Inversion analysis of GPS observations in Southwest Japan

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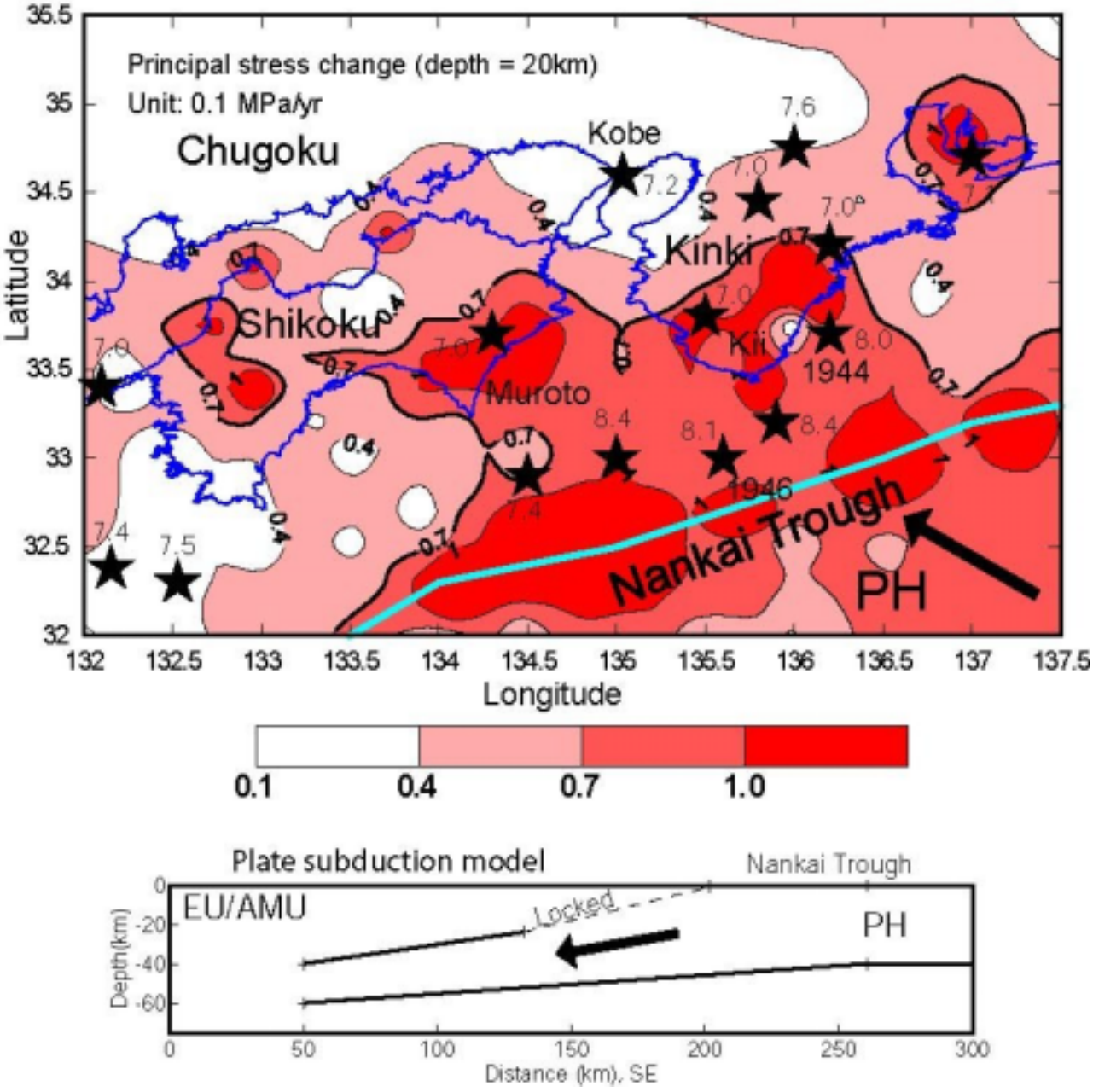
Inversion analysis of GPS observations on an island arc is to extract information about the geophysical or geodynamic sources from the crustal deformation determined by GPS. Island arc deformation in Southwest Japan is mainly associated with two types of geophysical sources. One is continuous plate subduction, which generates interplate deformation of magnitude larger than 10 mm/yr for most of stations south of the Median Tectonic Line (MTL). The other is activity of inland faults (or earthquakes), which generate intraplate deformation with a magnitude less than 10 mm/yr. Therefore, these two types of tectonic sources control the pattern and magnitude of the tectonic stress in Southwest Japan. Although seismicity indicates the release of some tectonic stress during interseismic stage, stress accumulation and deformation are largely occurring in an aseismic manner. It is essential to elucidate the properties of each source in order to determine the pattern of tectonic stress. We perform a series of inversion analysis to explore the plate subduction model and to infer the pattern of stress localization near the Nankai trough, southwest Japan. We determine the geometry of the subducted Philippine sea plate (PH) based on the observations from seismicity and rupture planes of previous interplate earthquakes. Parameters of the plate subduction model are determined by inversion of the GPS observations of 1996-2002. The model parameters estimated from the annual rates of deformation averaged over 1996-2002 are consistent with those inverted from the deformation of each year. The pattern of stress localization associated with plate subduction is almost unchanged during 1996-2002, which reflects a steady stress accumulation nature at the Nankai trough. Significant stress localization caused by plate subduction is detected at the segment of the Nankai trough between Muroto and southern Kii peninsular. The maximum stress accumulation rate (at a depth of 20 km) is estimated to be 0.7~1.0 bar/yr. The predicted stress concentration zone encompasses most of the epicenters of previous interplate earthquakes. In addition, activity of the MTL throughout Southwest Japan is clearly exposed after removing the deformation associated with plate subduction. A right-lateral sense motion of the MTL appears only on the eastern part of the Shikoku island. Dip-slip or thrusting related motion is found on other parts of the MTL and could be associated with fault motion in the deeper part of the island crust.

References

Zhao S. et al., Earth Planet. Sci. Lett., 206, 145-160, 2003. Zhao S. & S. Takemoto, Geophys. J. Int., 142, 300-318, 2000. http://www.geocities.com/subduction99/index.html


Principal stress change (depth = 20km)
Unit: 0.1 MPa/yr
Chugoku
Kobe
Kinki
Shikoku
Kii
Muroto
1944
1946
Nankai Trough
PH
Latitude
Longitude
35.5
35
34.5
34
33.5
33
32.5
32
132
132.5
133
133.5
134
134.5
135
135.5
136
136.5
137
137.5
0.1
0.4
0.7
1.0
Plate subduction model
Nankai Trough
EU/AMU
Locked
PH
Depth(km)
0
-20
-40
-60
0
50
100
150
200
250
300
Distance (km), SE