

PS The Origin of Complicated Fault System in Beibuwan Basin and the Application for the Evolution of South China Sea*

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Abstract

The Beibuwan Basin, located in the north part of the South China Sea, is rich in oil and gas resources. Over the entire Beibuwan Basin, 3D high-precision seismic data are obtainable. The fault system in Beibuwan Basin is as complicated as that in other rift basins in Southeast China. Interpretation of 3D seismic data, results of sandbox modeling, and theoretical analysis with application of our new brittle faulting model with multiple pre-existing weaknesses are used to investigate the complicated fault systems of Beibuwan Basin. Results show that the Beibuwan Basin is formed by the superposition of two-phase extension with different directions. In the first rifting stage during E1ch-E2l2 (65-38 Ma), the regional extension direction is NW-SE (about N 40° W), and the boundary fault of the basin is the Weixinan Fault (strike N 50° E). In the second-phase rifting (E3W, 38-23.3 Ma) and post-rifting (N-Q, 23.3-0 Ma), the regional extension direction rotates to the N-S direction. No.1 Fault becomes the north boundary fault of the basin, while the activation process of the Weixinan Fault ends. During post-rifting, a large number of faults remain active. Extension of the N-S direction continues, but the extension intensity declines.

This tectonic model can reasonably explain all phenomena of the complicated fault systems in Beibuwan Basin. This tectonic model has a significant influence on the theorized evolution of the South China Sea, which is a key region to understand the interactions among the plates of Eurasia, India-Australia, the Pacific and Philippine. However, the origin mechanism and spreading history of the South China Sea are still controversial. According to the origin of the fault system in the Beibuwan Basin, the origin of the South China Sea is the result of extension in a N-S direction, and the Southwest Trough (NE trend), which is on the basis of a large pre-existing weakness. The analysis also shows that the strike-slip activation of the Honghe Fault in the north part of South China Sea is passive. As such, the tectonic escape model of Tapponnier (1982) for the origin of South China Sea can be excluded.

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The origin of complicated fault system in Beibuwan Basin and the application for the evolution of South China Sea

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ABSTRACT: Beibuwan Basin, located in the north part of South China Sea, is rich in oil and gas resources. In the whole Beibuwan Basin, 3D high-precision seismic data are obtainable. The fault system in Beibuwan Basin is as complicated as that in other rift basins in the Southeast China. Interpretation of the whole 3D seismic data (Fig.3, Fig.4a), results of sandbox modeling (Fig.4b, Fig.6), and theoretical analysis with application of our new brittle faulting model (Tong & Yin, 2011; Tong et al,2014) with multiple pre-existing weaknesses are used to investigate the complicated fault systems (Fig.2, Fig.3a) of Beibuwan basin. Results show that Beibuwan basin are formed by the superposition of two-phase extension with different directions. In the first rifting stage during E_{1ch} - E_{2f} (65-38Ma), the regional extension direction is NW-SE (about N 40° W, Fig.7), and the boundary fault of the basin is Weixinan Fault (strike N 50° E, Fig. 1). In the second-phase rifting (E_{3w} , 38-23.3Ma) and post-rifting (N-Q, 23.3-0 Ma), the regional extension direction rotates to N-S direction (Fig.7 and Fig.8). No.1 Fault (Fig.1, Fig.3 and Fig.4a) becomes the north boundary fault of the basin, while the activation process of Weixinan fault stops. During the post-rifting, a large number of faults keep active. Extension of NS direction continues, but the extension intensity reduces. This tectonic model (Fig.7 and Fig.8) can reasonably explain all phenomena of the complicated fault systems in Beibuwan basin. This tectonic model has a significant influence on the evolution of South China Sea, which is a key region to understand the interactions among the plates of Eurasia, India - Australia, the Pacific and Philippine. However, the origin mechanism and spreading history of South China Sea are still controversial. According to the origin of the fault system in Beibuwan basin and other data, the origin of South China Sea is the result of extension of NS direction (Fig.8), and the South-west Trough (NE trend), which is on the basis of a large pre-existing weakness. The analysis also shows that the strike-slip activation of Honghe Fault in the north part of South China Sea is passive. As such, the tectonic escape model of Tapponnier (1982) for the origin of South China Sea can be excluded.

1 The characteristics of fault system in Beibuwan Basin

Table 1 Strata and tectonic evolution stages in the Beibuwan Basin

System	Series	Formation	Member	Age of the bottom(Ma)	Evolution stage
N-Q				23.3	Depression
E	E ₃	Weizhou (E _{3w})	E _{3w} ¹		Rifting
			E _{3w} ²		
			E _{3w} ³	32	
	E ₂	Liushagang (E _{2s})	E _{2f} ¹	38	
			E _{2f} ²	56.5	
	E ₁	Changliu (E _{1c})		65	

- ◆ In the first rifting stage, and the boundary fault of the basin is Weixinan Fault(Fig. 1).
- ◆ in the second rifting stage,). No.1 Fault (Fig.1, Fig.3 and Fig.4a) becomes the north boundary fault of the basin
- ◆ No.2 Fault is an almost continuous on top of the basement (Fig. 3), and changes upward (above E_{2f}^2) into a series of en echelon faults (Fig. 4(a))
- ◆ No.3 Fault (Fig.3 and Fig.4a) terminates suddenly on the No.0 transfer fault zone (Fig.3 and Fig.4a), and branches out into numerous, small scale, EW-trending faults in the east (Fig.3 and Fig.4a).

