Mesozoic sequence framework of eastern Yihezhuang salient, Jiyang depression, Bohai Bay basin, China

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Abstract: The Mesozoic sequence framework of the eastern Yihezhuang salient in Jiyang depression, which was a residual basin, was studied in order to improve the success rate of locating hydrocarbon reservoirs. First, through seismic profiles, well logs and cores, complemented with outcrops, totally 5 sequence boundaries in Mesozoic were recognized, which included Tg, Tmz3, Tmz2, Tgm and Tr. Based on the recognized sequence boundaries, the Mesozoic sequence framework of eastern Yihezhuang salient got established. The entire Mesozoic succession was interpreted as two first-order sequences. One first-order sequence consisted of Early and Middle Jurassic and Late Jurassic, composed of three third-order sequences, which included SQ-Fz_1, SQ-Fz_2 and SQ-St from bottom to top. Respectively, the other first-order sequence consisted of Late Jurassic, composed of only one third-order sequence as truncated by late tectonic movement.

Introduction

In marine basins, especially those on tectonically stable cotinental margins, the sequence framework mainly resulted from eustatic sea level changes [1,2]. Whereas, in tectonically active basins, tectonism increased or decreased accommodation, altered depositional base level, controlled the distribution of source areas, and even influenced local climatic patterns [3-5]. Tectonism turned to be the most important factor controlling sequence frameworks [6-8]. During Mesozoic in Eastern China, Indosinian movement and Yanshan movement happening affected sequence framework pretty much, which turned to be very complex [9].

From the above, it can be concluded that the sequence frameworks in pre-Cenezoic inland basin is of much interest, so this study takes the Mesozoic succession (J_{1+2}) in eastern Yihezhuang salient as an example to carry out this research.

Geological background

Yihezhuang salient was located in the north of Jiyang depression, and got separated from Zhanhua sag with Yinan fault trending EW in south and Yidong fault trending NE-SW in east as boundaries, respectively, close to Chezhen sag in the west and north with transitional slopes (Fig. 1). North to Chezhen sag, there is Chengnan fault, which is pretty important for the formation and evolution of Yihezhuang salient. Yihezhuang salient belongs to the up-thrown wall of Yinan fault, and down-thrown wall of Chengnan fault.

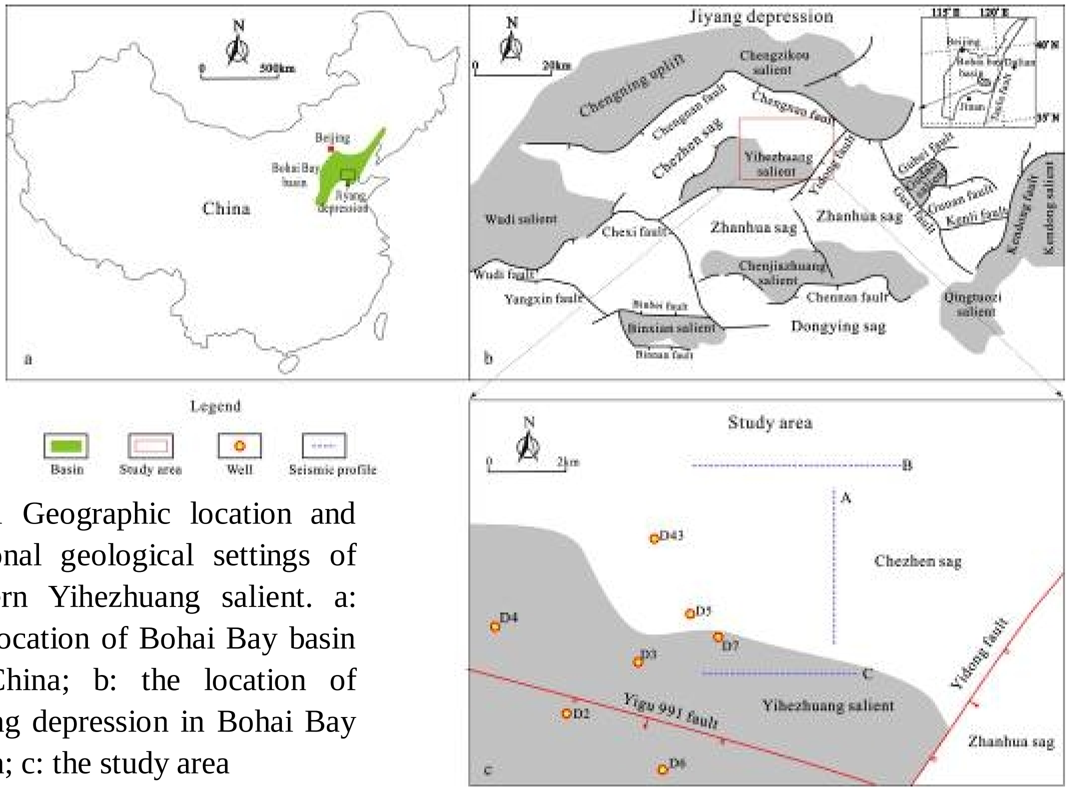

Fig.1 Geographic location and regional geological settings of eastern Yihezhuang salient. a: the location of Bohai Bay basin in China; b: the location of Jiyang depression in Bohai Bay basin; c: the study area

