Study on the controlling effect of Nanpu No. 2 Fault growth connection on buried hill evolution

Qing Zhang [1], WeiSong Peng [2]

[1].Northeast Petroleum University Geoscience Institute, Daqing 163318, Heilongjiang Province, China
[2].Research Institute of Exploration and Development, Jidong Oilfield Company, Petrochina, Baoding 063000, China

Abstract. Nanpu fault 2 has an important control action of buried hill, in order to study the growth of Nanpu fault 2 connection process and Nanpu no. 2 the control function of buried hill through the application of slip - distance curve and slip back stripping method to study the growth of the Nanpu fault 2 connection process, and the use of equilibrium profile to analyze its effect on the tectonic evolution of the buried hill. The results show that the Nanpu No. 2 fault is characterized by segmentalized growth, caledonian quiet structure, and widely distributed carbonate deposits. After the middle-late Caledonian uplift, the strata suffered from denudation. Strong folding occurred in The Indochinese period, and in the Himalayan Period, the Nanpu no. 2 fault was weakly active in the Shahejie sedimentary period and developed only in the north, forming the prototype of buried hill at this time. During the sedimentary period of Dongying Formation, the structure reversed slightly, which is also known as the Dongying Movement. At this time, fault no. 2 strongly extended southward, and buried-hill was formed and basically formed. The research results have certain reference value for oil and gas exploration in Nanpu sag.

Key Words: Nanpu No. 2 fault; Buried hill; Fault growth; Fault connection.

1. Introduction

As for the growth connection of faults, Segall proposed the concept of segmented growth of faults when studying discontinuous faults [1]. Peacock divides the fault from isolation to complete rupture of the transition zone into three stages [2], namely the isolation fault stage, the "soft connection" stage, and the "hard" connection stage. Childs believed that the relatively low value area on the distance-distance curve was the connection part of fracture growth, namely the transition zone [3].S.-S.Xu studies the growth connection of faults through the ratio of average displacement to maximum displacement of faults [4].Darko Spahic identified fault growth connections using high-resolution 3D seismic data [5].In recent years, many scholars believe that boundary faults are formed by the interaction between multiple fault segments that existed in the early stage and eventually connected in the segmented growth process, and put forward a growth model [6].

2. Formation characteristics

The overlying strata of buried hill in Nanpu depression are Mesozoic, Shahejie formation, Dongying Formation, Guantao Formation and Minghuazhen Formation.

The buried hills in Nanpu Depression are located in Paleozoic strata, which are composed of Cambrian Fujunshan Formation, Mantou Formation, Zhangxia Formation, Gushan Formation, Fengshan-Changshan Formation, Ordovician Yeli Formation, Liangjiashan Formation and Majiagou Formation from bottom to top (Table 1).

https://doi.org/10.1051/e3sconf/202235203028

Table 1. Comprehensive columnar table of Paleozoic strata in Nanpu Depression

Structural layer (Grade I and II)		Sub-structural layer (Grade 3)	Contact relationship Tectonic movement	basin prototype	Structural characteristics and stratum preservation in Nanpu Depression
Cap layer structural layer	Neogene - quaternary structural layer	N-Q	Angular unconformity	Post-intracontinental extensional depression basin	The whole settlement
	Paleogene structural layer	E	Himalayan movement Angular unconformity	Intracontinental extensional faulted basin	Fault block movement, differential settlement, cut barrier fault block
	Middle and lower Jurassic - Cretaceous structural layer	K_2	Late Yanshanian Movement Angular unconformity	Post-intracontinental extensional depression basin	denudation
		J_3-K_1	Late Yanshanian movement Angular unconformity	Intracontinental extensional depression	Fault block activity, differential subsidence, local denudation
		J_{1-2}	Middle Yanshan Movement Angular unconformity	It may be intracontinental depression or extensional fault depression	
	Middle late Proterozoic - Triassic structural layer	C_2-T	Indosinian movement Parallel unconformity	Marine - continental transitional facies - continental craton basin	Local erosion
		∈-O_2	Caledonian movement Parallel unconformity	Marine craton basin	Local erosion
		Pt_{2-3}	Jixian movement Angular unconformity	Chasmic trough	
Base layer	Early proterozoic structural layer	Pt_1	Luliang movement Angular unconformity		
	Archaean structural layer	Ar	Five movement		