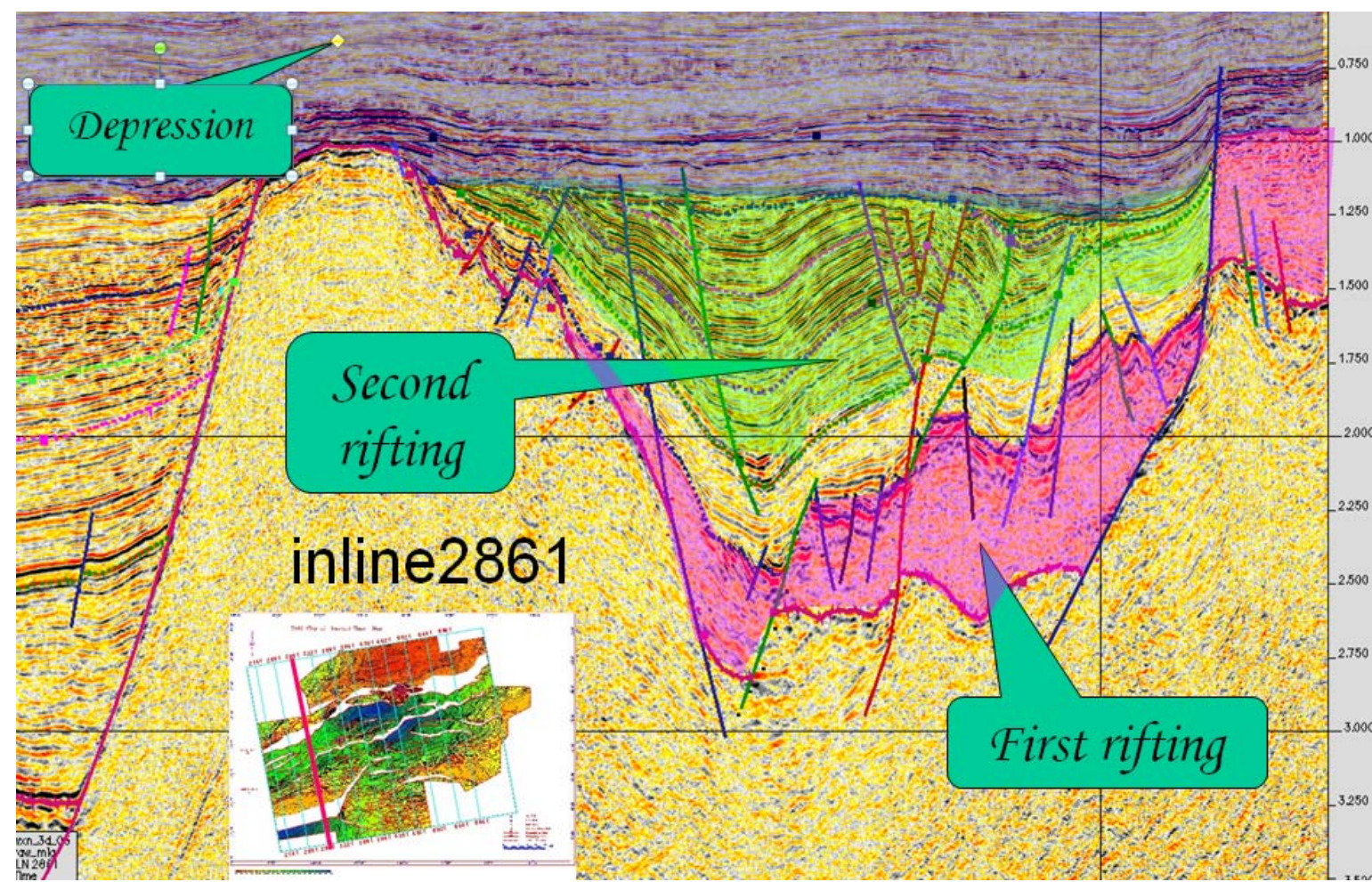


Fig. 2 Typical seismic section shows the sequences of Beibuwan basin

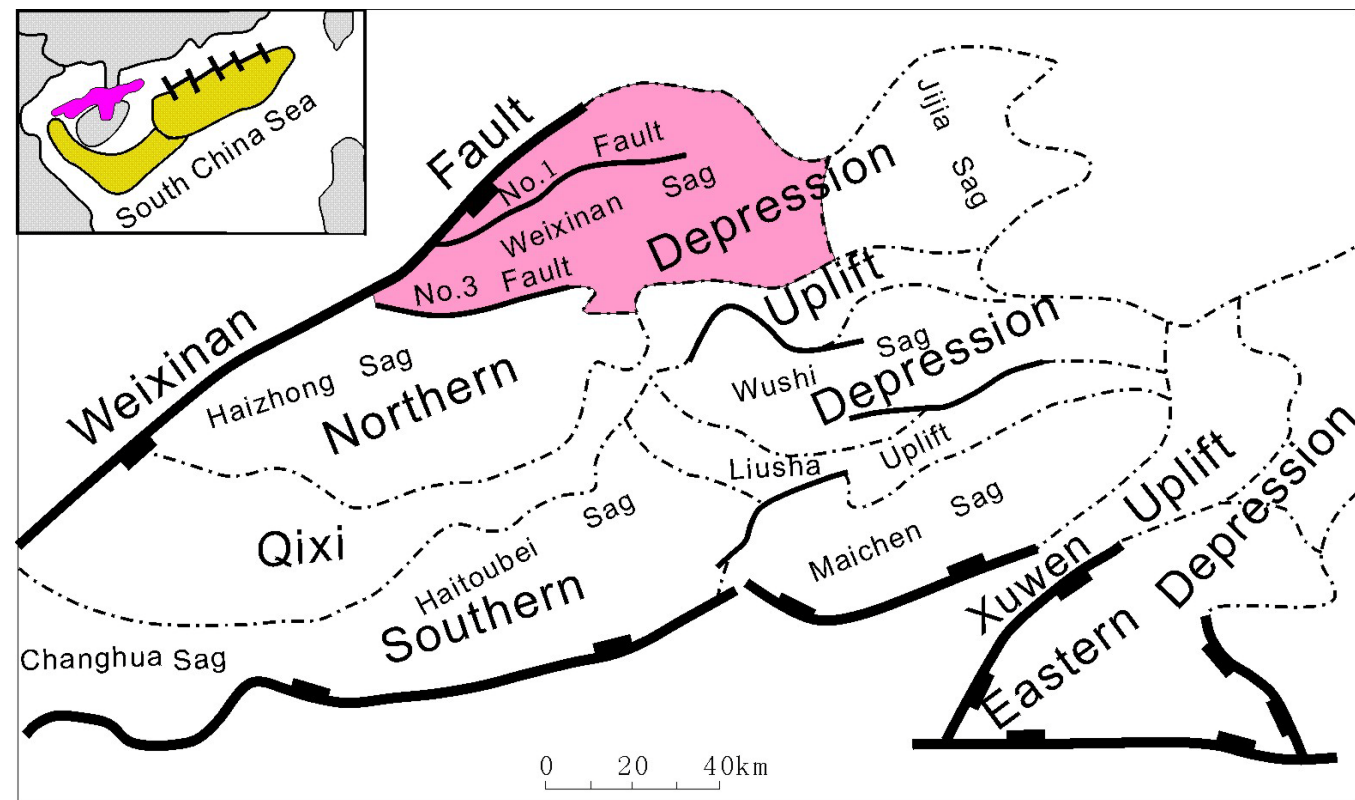


Fig. 1 Distribution of tectonic units of Beibuwan Basin and the location of Weixinan Sag (pink area). Small figure in the up-left corner shows the location of Beibuwan Basin (red area). (After CNOOC, Zhanjiang Branch)

