Bends on Continental Transforms and the North Anatolian Fault in the Marmara Sea

Nano Seeber and Cecilia McHugh, Lamont-Doherty Earth Observatory, Palisades NY
Marie-Helene Cormier, University of Missouri, Columbia, MO
Omer Emre, Directorate of Mineral Research and Exploration (MTA), Ankara
Chris Sorlien, Institute for Crustal Studies, University of California, Santa Barbara, CA

Several of the larger basins along the North Anatolian fault (NAF) in northwest Turkey share striking features. They are narrow triangular half grabens bordered along one of the long flanks by one of the segments of the NAF. Subsidence is asymmetric both across and along the basins so that tilting is oblique, toward the border faults and toward the apexes of the triangles where subsidence is fastest. The border faults dip toward the basins and accommodate oblique slip with a maximum dip to strike ratio at the apex. All these apexes are situated at prominent bends of the transform, with the basins developed on the extensional side of the bends. Prominent examples are the Tekirdag, Cinarcik, and Duzce basins. The horizontal to vertical motion ratios at the apexes of these basins are 0.1-0.2 (long term) based on the overall geometry of the Tekirdag Basin; 0.3-0.4 based on Holocene subsidence and current geodetic dextral motion at the Cinarcik Basin; and 0.8-1,0 for the 1999 rupture of the Duzce segment. In all 3 border faults the vertical components seem to vanish before the topographic end of the basins. Another important asymmetry in the system is the behavior of the opposite walls across the fault at the bends. In general, a change in strike along a transcurrent fault requires off-fault deformation, but not necessarily on both sides of the fault. In the three examples along the NAF, vertical deformation is largely confined to the hangingwall side of the faults. The behavior of these non-vertical transcurrent faults is thus similar to dip-slip faults where slip over vertical bumps and fault growth result in deformation only above the fault. Having no deformation in the footwall implies that the shape of the fault is fixed to that side. This behavior is manifested by the pattern of growth of the triangular transform basins. The basins develop on the hangingwall side, but are growing in response to the bends, which are fixed to the opposite sides. Thus the pattern of vertical motion that creates the basins is fixed to the inactive opposite sides of the fault and moves upstream at the dextral speed of the fault on the side where it is active. This accounts for the subsidence being fastest not only at the narrowest, but also the youngest end of the basins. Away from the bend, more subsidence has had time to accumulate and basement depth increases while subsidence rate decreases as the effect of the bend wanes. The Tekirdag basin is on the north side of the Ganos bend of the NAF while the Cinarcik basin is on the south side of the Tuzla bend. These bends are fixed on the Anatolian and Asian sides of the fault, respectively, thus they are moving apart at the plate speed lengthening the Marmara Sea. We present a simple Marmara Basins evolution model based on our concepts of how basins develop downstream of bends on the master transform fault and on published bathymetry and subsurface data (Rangin et al., 2002; Okay et al., 2000; Polonia et al., 2002). This model lets the Anatolia rigid block south of the northern branch translate (28km) and rotate CCW (2.4°). The deformation zone broadens in the Marmara sea area to include three separate domains decoupled from both plates: The Cinarcik-Imrali pair of extensional basins, the Central Marmara High zone of

compression and left shear to account for the Istanbul bend on the NAF, and a zone of clochwise rotating blocks between Tekirdag and Central basins. These internal domains involve multiple faults and/or rotations that absorb some of the dextral strain from the Northern branch of the NAF and segment the fault.

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