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Seismic structure from sea-bottom to mantle top of the North Anatolian fault in the Sea of Marmara (NW Turkey)

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New constraints on the deep structure in the North Marmara Trough (NMT) have been investigated during the Seismarmara-Leg1 survey. This survey consisted of a grid of MCS marine deep-penetration multichannel reflection profiles, in addition to coincident reversed and overlapping refraction profiles sounding with the same source recorded on OBS, Ocean Bottom Seismometers and on land stations (Laigle et al., EPSL, 2008, Bécel et al., Tectonoph. 2009 and in press).

Results illustrate a complex partitioned motion of the North Anatolian Fault localized on active faults with diverse natures and orientations. MCS sections crossing the Cinarcik and Imrali basins in the eastern half of the NMT, reveal several active faults that involve the basement and have changing strike and proportions of normal and strike-slip displacement. They might be viewed as petals of a large scale negative flower-structure that spreads over a width of 30 km at surface and is rooted in the deeper lithosphere. Under the Central Basin, a very deep sediment infill is revealed and its extensional bounding faults are active and imaged down to 6 km depth. We interpret them as two deep-rooted faults encompassing a foundering basement block. The segment between the deep eastern basins and the Central Basin contains also a tilted basement block, with the subdued Kumburgaz marine basin in its hanging wall and a sediment-filled one on top of its southward tilted footwall. The width of the NMT, and the sizes of the tilted blocks it contains and basins they control, vary along it. Nevertheless a similar process prevailed: a deformation partitioned over more than one or even two faults across the NMT that may have changed activity with time at places.

For the deeper structure, with the strong seismic source recorded up to 200 km offset, the Moho boundary is positively identified from reversed observations at large offset by land stations, as well as at several OBS. A significant and sharp reduction in its depth occurs from both the eastern and western rims into the North Marmara Trough, with the crustal thinning from the south appearing as more progressive. The wide-angle reflections on OBS and land stations as well as MCS profiles document a lower crustal reflective layer, which appears to follow Moho topography. Furthermore, MCS profiles along and across the southwestern margin of the NMT document a dipping reflector through the upper crust with tilted basement blocks on top, that is suggested as a normal sense detachment extending in depth towards the reflective lower crust. The upwarp of the Moho and lower crustal layer towards the NMT suggests that crustal thinning occurs mostly in the upper crustal part, with lateral transport of the material towards WSW in the footwall of the detachment, and possibly other features to the south, in the motion of Anatolia with respect to stable Eurasia oblique to the North Marmara Trough. Layer thinning can be accommodated in an asymmetric partitioning of the displacement on several branching faults at lithospheric scale. The supracrustal structure is suggested to represent then the overburden deformation induced from horizontal plane simple shear occurring in depth at lithospheric scale, and in front of the North Anatolian Fault when it propagated.