

Crustal stress field formed by plate convergence and topography in northeastern Japan

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We estimated the crustal stress field in northeastern Japan prior to the 2011 Mw9.0 Tohoku-Oki earthquake based on earthquake focal mechanisms determined using seismograms from temporary and permanent seismic networks deployed in this area. Results show that the arc and back-arc are characterized by spatially uniform margin normal compression. However, the fore-arc has different stress orientations. The Kitakami and Abukuma mountain ranges in the north and south have s_1 axis oriented nearly N-S and vertical, respectively, and the region in between without mountain range has a similar stress field to the arc and back-arc. This indicates that the margin normal compression in the arc and back-arc is not caused mainly by the coupling with the Pacific plate but perhaps by the convergence of the Eurasia plate from the back-arc side. Anomalous stress fields in the mountain ranges of the fore-arc are probably due to gravitational force.

Spatially homogeneous margin normal compression is observed throughout the arc and back-arc as already mentioned, but the stress field even in those regions might also be influenced by the topography. Using the distribution of the generalized stress ratio (Simpson, 1997), we found a clear spatial correlation between strike-slip fault stress regime (i.e. higher ν) and high mountain ranges in those regions, which again suggests that the prevailing stress field has been influenced by topographic loading, though the s_1 orientation is constant.