A Magnetotelluric Study of the Altyn-Tagh Fault in the North Margin of the Tibetan Plateau

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The on-going continent-continent collision between the Indian and Eurasian plates has created the spectacular topography of the Tibetan plateau. The tectonic processes that occurred during this collision process are still not fully understood and different tectonic models have been proposed. Horizontal motions are clearly important, as evidenced by the major strike faults that characterize the Northern and Eastern parts of the Tibetan Plateau. However, the contribution of horizontal motion on these faults to the overall mass balance of the orogen is still not resolved (Yin and Harrison 2000). Another important tectonic process that has been discussed is the possibility of widespread crustal flow, although the spatial extent of this in Northern Tibet is not well defined (Clark and Royden 2000).

The INDEPTH project (InterNational DEep Profiling of Tibet and the Himalaya) has undertaken a series of integrated geological and geophysical studies across the Tibetan Plateau since 1993 (Nelson, et al. 1996). The final stage of the INDEPTH study (INDEPTH-IV) has been focussed on the dynamics of the Northern Tibetan Plateau. As part of this study, a series of magnetotelluric (MT) profiles have been collected across the Altyn Tagh Fault (ATF) in the Qinghai and Gansu provinces (Figure 1). The MT method provides images of subsurface resistivity. This parameter is sensitive to the presence of fluids and temperature and gives important constraints on crustal rheology. MT data has been effectively used in studies of active tectonics, including studies of strike-slip faults (Unsworth and Bedrosian 2004) and the Tibetan Plateau (Bai, et al. 2010, Unsworth, et al. 2005, Wei, et al. 2001). In this paper, we present some preliminary results from the MT data on the ATF-East profile (Figure 2).

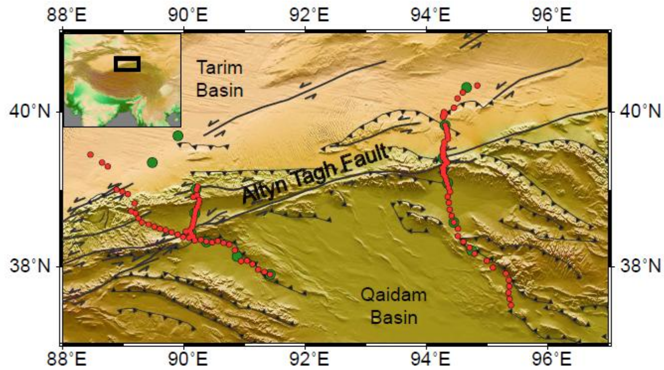

Figure 1. Topography map of the survey area. Red dots are broadband MT stations, and green dots are long-period MT stations.

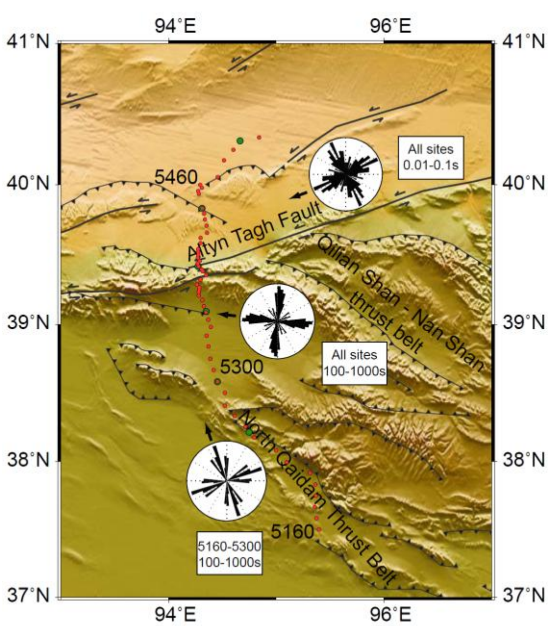

Figure 2. Map of the ATF-East line with rose diagrams showing strike analysis results.

Strike Analysis

The strike direction was determined using the multi-site, multi-frequency tensor decomposition technique of McNeice and Jones (2001). The northern and southern sections of the profile belong to different tectonic domains and have different strike directions. Thus the profile was divided into two sections, and results plotted as rose diagrams in Figure 2. It should be noted that strike directions determined with MT include an inherent 90° ambiguity. Therefore, other geological information is needed to determine the correct strike direction. The rose diagrams show that the strike direction varies with the period of the EM signal. The shallow structure is sampled by the short period band (0.01 – 0.1 s), that gives a strike direction that is parallel to the surface trace of the Altyn Tagh Fault, as shown in the upper rose diagram on Figure 2. As period increases, the depth sampled increases and the strike direction becomes parallel to the thrust faults in the southern part of the profile. Another notable feature is the different long-period strike direction in the northern and southern parts of the profile. The strike direction of the southern part reflects the North Qaidam Thrust Belt (see the lower rose diagram).

Inversion Model

Giving the complicated geometry implied by the strike analysis, the inversions were focussed on the northern section of the profile. The MT data was rotated to a strike direction of N60°E and inverted with the algorithm of Rodi and Mackie (2001). As shown in Figure 3, conductive anomalies were found directly below the surface trace of the Altyn Tagh Fault. A conductive feature under the Qaidam basin was also detected in the inversion model. This is likely due to fluids in the fractured zone as the moving block of the Tibetan Plateau meets the stable block of Tarim Basin in the North. This large conductor may connect with the conductive layer already known to be widespread in the Tibetan crust. No major feature extending through the entire lithosphere is observed in this model, which implies that the Altyn Tagh Fault is relatively shallow feature at this location. This feature suggest that the eastern segment of the Altyn Tagh Fault is a crustal-scale structure, as suggested by Burchfiel et al., (1989).

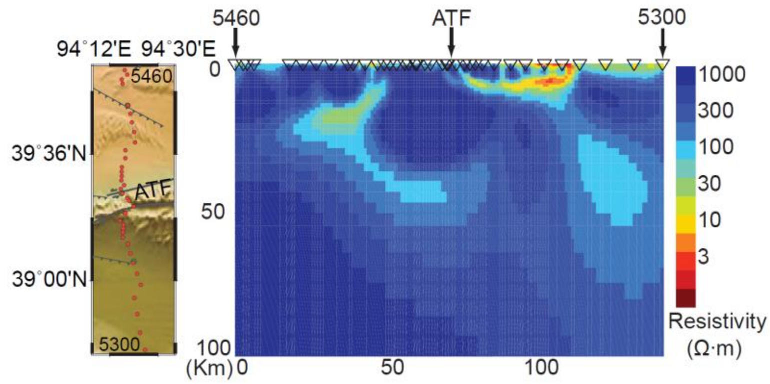

Figure 3. A comparison of the inversion model with the surface topography and geological structures along the northern section of ATF-East profile.

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