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Stress-induced crustal anisotropy in Marmara region

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In this study we have used the aspect ratio, cross-correlation and systematic analysis of crustal anisotropy methods to analyze shear wave splitting from local earthquakes recorded by 33 TURDEP (Multi-Disciplinary Earthquake Research in High Risk Regions of Turkey) and 35 KOERI (Kandilli Observatory and Earthquake Research Institute) stations in the Marmara region between 2005 and 2011. The main aim of this analysis is to determine shear wave splitting parameters. The observed fast directions of crustal anisotropy generally are not uniform for the whole region. This reflects the direction of maximum horizontal compression (Vsh), suggesting that two major mechanisms of anisotropy in the crust under study area is regional stress. Splitting delay times range from 0.1 to 0.6 s. Variations in fast directions may be interpreted as a result of intensely sheared zones of deformation imposed by strike-slip motion of the northern branches of the North Anatolian Fault. This observation also explain variations in stress changes excited by moderate earthquakes. In addition, we observed clear temporal variations in fast directions or time delays relating to changes in stress before and after the 2006 Manyas earthquake (Mb=5.3).

In addition to shear wave splitting analysis, we have used the ANITA code to investigate 3-D anisotropic P and isotropic S velocity distribution due to P and S travel times from local earthquakes. To measure an orthorhombic anisotropy with one predefined direction oriented vertically, four parameters for each parameterization cell are determined. Three of the parameters describe slowness variations along three horizontal orientations with azimuths of 0, 60, and 120, and one is a perturbation along the vertical axis. Also, simultaneous tomographic inversion for the Vp and Vs anomalies and the Vp/Vs ratio and source locations are done using the LOTOS code. Our results from this study show that the crustal velocity and the uppermost mantle structure beneath Marmara are strongly anisotropic with 5–10% of maximal difference between slow and fast velocity in different directions. Fast velocity exhibit nearly NE-SW orientated in the eastern Marmara. But, we do not see similar pattern in the western and Thrace parts of Marmara region. It is probably caused by regional active stress regime. Furthermore, a large and very intense anomaly in velocity for P and S models are observed respectively.
Our final results indicated that non-uniform fast directions at most stations are related to distribution of the regional stress, suggesting that the anisotropy in the crust is mainly caused by structural fabrics responding to the stress field.