Spatial distribution of stress orientations in Southwestern Japan and its implication for the strength of the median tectonic line

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In Japan, many devastating earthquakes have historically occurred. There exist many active faults which may cause M>7 inland earthquakes in southwestern Japan. The Median Tectonic line (MTL) is one of the most active inland faults. Because of its large length, MTL has the potential to produce a very large earthquake. It is suggested from GPS analyses that steady aseismic slip at depth (>15 km) has continued to load shear stress on the shallower part of the fault plane of the MTL [Tabei et al., 2002]. In this study, we analyzed focal mechanism data to constrain stress and friction parameters of the MTL.
First of all, we determined focal mechanism solutions by using first-motion polarity data picked by Hi-net. We beforehand selected events with more than 15 first-motion polarity data, and searched acceptable nodal planes for each earthquake which can explain more than 90% of the first-motion data. We then omitted poorly-constrained focal mechanism of which RMS of acceptable nodal planes are more than 30°. As a result, we obtained 25,882 focal mechanisms data for the period between 2001 and 2015. This is 10 times as many as those listed in JMA catalogue. We then selected 14,460 focal mechanisms which occurred shallower than the plate boundary.
Next, we applied the stress tensor inversion method to this data set to investigate the detailed distribution of stress orientations. We first applied the stress tensor inversion developed by Michael [1987] to all the data. The estimated orientation of σ1-axis is WNW-ESE and the stress regime is strike-slip. This orientation largely differs from the orientations of the strain-rate and the relative plate movement as shown in previous studies [e.g. Wang, 2000]. One possible explanation is the effect caused by the collision between northeast and southwest Honshu. This stress orientation is unfavorably-oriented [Sibson, 1985] for the activation of the MTL.
Furthermore, we investigated the spatial distribution of stress orientations by using the following three approaches to subdivide the focal mechanisms catalogue: (a) employed a nonhierarchical clustering algorithm K-means,(b) assigned the focal mechanisms to each meshes with a 1.0° spacing, and (c) assigned the nearest 15-30 focal mechanisms to each grid node with a 0.1° spacing. In all cases,σ1-axes were estimated to be E-W in most of regions. However, the σ1-axes oriented NE-SW in the San-in region as shown in Kawanishi et al. [2009] based on the temporary seismic network data. This regions is situated highly strain concentration zone (Nishimura, 2014), and the orientations of stress is similar to that of the strain rate. Also, σ1-axis is oriented NW-SE in northern Shikoku. In this region, seismic activity is seen along the north-dipping MTL [Sato et al., 2015]. The focal mechanisms have a large diversity there. In Kii-Peninsula, the reverse fault stress regime was estimated. This distribution seems to correspond to the surface topography as seen in northeastern Japan [Yoshida et al., 2015]
The σ1-axes estimated along the MTL are oriented E-W, which are unfavorably-oriented for the reactivation on the MTL. We calculated the upper bound of the apparent frictional coefficient of the MTL to become easier to reactivate rather than form a new optimally oriented fault in intact crust. Estimated upper bound of the apparent frictional coefficient is less than 0.4 along most of the segments, which suggest the MTL is weak.

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