Being influenced by Indosinian movement, Yanshan movement and Himalayan movement, the Mesozoic succession in eastern Yihezhuang salient got severely denudated, with only Jurassic system developed (Table 1).

Table 1 The stratigraphic division and basin filling evolution of the Yihezhuang salient, Jiyang depression, Bohai Bay basin (Modified after Zhang et al., 2009)

Geologic age		Strata	Sequence boundary	Sequence division	Sequence order		Tectonic stage
Cenozoic		Rift basin, sepetated with underlying strata by unconformity-Tr					
			Tr				LEYSM
Mesozoic	Late Jurassic	Mengyin Formation		SQ-J_3My	III	I	Middle Yanshanian
			Tgm				
	Middle Jurassic	Santai Formation		SQ-J_2St	III	I	
			Tmz2				MEYSM
		Upper member of Fangzi Formation		SQ-J_1Fz$_2$	III		Early Yanshanian
			Tmz3				
	Early Jurassic	Lower member of Fangzi Formation		SQ-J_1Fz$_1$	III		
			Tg				IDM
Paleozoic		Craton, seperated with overlying strata by unconformity-Tg					

LEYSM = late episode of Yanshan movement; MEYSM = main episode of Yanshan movement; IDM = Indosinian movement

Material and methods

The study area has always been one of the important zones for oil exploration and development in Shengli Oilfield Co. Ltd., Sinopec. Large number of geology data has been accumulated after many years of exploration and development, which provided profitable conditions for researching in this study. Moreover, we carried out one week of field work to observe early Yanshanian outcrops nearby the study area.

Recognition of sequence boundary

Identification of sequence boundaries in the study area is based on analysis of 3-D seismic profiles, complemented with well logs and core data. We recognized the sequence boundaries on the basis of the following criteria.

1. Generally, unconformities and their correlative conformities are used as sequence-bounding surfaces [10], because they represent time-barrier surfaces. Unconformable stratigraphic contacts are reflected on seismic profiles as truncations, and surfaces of onlap (Fig. 2).

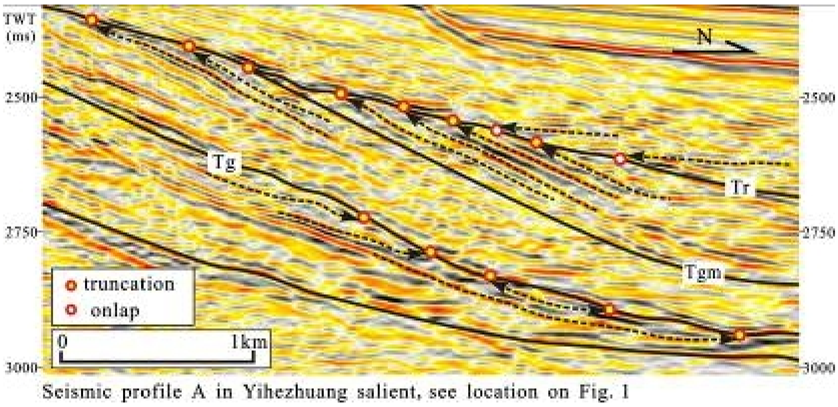

Fig.2 Annotated 3-D seismic profile across Yihezhuang salient showing sequence boundaries (sb). The boundaries are characterized by truncation and onlap.

2. Sequence boundaries are also represented by abrupt changes in physical characteristics such as lithology and sedimentary facies. Such boundaries can be identified through shapes of well logs (Fig. 3).

