and fracture cavity aggregate are evaluated and optimized according to the structural location,

reservoir porosity, cave number, fracture development degree and fracture cavity combination relationship of fracture cavity aggregate, which provides important technical support for carbonate reservoir development and horizontal well location deployment.
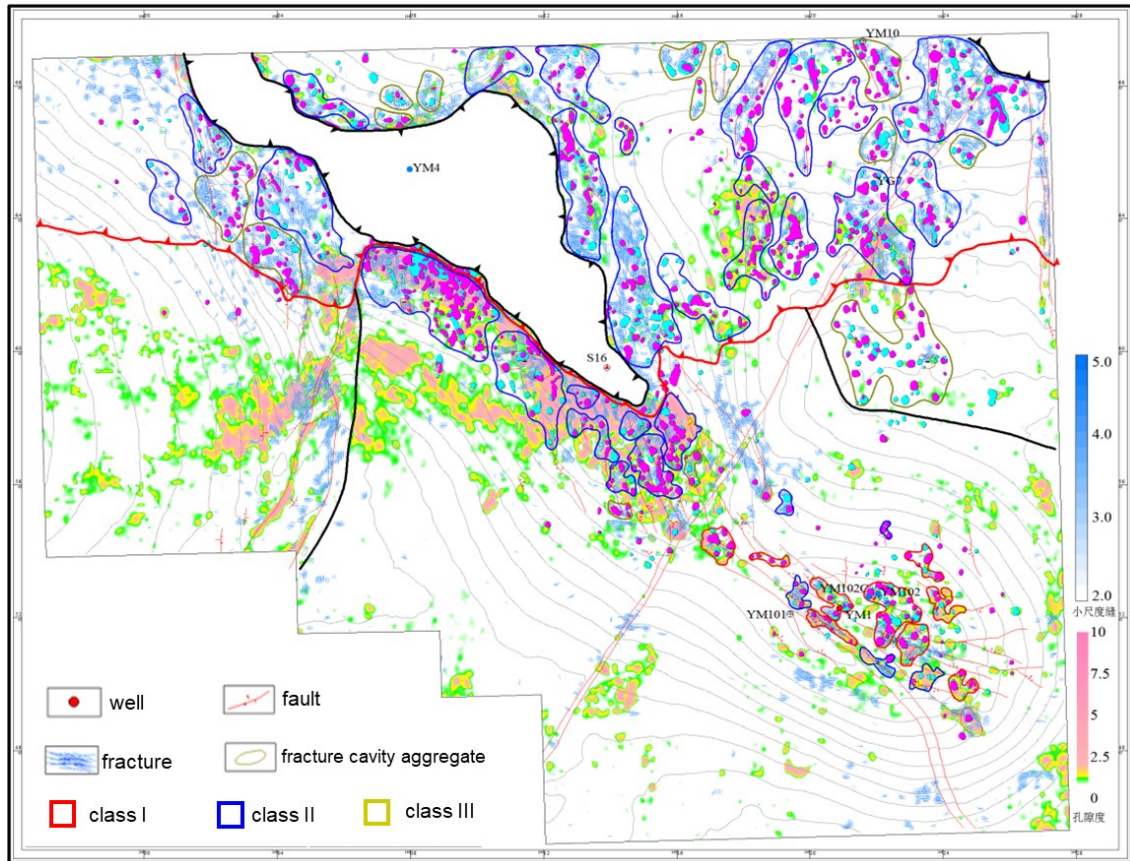

Fig.3 comprehensive evaluation plan of Yingmai 1 large fracture cavern

Table 1 evaluation standard of fracture cavity

	Reservoir porosity greater than 4% There are more than 3 karst caves predicted by seismic attributes Fracture developed	Reservoir porosity greater than 4% There are more than 3 karst caves predicted by seismic attributes Fracture developed	Reservoir porosity < 4% There are more than 3 karst caves predicted by seismic attributes Fractures relatively developed	Reservoir porosity < 4% Less than 3 karst caves predicted by seismic attributes Few fractures developed
Yingmai 1 anticline	I	II	II	II
South slope of Shahejie 16	II	III	III	III
Buried hill and other structural locations	II	III	III	III

Based on the analysis of the top structure of carbonate strata, Yingmai 1 anticline is the most favorable exploration area with the best reservoir cap rock combination for oil and gas preservation, so the fracture cavity aggregate in the anticline area is the most favorable target selection area; in the slope zone, the structural slope is larger, and the reservoir cap rock condition is slightly worse than that in Yingmai 1 anticline area, which is the second consideration area; the cap rock condition near the buried hill area is poor. The reservoir conditions are not good, and there are no favorable optimization conditions. Starting from different structural positions, according to the spatial position of deep reservoir development, large porosity, fracture cavity Association, etc., we have formulated the following evaluation criteria (Table 1) to evaluate the carbonate fracture cavity aggregate in Yingmaili area (Fig. 3).

4. Conclusions and suggestions

Based on the above study on the identification and division of fracture cavity system and fracture cavity aggregate of carbonate rock in Yingmaili area, as well as the grade evaluation of fracture cavity aggregate, the following understandings are obtained:

1. The spatial distribution of carbonate fracture cave system is mainly controlled by faults, fractures, paleogeomorphology and karstification. The reservoirs are distributed in the buried hill and anticline area, followed by the slope zone. The fracture cave system is mainly developed in the structural position with strong dissolution.

2. This study mainly uses the method of static division to analyze the fracture cavity aggregate; fracture cavity aggregate is concentrated in Yingmai 4 anticline area, Yingmai 1 anticline area and yinggu 7 slope zone. It is mainly affected by the karst of buried hill and the control of interlayer karst.

3. The evaluation of fractured vuggy reservoirs provides an important basis for the connectivity research and horizontal well trajectory deployment of carbonate fractured vuggy reservoirs.

References

[1]   Zheng Xin, Zhang Xiaodong. Research progress of seismic exploration technology. 2014

[2]   Chen Jialiang, LAN Suqing, Wang Changjie. Prediction method and application of fractured reservoir. Progress of exploration geophysics. 2012

[3]   Ye Desheng, Wang Genchang, Lin Zhongmin, et al. Characteristics and hydrocarbon potential of Cambrian Ordovician carbonate reservoirs in northern Tarim Basin [M]. Chengdu: Sichuan University Press, 2010, 17-18

[4]   Xu Liping. Application of multi-attribute fusion technology in carbonate fractured vuggy reservoir prediction in Tazhong oilfield. Acta engineering geophysics, February 2010, Vol. 7, No. 1

[5]   Wu Xinsong, pan Wenqing, Gu Qiaoyuan, Han Jianfa. Distribution of paleokarst cave reservoirs in Lunxi area, Tarim Basin. Petroleum geology and recovery factor. December 2011, 12

[6]   S. F，Zhu，X.，Toksoz，N.: "Anisotropy of Aligned Fractures and P Wave Azimuthal AVO Response"，67th Ann., Internat. Mtg.，Soc. Expl. Geophys.，2001-2004 (1997).

[7]   F. S, Shaoguo Yang. Integrated Fractured Reservoir Characterization By Using 3-D Prestack Seismic Data and Log data. EP-Tech_SEG. 2003_paper_1

[8]   S. F, Jesus Sierra，Daniel R. Burns，M. Nafi Toksoz. Azimuthal offset-dependent attributes applied to fracture detection in a carbonate reservoir. Geophysics. 2002，(Vol. 67): 355～364