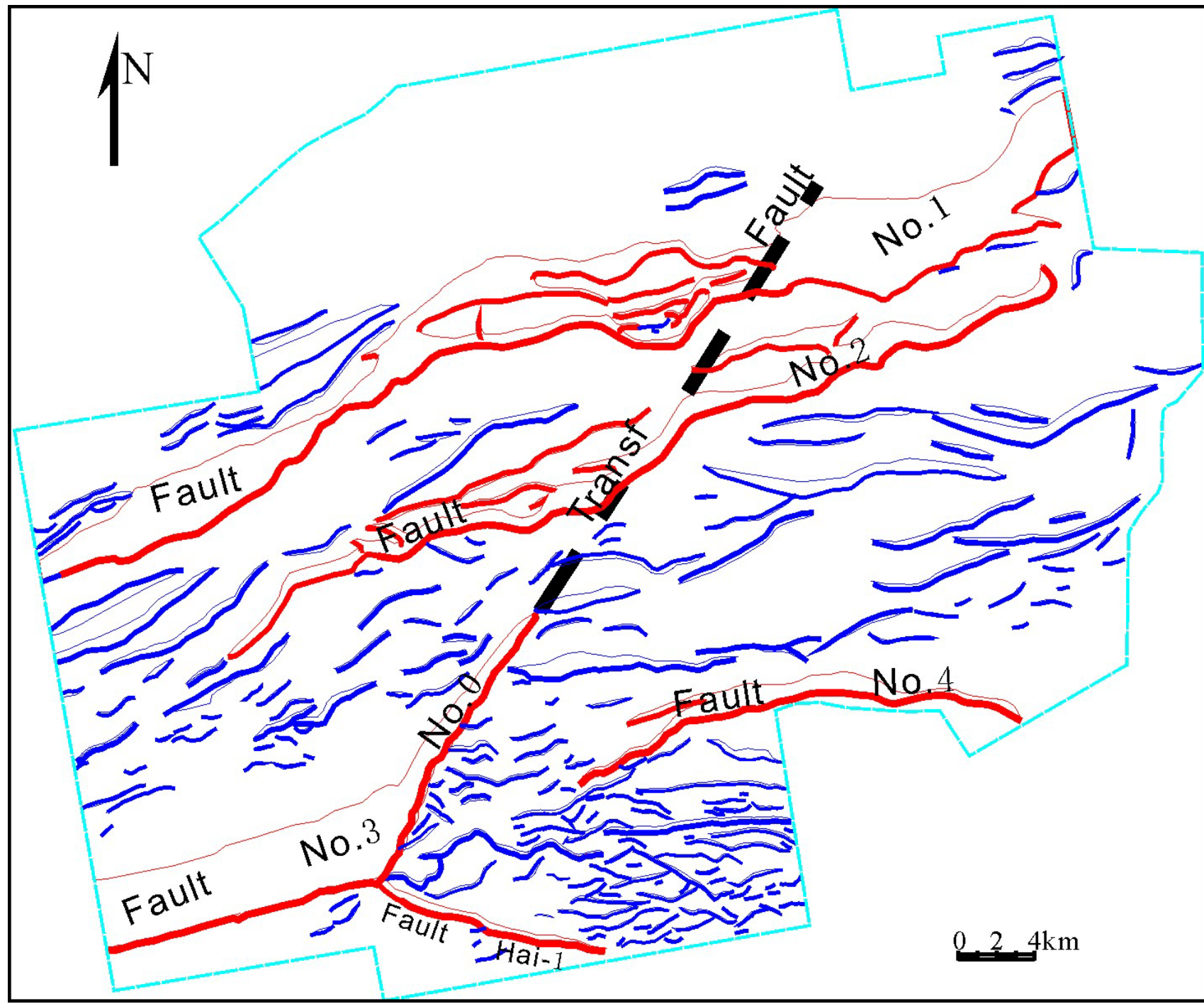


Fig. 3 Fault distribution map at the bottom of Changliu Formation in the Weixinan Sag from 3-D seismic data interpretation

