



3D geometric and kinematics characteristics of a segmented normal fault zone: A case study from the Gaoqing-Pingnan fault zone of western Dongying depression, Bohai bay basin, China

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Gaoqing-pingnan fault zone characterized as “S” plane shape is the boundary of western Dongying depression. The western Dongying depression includes two secondary negative tectonic units: Huagou and Boxing sub-depression. The study area underwent several phases of extension in the early Cenozoic, but the extensional direction mainly deflects along nearly N-S. According to the changes of the fault strike, Gaoqing-pingnan fault zone can be divided into three segments: Huagou (E-W), Pingnan (NNE), and Binnan (NEE). By analysis of 3D seismic interpretation results and geometry model, we find that the attitude and combination type of the three segments are markedly different although they are influenced by the same extension stages. On attitude, Huagou and Binnan segments paralleling to early Cenozoic structural strike of Dongying depression are characterized by slower dip angles, but the Pingnan segment which parallels to strike of Tanlu fault zone is characterized by steeper dip angles. On combination types of faults, Huagou and Binnan segments mainly develop extensional types; Binnan segment not only develop extensional types like formers, but also develop strike-slip types such as half a flower and horsetail faults in vertical profile, feathery and en echelon faults in plane. In order to explain the structural differences, further study on kinematics was done with seismic coherence cube and Strata thickness data of wells. The time slices of coherence cube and seismic sections indicate that nearshore fans which develop in hanging wall of Pingnan segment in the Es_4 - Es_1 migrate along the NW direction. What is more important, Strata isopachous map reveals the same kinematics regularity that the depocenter of Boxing sub-depression also migrate along the NNE direction in Es_4 - Es_1 . In contrast, both of migratory direction of fans and depocenter in Huagou sub-depression are perpendicular to the strike of Huagou segment during Es_4 - Es_1 . In conclusion, the structural evolution of Pingnan segment is controlled by the oblique extension, but the Huagou and Binnan segments are controlled by the perpendicular extension in the early Cenozoic. This study offers a case study on understanding the evolution of a segmented normal fault zone in rift basin of eastern China.