Local stress map in and around Kanto district

*Kazutoshi Imanishi[1], Takahiko Uchide[1], Reiken Matsushita[1], Makiko Ohtani[1]

1. National Institute of Advanced Industrial Science and Technology

Knowledge of the tectonic stress field is of great importance for various fields of geoscience including the modeling of geodynamic processes and the evaluation of seismic hazards. As for the seismic hazard assessment, the evaluation crucially depends on the adopted stress field, so we need to know a local-scale stress pattern near the faults that is as detailed as possible.

We chose the Kanto district as the first case study, which includes the northwest margin of the Kanto Plain fault zone and Tachikawa fault zone as well as Itoigawa-Shizuoka tectonic line active fault system. In order to increase the spatial resolution of the stress map, we included more data than the routine catalog (e.g., Japan Meteorological Agency (JMA) earthquake catalog) by determining the focal mechanisms of small earthquakes down to M1.5.

Focal mechanisms were determined from P-wave polarity data as well as body wave amplitudes. In total, we obtained 2000+ well-constrained solutions of microearthquakes shallower than 25 km that occurred over approximately the past 14 years. Most of earthquakes show reverse faulting and strike-slip faulting mechanisms, while normal-faulting earthquakes locally distribute in the coastal region of the Pacific Ocean. We merged our focal mechanism catalog with JMA earthquake catalog, which becomes a source of information on the estimation of the stress map. For each focal mechanism, we first defined the direction of maximum horizontal compressive stress (S_{Hmax}) and the type of faulting. We classified the S_{Hmax} directions based on plunge of P, B, and T-axes, following Zoback (1992). Regarding the type of faulting, we adopted the rake-based classification approach introduced by Shearer et al. (2006), which provides a single scalar value on a continuous scale (fptype) varying from −1 (normal faulting) via 0 (strike-slip faulting) to +1 (reverse faulting). We then estimated a stress pattern by computing the mean S_{Hmax} and fptype on a grid interval of 10 km.

Overall, the obtained stress pattern agrees well with that by the conventional stress tensor inversion, suggesting that an ensemble average of the stress-release patterns of earthquakes provides a good approximation of the true stress pattern (e.g., Terakawa and Matsu'ura, 2008). Comparing with previous stress maps in the present study area, our map succeeded in reducing the blank area of stress information. The obtained stress map clearly shows a complex pattern of the stress orientation as well as the type of faulting, which cannot be explained only by the result of relative plate motion and the collision of Izu peninsula. In the spatial scale of a few 10 km, however, the stress field shows similar pattern, suggesting an existence of multiple tectonic stress provinces in the area. We are planning to explain these features by considering the stress exerted by surface and Moho topography loading the crust and the stress perturbation caused by fault zone structures.

Acknowledgements: We are grateful to Japan Meteorological Agency (JMA) for the hypocenter list. The seismograph stations used in this study include permanent stations operated by National Research Institute for Earth Science and Disaster Resilience (NIED), JMA, Earthquake Research Institute at University of Tokyo, and Disaster Prevention Research Institute at Kyoto University.

References

Shearer, P., G. A. Prieto, and E. Hauksson (2006), J. Geophys. Res., 111, doi:10.1029/2005JB003979.
Terakawa, T. and M. Matsu'ura (2008), Geophys. J. Int., 172, 645-685, doi:
10.1111/j.1365-246X.2007.03656.x.
Zoback, M. (1992), J. Geophys. Res., 97(B8), 11703–11728, doi:10.1029/92JB00132.

Keywords: stress map, Kanto district, microearthquakes, focal mechanism solution