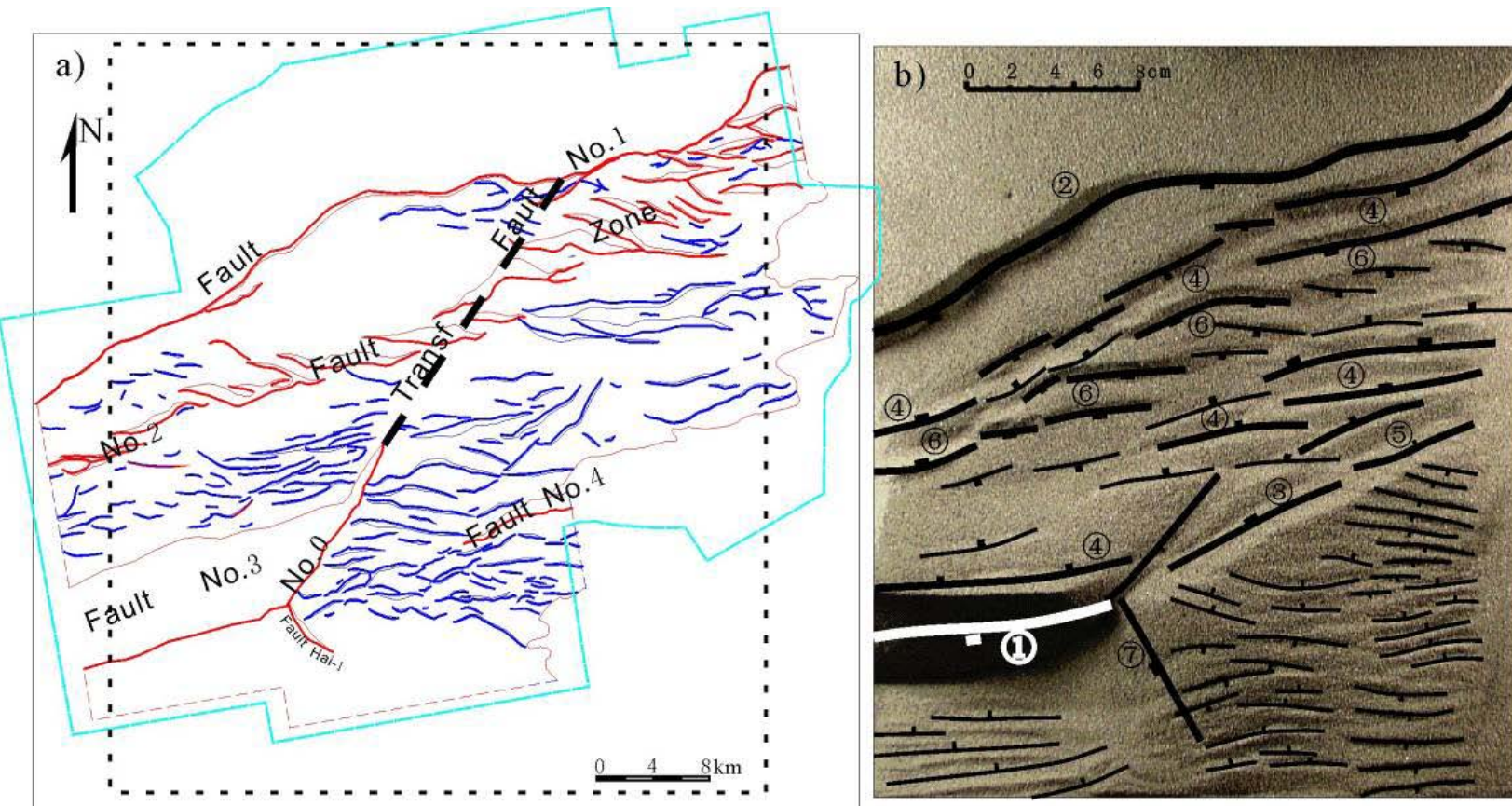


Fig. 4 Comparison between the 3-D seismic data interpretation and sandbox modeling results. (a) Fault system distribution at the bottom of first member of Liushagang Formation from 3-D seismic data interpretation, where the rectangular box (inside the dotted line) is the modeling region; (b) Plan view of sandbox modeling results and interpretation (the number is fault formation order)