3. Geometric characteristics of No. 2 fault

Nanpu fault is located in the southwest of the Nanpu sag of bohai bay, 2 for the NE, tendency for the NW, Nanpu extension length of 18 km, 2 biggest fault throw 1100 m, is a normal fault, for III level faults in this area, also is the main control Nanpu no. 2 of the buried hill a fault, broken up into the paleogene system in central, broken down into the basement, It shows that the fault is a long-term active fault, with large fault distance at the bottom and small fault distance at the top. It is a inherited fault. From the perspective of strike, the section is relatively straight. Faults control the sedimentary and tectonic evolution of Cenozoic strata (FIG. 1).

The southern part of Nanpu no. 2 fault has a Three-Dimensional inclination of NW with a dip Angle of about 55°. The fault did not develop in minghuazhen formation and Guantao Formation, but developed strongly in Dongying Period. The fault style of Dongying Formation is shovel type. The maximum fault distance is about 700m, and the fault is most developed in dongying Formation. The Nanpu no. 2 fault has a NE strike in the middle and a NW dip in the 3D seismic profile with a dip Angle of about 60°. Nanpu no. 2 fault is well developed in the minghuazhen and Guantao formations in the middle, and relatively well developed in the Dongying Formation. The fault pattern of Dongying Formation is shovel-type, and the stratum of the second member of Dongying Formation is denuded strongly. Faults in Shahejie Formation are also well developed, and the fault profile is shovel-type. The second Member of Shahejie formation is absent and faults are most developed in the central Dongying Formation.

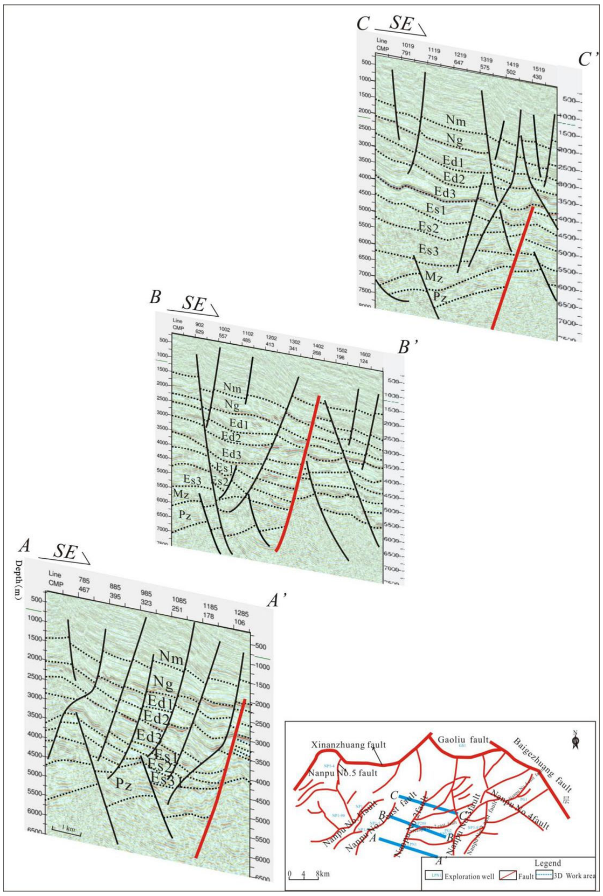

Fig.1 Joint section of Nanpu No.2 fault

The northern Nanpu No. 2 fault has a NE strike and a NW dip Angle of about 40° in the seismic profile. In minghuazhen formation and Guantao Formation, the Nanpu No. 2 fault was sheared by the overlying fault with NE tendency during the eastern second member, which prevented its growth. The faults developed in shahejie period, and the fault profiles were shovel-shaped and seat-shaped. The shovel-shaped faults developed for a long time, while the seat-shaped faults developed for a short time. The second member of Shahejie formation is absent and faults are developed in Paleozoic.

