Electrically anisotropic structure of the Annanba-Subei segment along the Altyn Tagh fault: implications for the spatial distribution of damage zones and seismic hazards

Zeyi Dong, Qibin Xiao, Zelin Sun, Ji Tang, Bing Han and Lifeng Wang

State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration,
dongzeyi@ies.ac.cn

SUMMARY

Damage zones are volumes of deformed wall-rocks around faults that result from the initiation, propagation, interaction and build-up of slip along faults. The existence of damage zones can enhance complex stress distribution along faults and tend to dynamically affect earthquake nucleation and rupture propagation. Therefore, an understanding of the spatial distribution and geometric characterization of fault damage zones can help to reveal fault growth processes, provide clues about locations of future earthquakes, and improve earthquake probabilistic hazard assessment. Previous studies of fault damage zones were mainly based on direct field observations, which provided limited knowledge of the 3-D distribution of damage zones, especially their subsurface structure, because faults are rarely completely exposed in 3-D. Fault damage zones may extend for kilometers and exhibit structural anisotropy, which potentially causes electrical anisotropy in rocks. It appears that electrically anisotropic structure provides a new means to characterize fault damage zones.

The Altyn Tagh fault (ATF), defining the northern boundary of the Tibetan Plateau, is the largest active left-lateral strike-slip fault in Asia, with a total length of ~2000 km. The Annanba-Subei segment, located at the eastern part of the ATF, is a strong seismic gap with a risk of Mw 7+ earthquakes, and revealing the fault zone architecture is of great significance for the prediction and mitigation of seismic hazard risk in this region. We investigate the 3-D electrically anisotropic structure of the Annanba-Subei segment along the ATF based on collected magnetotelluric data. Our 3-D electrical resistivity model reveals that the widths of the anisotropic anomalies in the horizontal direction gradually widen along the fault from west to east, while they gradually narrow vertically, which indicates the spatial distribution characteristics of fault damage zones. Combining the fault's geometric and kinematic information and historical earthquakes, we predicate the likely locations of future strong earthquakes.

Keywords: Altyn Tagh fault, Damage zones, Magnetotelluric, 3-D electrically anisotropic structure, Seismic hazards