2 Sandbox modeling of second phase extension

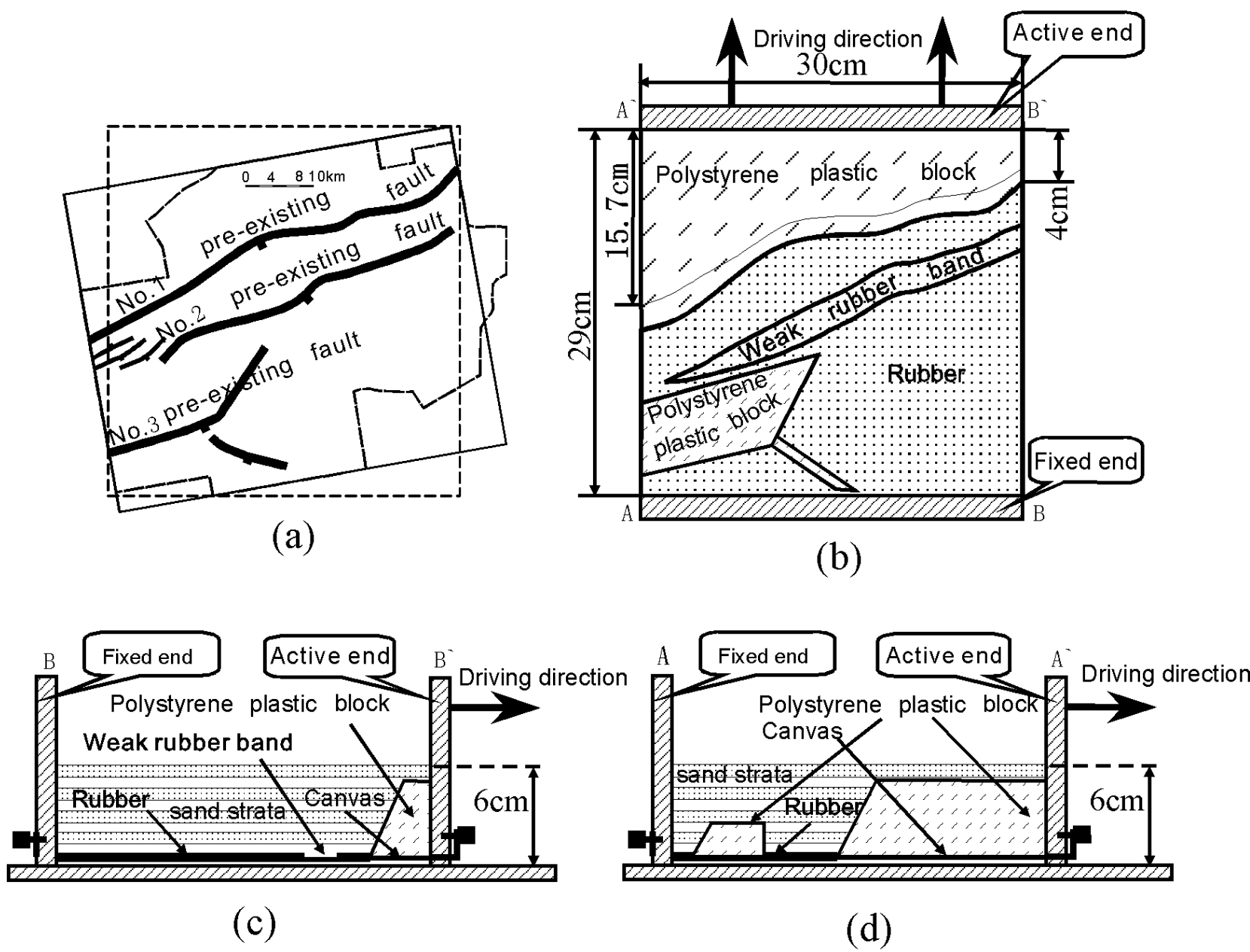
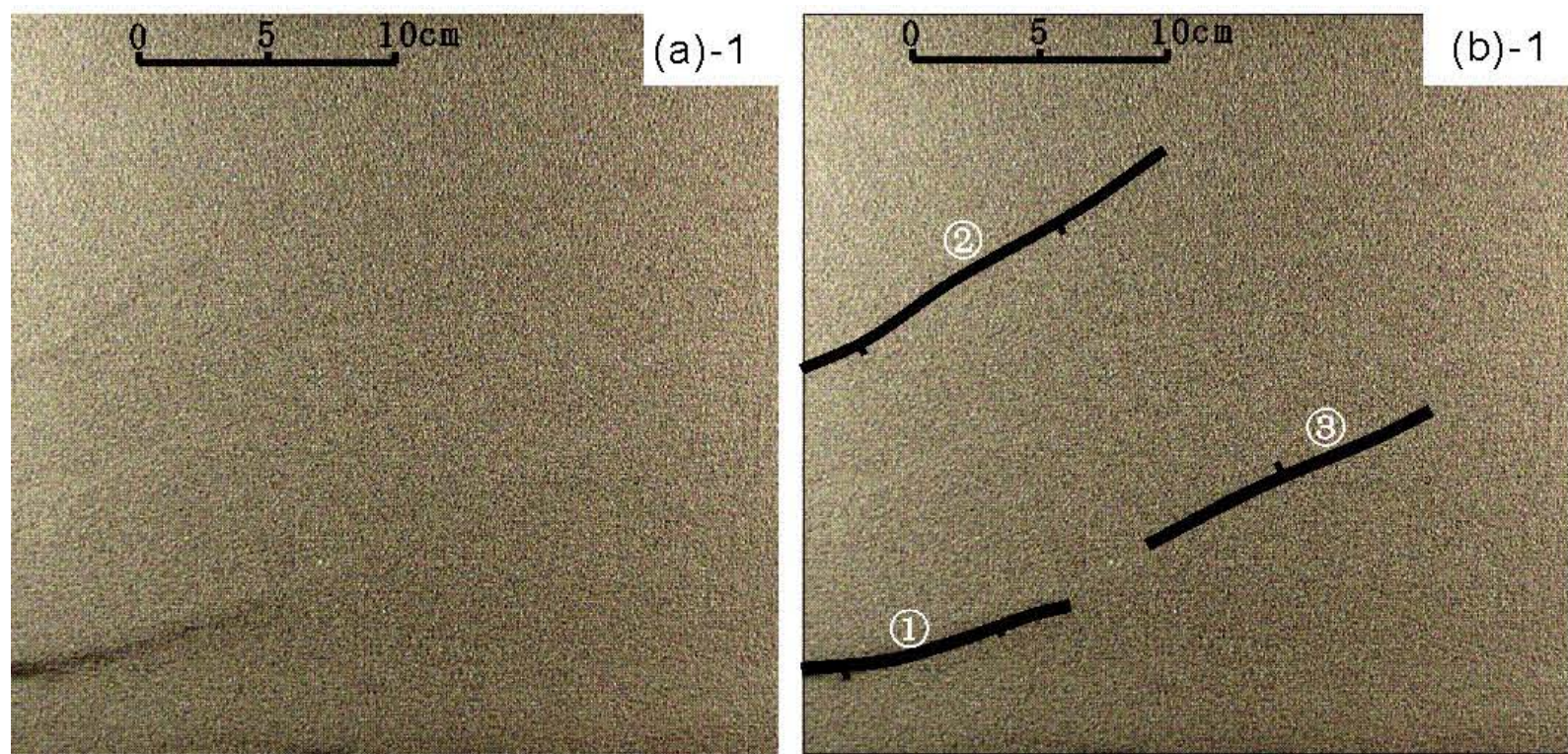
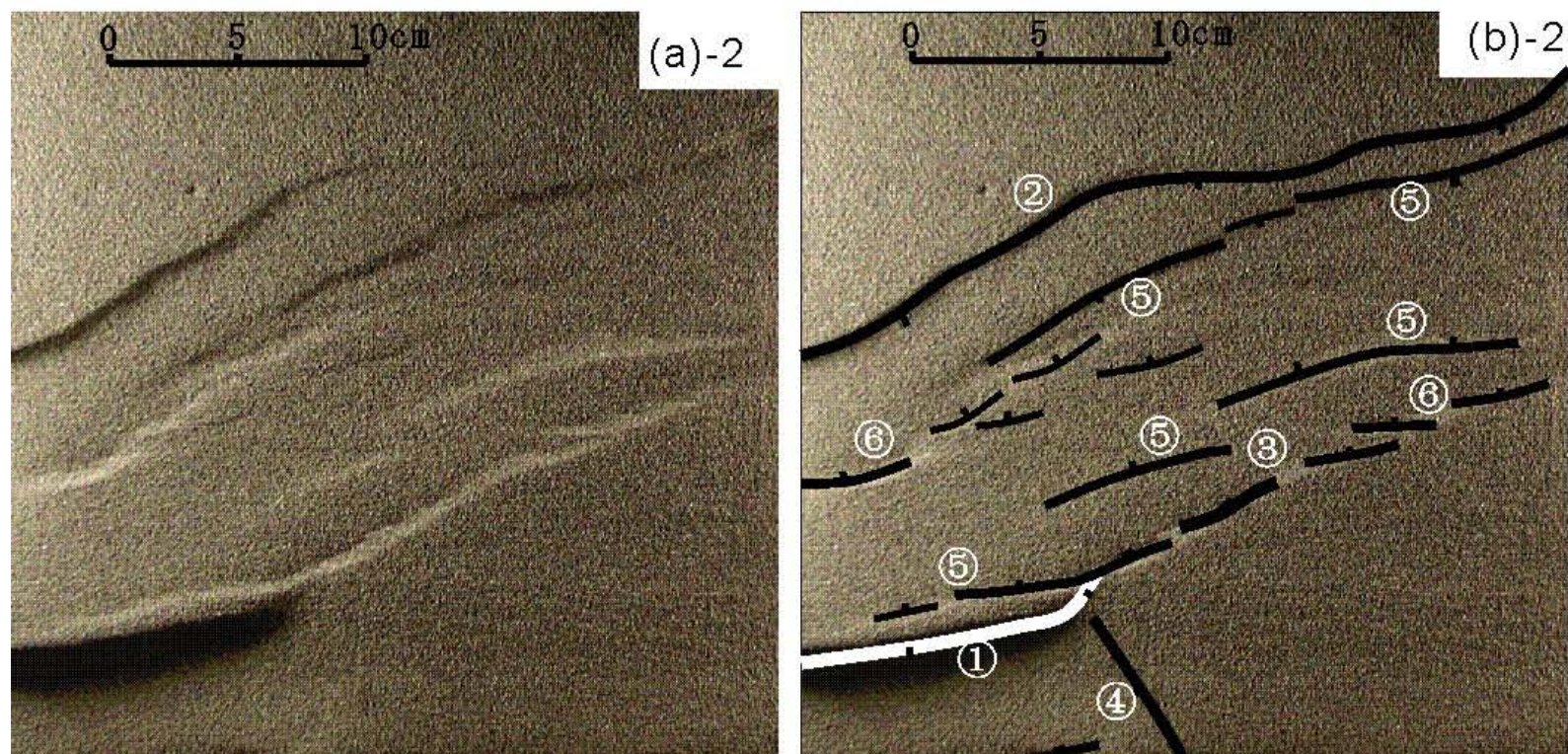


