

Cenozoic Evolution of the Chengbei Fault, a Half-Graben Boundary Fault in the Bohai Bay Basin, East China

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The NW-trending Chengbei fault is located in the Bohai Bay basin in east China, and represents the SW-dipping boundary fault of the Chengbei half-graben. The Cenozoic evolution of this fault has important implications for natural resources, specifically because: (1) the fault passes through the mining boundary of CNOOC and SINOPEC; (2) the distribution of major source rocks in the Chengbei half-graben is controlled by the fault activity; and (3) the fault can act as a migration pathway during hydrocarbon expulsion. Here, we conduct a detailed analysis of a large industry dataset of seismic and well data to interpret the tectonic growth and development of this fault system.

Based on ~1,000 km² of 3D seismic data, ~10,000 km of 2D seismic data, and 17 exploratory wells collected by CNOOC and SINOPEC, we interpret six interfaces in the Cenozoic strata. By analysing fault-parallel seismic sections, isopach maps of different sections, throw-distance plots and back-stripping, we define three stages of fault evolution in the Cenozoic: (1) the Paleocene to early Eocene (c. 65 to 42 Ma); (2) the late Eocene to Oligocene (c. 42 to 23 Ma); and (3) the Neogene to present (c. 23 to 0 Ma).

In the first stage, the Chengbei fault was composed of four roughly NW-SE striking fault segments. Two of these faults were soft-linked by an unbreached relay zone, while the other two were hard-linked. Three transverse anticlines formed, corresponding to the fault linkage points, with axes perpendicular to the Chengbei fault. Strata onlaps indicate that three of the four segments experienced growth in the strike direction during this stage. Towards the end of this stage, the two sets of faults linked together.

In the second stage, the fault segments grew mainly in the vertical direction, into the thick strata that were deposited in the half-graben. The southern transverse anticline became inactive, but the middle and northern anticlines continued to grow. At the end of this stage, the two soft-linked faults connected together, and as a result the Chengbei fault became one continuous normal fault with some branches. This was also the end of the rifting stage of the Chengbei half-graben.

In the third stage, the growth of Chengbei fault weakened. Today, the fault is composed of multiple soft-linked NW-SE and E-W striking fault segments. The fault segments in the south are more continuous and active than those in the northern part.

This detailed study of the tectonic evolution of the fault system provides a framework for evaluating the source rock distribution and hydrocarbon migration in the basin.