Structural architecture of Neoproterozoic rifting depression groups in the Tarim Basin and their formation dynamics

Bizhu He[1], Cunli Jiaot[2],Taizhu huang[3], Xingui Zhou[4], Zhihui Cai1, Zicheng Cao3, Zhongzheng Jiang3, Junwen Cui1, Zhuoyin Yu1, Weiwei Chen1, Ruohang Liu1, Xiaorui Yun1&Guangming Hao1

[1]Institute of Geology, Chinese Academy of Geological Sciences, Beijing 100037, China, hebizhu@cags.ac
[2]Exploration and Production Research Institute of SINOPEC, Beijing 100083, China
[3]Institute of Northwestern Petroleum Subsidiary of SINOPEC, Urumqi 830011, China
[4]Oil and Gas Investigation Centre of China Geological Survey, Beijing 100029, China

The Tarim Basin is the largest oil-bearing superimposed basin in northwestern China. The evolution and tectonic properties of the initial Tarim Basin have been hotly disputed and remain enigmatic. The Neoproterozoic basin is covered by a vast desert, and a huge thickness of sedimentary strata has experienced multiple tectonic movements and has low signal- to- noise ratios (SNRs) of seismic reflection data, all of which have posed critical obstacles to research. We analysed four field outcrops, 18 wells distributed throughout the basin, 27 reprocessed seismic reflection profiles with higher SNRs across the basin and many ancillary local 2D and 3D profiles and aeromagnetic data. We found about 20 normal fault-controlled rift-related depressions of Cryogenian and Ediacaran age scattered throughout the basin, which developed on the Precambrian metamorphic and crystalline basement. The structural framework is clearly different from that of the overlying Phanerozoic strata. The rifting depressions consist of mainly half grabens, symmetrical troughs and horst-grabens. From the northeast to southwest of the basin, they are divided into three rifting depression groups with WNW, ENE, and NW-trends that are mainly controlled by normal faults. The maximum thicknesses of the strata are up to 4100 m. From the Cryogenian to Ediacaran, most of the main inherited faults were active and eventually ceased at the end of the Ediacaran or Early Cambrian, whereas subsidence subsidence centres appeared and migrated eastwards along the faults. They revealed that the different parts of the Tarim continental block were in NNE-SSW-oriented and NNW-SSE-oriented extensional paleo-stress fields (relative to the present) during the Neoproterozoic, and were accompanied by clockwise shearing. According to the analysis of the activities of syn-sedimentary faults, filling sediments, magmatic events, and coordination with aeromagnetic anomalies, the tectonic properties of the fault depressions are different and reflect primarily continental rifts or intra-continental fault-controlled basins. The rifting phases mainly occurred from 0.8–0.61 Ga. The formation of the rifting depression was associated with the initial opening of the South Altun-West Kunlun Ocean and the South Tianshan Ocean, which were located at the northern and southern margins of the Tarim Block, respectively, in response to the break-up of the supercontinent Rodinia and the initial opening of the Proto-Tethys Ocean.

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