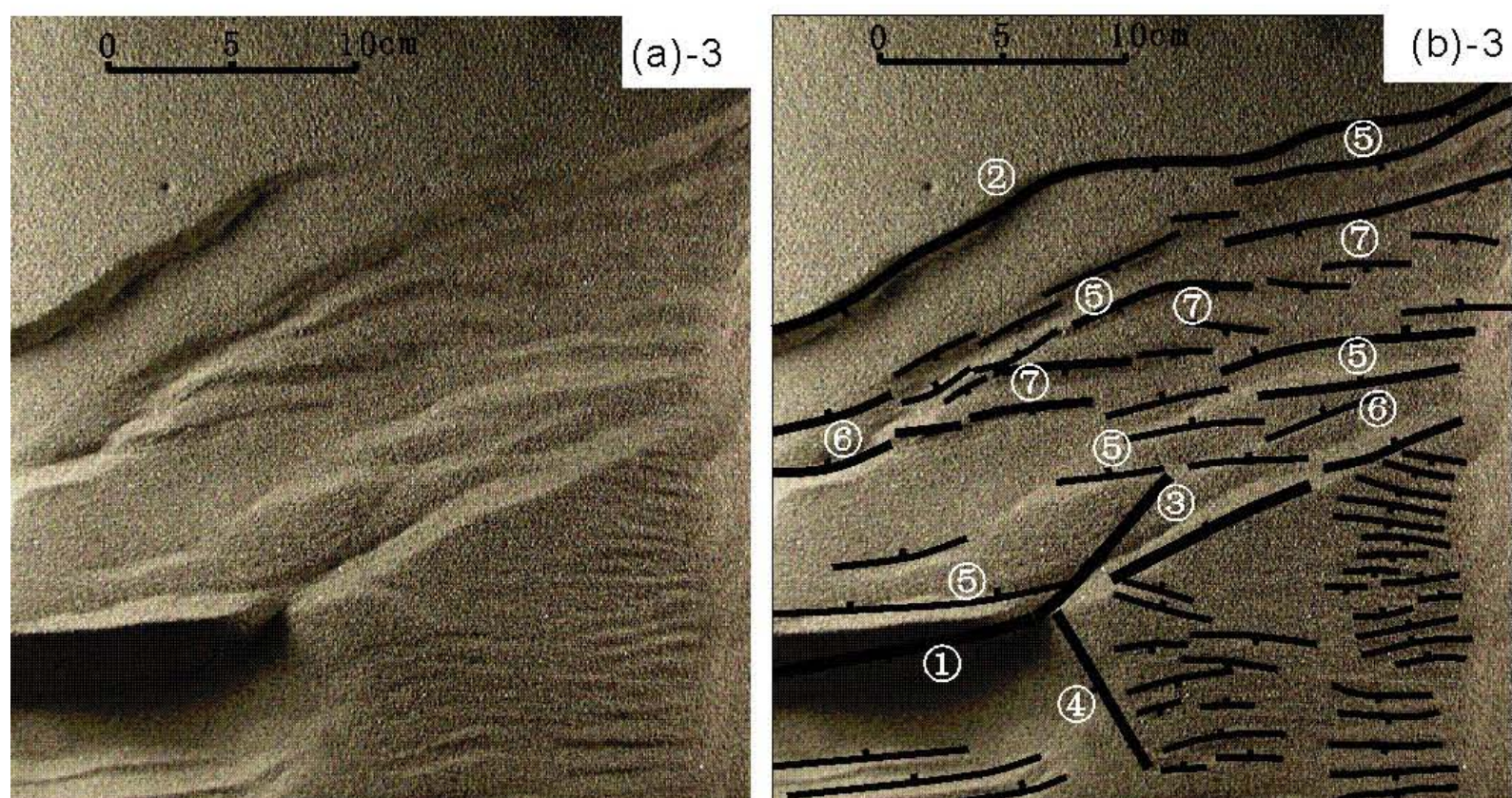
Fig. 5 Experimental model of Weixinan sandbox modeling. (a) Location of pre-existing faults after balanced restoration; (b) Plan view; (c) A-A section view; (d) B-B section view, section location seen in (b)