4. Fault growth connection

The nucleation point is located at the maximum fault distance. After the restoration of Minghua Town and Guantao period, the eastern member has the largest fault distance of about 120m in the middle of the fault. After the restoration of the eastern first section, the maximum fault distance in the eastern third section is about 450m. After the restoration of Dongying Period, the maximum fault distance of Shahejie is about 150m, and the fault is well developed in the middle. After the restoration of Shahejie, the northern distance of the Mesozoic top fault is about 50m, and no fault is developed in the southern part of the fault during this period. It can be seen that the activity of Nanpu No. 2 fault was weak in shahejie period, with segmentalized growth characteristics, which was formed by the segmentalized growth connection of two NE trending small faults. In the sedimentary period of Dongying Formation, it strongly expanded southward and was basically formed, and no. 2 buried-hill was formed in this period (FIG. 2, 3).

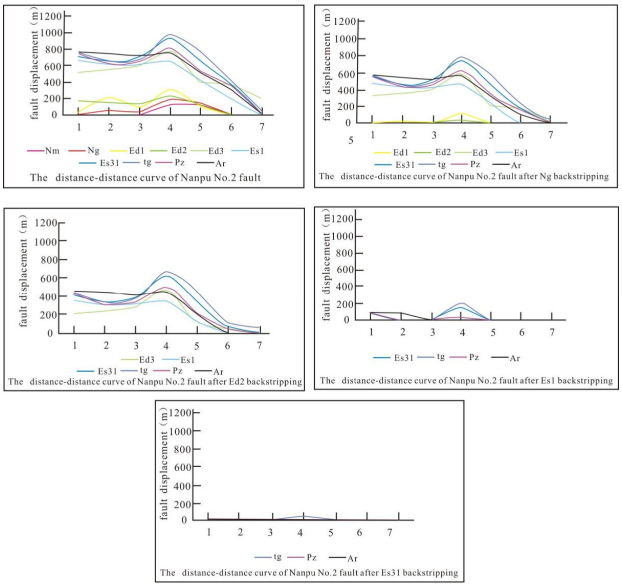

Fig.2 Distance-distance curve and backstripping of Nanpu No.2 fault

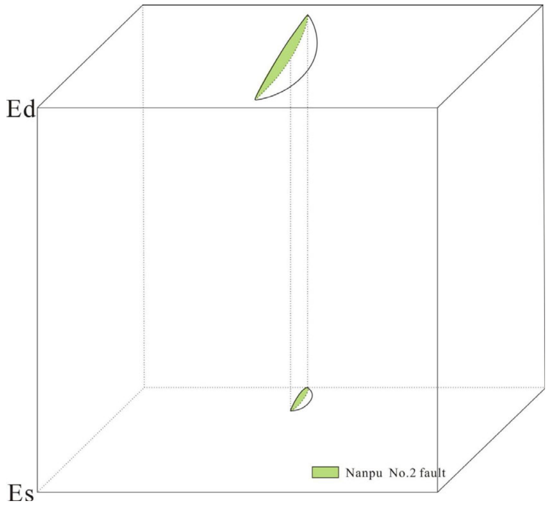

Fig.3 Evolution model diagram of Nanpu No.2 Buried hill

5. Conclusion

Through 3 d seismic analysis, according to the geometry and kinematics characteristics of the fault, the fault activity mechanism, which by slip back stripping method, fault slip - distance curve drawing, effectively restore the evolution process of the growth fault form, which determine the formation period of faults, it is concluded that Nanpu shahejie formation sedimentary period 2 fault activity is weak, only in the north, During the sedimentary period of Dongying Formation, the buried-hill Nanpu no.2 was formed. Based on the 3d seismic interpretation of faults, it is speculated that there was strong tectonic movement in Dongying period, which resulted in several nearly EAST-west tensional faults, intense denudation of the third member of the Eastern member and absence of the second member of the Shahejie member.

Acknowledgements

Project source: Horizontal subject: study on hydrocarbon accumulation law of buried hill in Nanpu depression.

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