Localized strain rate in the Tohoku region before and after the Tohoku-Oki earthquake

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The 2011 Tohoku-Oki earthquake (Mw9.0) provides us the first opportunity to examine the responses of strain concentration zones and active faults to megathrust earthquakes with dense permanent GNSS network. In this presentation, we report the differences and/or similarities between pre- and post-seismic crustal deformation of the Tohoku-Oki earthquake using GNSS data in the Tohoku region, and compare it with the case of the Atotsugawa fault system, central Japan (Inamatsu and Takada, JPGU2017).
We used daily coordinates obtained from GEONET and the GNSS stations around the Atotsugawa fault operated by the university group. For the interseismic periods (before and after the earthquake), we estimated the velocity field by removing annual and semi-annual components. For the co-seismic displacement, we calculated the average coordinates of six days just before and after the earthquake and subtracted the former from the latter. From the velocities and displacements thus obtained, we calculated the strain rates following the method of Shen et al (1996). Next, we approximate the long wavelength components, which reflects the afterslip and/or the viscoelastic relaxation following the Tohoku-Oki earthquake, by polynomial function for each component, and remove it to extract the short wavelength component.
In and around the Atotsugawa fault, far from the rupture area of the Tohoku-Oki earthquake, the localized strain rate pattern before and after the quake are similar to each other. And these patterns are completely different from the co-seismic strain pattern, which means that interseismic strain concentration is mainly caused by inelastic straining. On the other hands, in the Tohoku region (near the rupture area) localized strain rate before and after the Tohoku-Oki earthquake are different each other. Considering dependence of inelastic strain rate on absolute shear stress, the difference between the Atotsugawa and the Tohoku region may be explained by amount of coseismic stress change; it is far smaller than absolute stress accumulated over a long time scale for the Atotsugawa region, and is comparable to the absolute stress for the Tohoku region.
We examined the spatiotemporal distribution of localized strain rate in the Tohoku area after the Tohoku-Oki earthquake, and compared it with known crustal heterogeneities. We found and quantified the following things. (1) In and around the caldera areas where coseismic subsidence have been detected by InSAR (Takada and Fukushima, 2013), the localized subsidence and contraction continue after the Tohoku-Oki earthquake. (2) Especially around Mt. Akitakoma, shear strain rate is extremely concentrated. (3) Relative subsidence along the Ou backbone range can be traced to the proximity of Mt. Nasu. (4) All of the above localized strain rate decreases with time. As for (3), we need further effort to gain signal-to-noise ratio to investigate the detail of vertical deformation along volcanic front from the south Tohoku to the north Kanto region.

Keywords: Tohoku-Oki earthquake, GNSS, inelastic strain