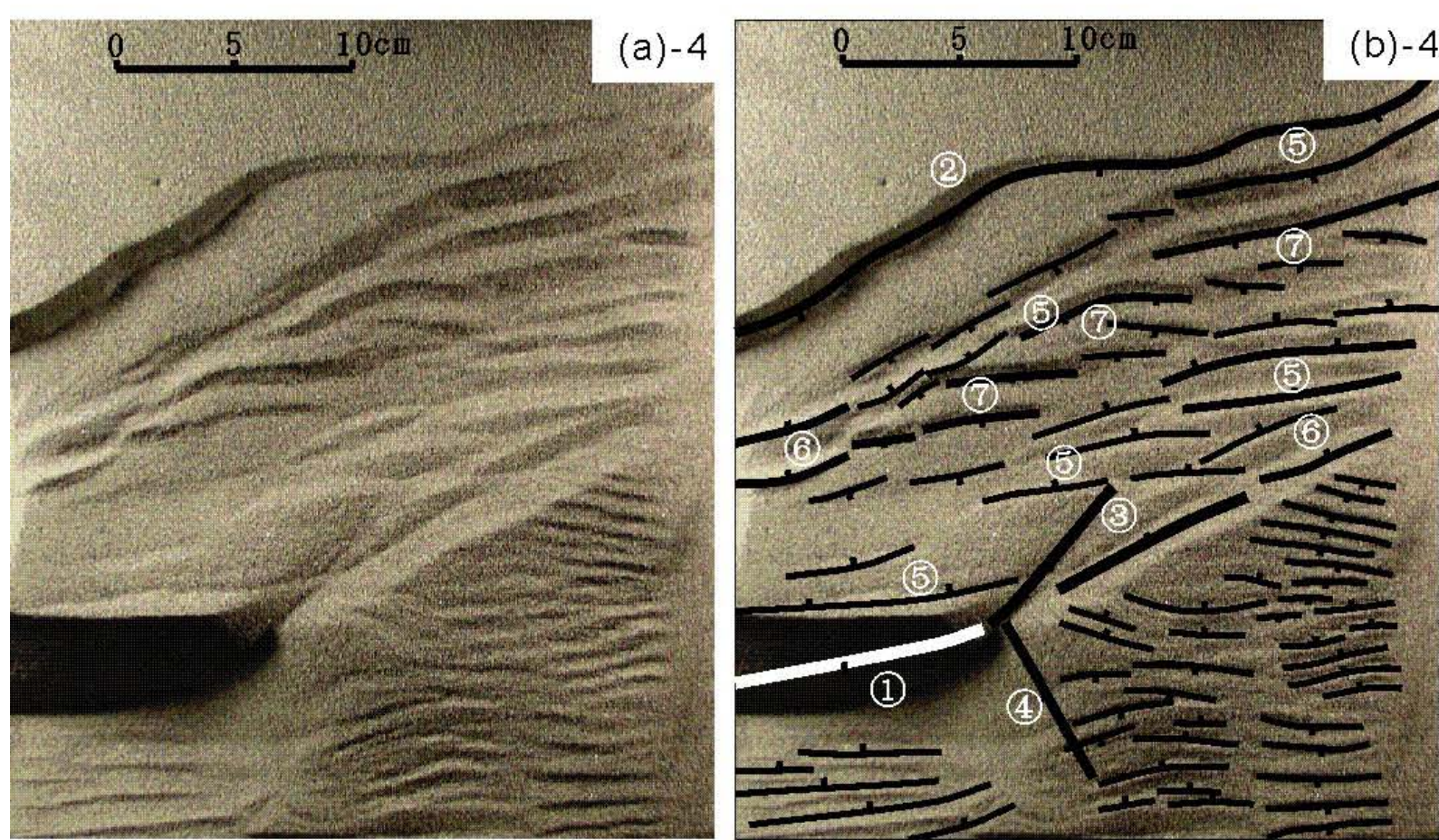
(1) Stage 1 :deformation result
Where extension displacement d=0.90cm, et=4.63 %
(a)Original photo; (b)interpretation figure, the same in the following



(2) Stage 2 :deformation result
Where extension displacement d=2.08cm, et=10.7 %



(3) Stage 3 :deformation result
Where extension displacement d=4.10cm, et=21.09 %



(4). final Stage : deformation result
Where extension displacement d=6.93cm, et=35.65 %

Fig. 6 Results of different deformation stages of sandbox modeling and interpretation (the number is fault formation order). (a): sandbox modeling results; (b): interpretation of sandbox modeling results

