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Late Quaternary slip rates and paleoearthquakes along the Yabrai range-front fault in the southern Gobi-Alashan block

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Study on the active faults of the southern Gobi-Alashan block is significant to understand the tectonic deformation processes associated with the Tibetan Plateau and Ordos block. With this knowledge in mind, the present study aims to answer what the major process is governing the tectonic deformation and the structural relationships between Gobi-Alashan and adjacent regions. Since this area was featured by late Quaternary active tectonics, the activities and paleoearthquakes around the block need be studied and reconciled. So, we will focus on one of those active structures, the ranger-front fault along Yabrai Shan, to address some basic problems.

Three aspects are analyzed, i.e., geomorphology, kinematic characteristics and paleoearthquakes of the range-front fault along the Yabrai Shan. By combining previous studies and Differential GPS measurements, implications of the fault for the regional tectonics has been discussed. The main conclusions are summarized as follows:

This fault consists of three segments. The most active segment is in the southwest. The southwest segment is about 35 km long. Its scarp, about 1-2 m high, might be the result of the most recent event (MRE) and stretches NE60° almost the full segment. Existence of free surface indicates that the elapsed time of the last event must be not long. The middle segment is about 31 km in length. Just a single fault plane was identified along the main bounds of the Yabrai Shan, but the fault consists of several splays in the north. In contrast to the simple geometric structure of the middle segment, the northeast segment comprises several faults. Scarps of the most recent earthquake event are clear but tend not to be continued. Field investigation reveals about 0.5-1.5 m up to 2 m height.

This work determined slip rates by combining fault-scarp measurements and cosmogenic exposure age dating. Study on slip rates shows that the Holocene dip-slip rate of the Yabrai fault is 0.11 ± 0.03 mm/a. Scarp vertical heights along the fault show that the middle and north segments have obviously higher displacements than the southwestern segment.

Trenching and field survey along the surface ruptures indicate that there were five strong earthquakes along the range-front fault. The most recent event on the fault was about 1.5 ka ago, and the others were dated the late Pleistocene, i.e., $>$60 ka, $>$50 ka, $\sim$30 ka, $\sim$ 3 ka, respectively, with about 10 ka recurrence interval of major earthquakes.

A previous seismic reflection profile suggests that the Yabrai Shan range-front fault was evolved as a normal fault since Cretaceous before the presence and formation of the Tibetan Plateau. Therefore, this work concluded that the range-front fault of the Yabrai Shan is not resulted from the Indo-Asian collision. It should be studied whether the outward growth of the Tibetan Plateau governs tectonic deformation of the fault today, and which deformation model is suitable for the regions adjacent to Tibet, Ordos and Gobi-Alashan. This study would play a great role for constraining the tectonic evolution of the Tibetan Plateau.