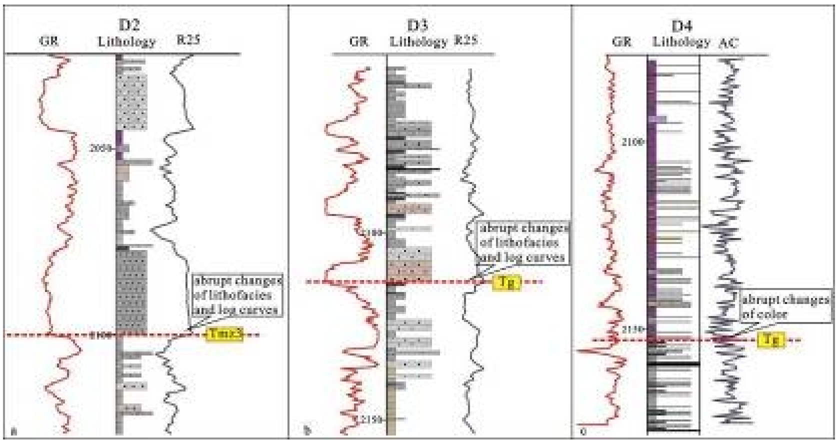

Figure 3. a and b: The difference between lithology and log shapes up and down sequence boundary (sb)-Tmz3 and Tg. The lithology up Tmz3 or Tg is thick sandstone, and the log curves are box-shaped, both of which are different from the below. c: The sequence boundary can be also featured by abrupt changes in lithology colors. (See location of wells on Fig. 1)

3. Channel erosion surface in one kind of unconformities and could serve as sequence boundary, which is characterized by channel floor lag deposit (Fig. 4). In Boshan, close to Yihezhuang salient, there developed perfect outcrops of Mesozoic succession (Fig. 4), which can provide obvious evidences for recognizing sequence boundaries.

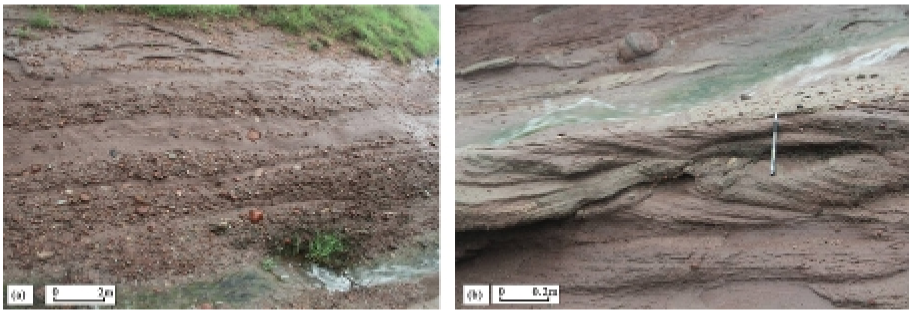

Fig.4 Mesozoic outcrops and sequence boundaries in Boshan area (a: channel floor lag deposit of Santai formation in Boshan area; b: basal erosional unconformity surface of Santai formation in Boshan area, above which, there developed channel floor lag deposit)

According to the preceding three criteria recommended, the sequence framework of the study area is established (Fig.5), with two orders of unconformity-bounded sequences recognized. The entire Mesozoic succession (Tg-Tr) is considered to comprise two first-order sequences, and the Lower member of Fangzi formation, Upper member of Fangzi formation, Santai formation and Mengyin formation turn to be three third-order sequences (Table 1).

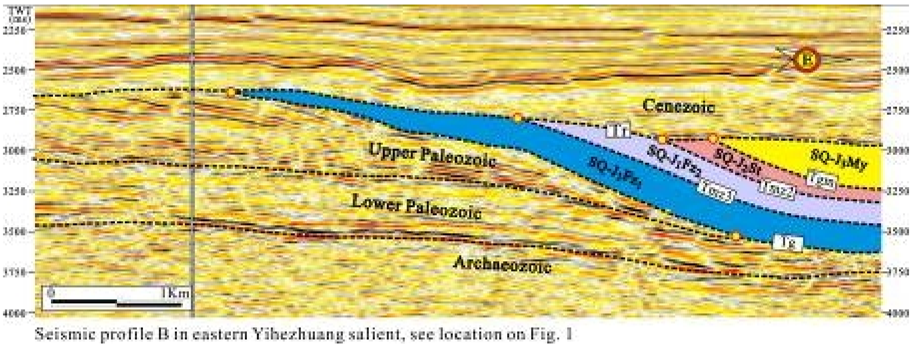

Fig.5 Pre-Cenezoic sequence framework of Eastern Yihezhuang salient, Jiyang depression

Conclusions

There were five sequence boundaries developing in eastern Mesozoic Yihezhuang salient, including Tg, Tmz3, Tmz2, Tgm and Tr in ascending order, among of which, Tg, Tgm and Tr were three first-order sequence boundaries, and Tmz3 and Tmz2 were two third-order sequence boundaries.

Succession deposited in Mesozoic constituted two first-order sequences and four third-order sequences. The Early and Middle Jurassic, consisting of SQ-Fz1, SQ-Fz2 and SQ-St, is one first-order sequence. Respectively, the late Jurassic consisting of SQ-My is the other first-order sequence.

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