3 Origin model of Beibuwan basin and South China Sea

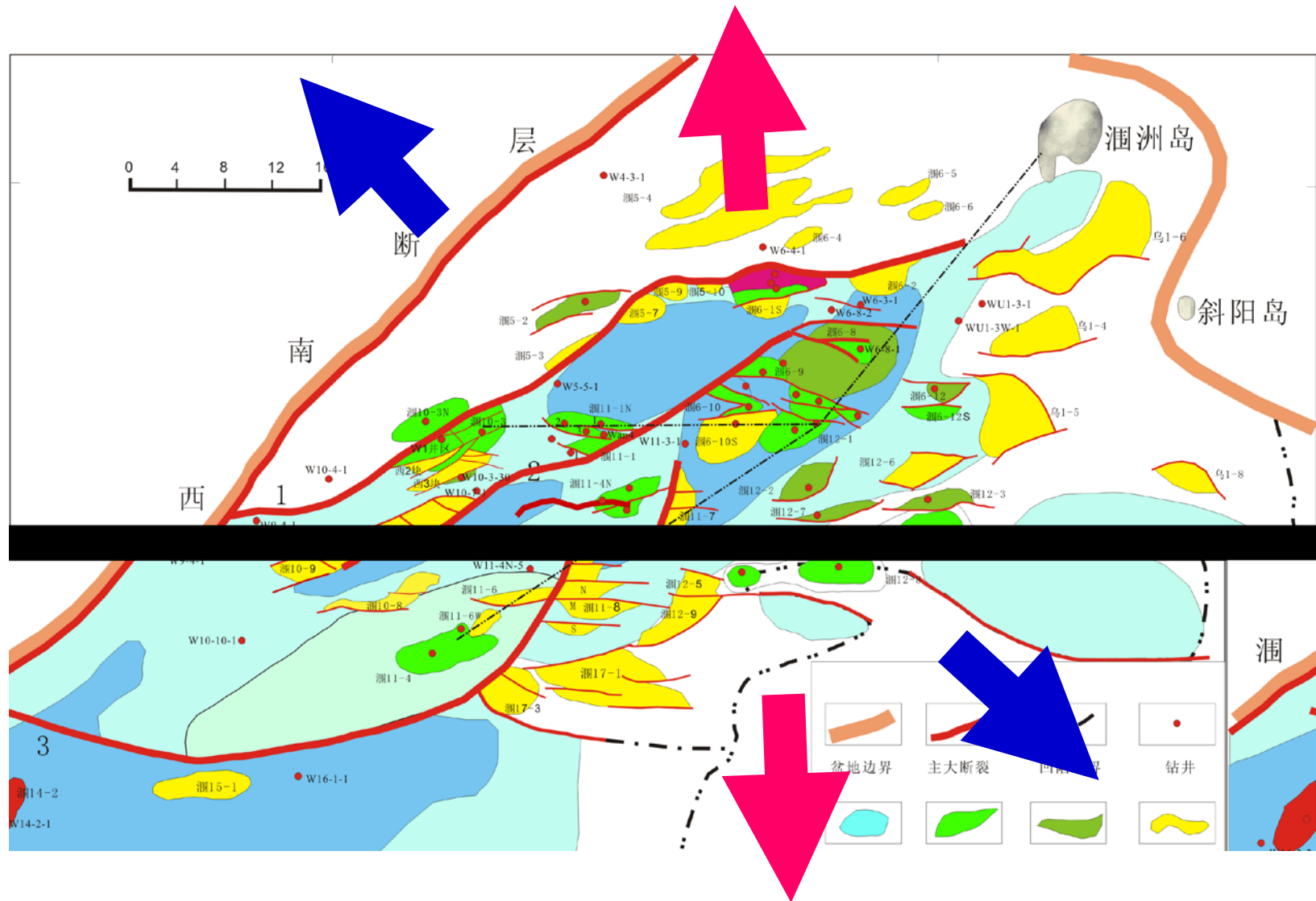


Fig. 7 The origin model of Beibuwan basin.
Blue arrow shows the extension direction of the first rifting stage; red arrow shows the extension direction of the second rifting stage

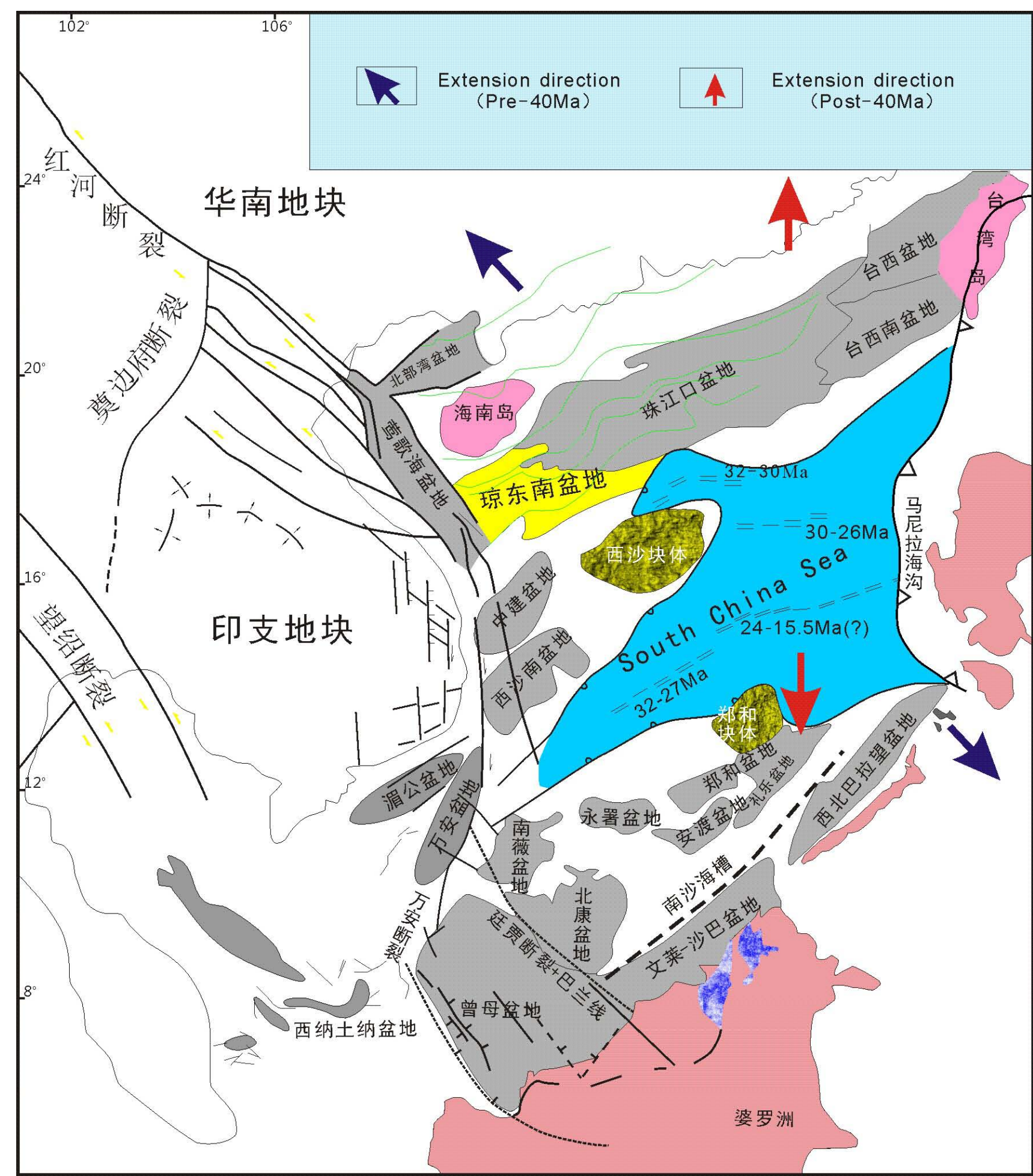


Fig. 8 The origin model of South China Sea and surrounding area.
During E_{1ch} - E_{2f} (65-38Ma), it is a continental rifting stage (first extension phase), South China Sea has not formed. South China Sea is a result of N-S direction extension. Blue arrow shows the extension direction of the first rifting stage; red arrow shows the extension direction of the second rifting stage

4 Reference

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If there is any question, please contact me with Email

(Can not attend the conference)