Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SSS34-01 Room:201B Time:May 23 16:15-16:30

Visualizations of crustal deformation of Japan using GSI GEONET data

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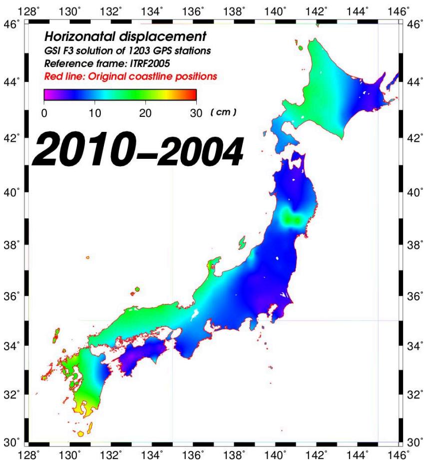
The Geographical Survey Institute of Japan(GSI) has about 1300 GPS station(GEONET) in Japan for more than 18 years observing Japanese inland crustal deformation, and the GEONET has enable us to watch how Japan is continuously deforming at a rate of a few cm/year. By utilizing the GEONET data, we succeed in visualizing how Japanese islands move, deform, elevate with time, with no limitations such as types of data, time intervals, area, and types of visualization methods.

From the animation, we can easily understand the deformations in Japan before and after the March 11, 2011 earthquake. However, it is difficult to understand the rates of accumulation for the deformations. In this study, the displacements of GPS stations and the strain distributions using Delaunay triangulation method are used for the visualization. In addition, an animations of Japanese crustal deformation with time series of epicenters are also created.

It is important to create animations of Japan using various data sets such as topography, gravity anomaly, seismicity, displacement velocity, and strain distribution to detect anomalous events. Prompt recognition of these events may help the Japanese people to prepare for natural disaster such as big earthquakes and tsunamis. Finally, it is also important to utilizing this kind of animations in school education for kids to recognize Japanese crustal activities.

All animations created in this study is downloadable at
http://kutty.og.u-tokai.ac.jp/~harada/

Keywords: Japan, Crustal motion, GPS, GEONET, Visualization



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SSS34-02 Room:201B Time:May 23 16:30-16:45

Estimation of the viscoelastic relaxation following the 2011 off the Pacific coast of Tohoku earthquake

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We are developing a 3-D viscoelastic model using the Finite Element Method to describe the postseismic deformation following the 2011 Tohoku-oki earthquake. The purpose of this presentation is how much viscoelastic relaxation contributes to the observed postseismic deformation. The viscoelastic relaxation strongly depends on the value of the mantle viscosity. The previous studies reported that a range of mantle viscosity under the Tohoku district is estimated to be 10^{18} to 10^{19} Pas. I computed the viscoelastic relaxation using a range of mantle viscosities 10^{17} to 10^{20} Pas.

Our model suggests that viscoelastic relaxation contributes to the observed 21 months postseismic horizontal displacement significantly in the Tohoku area when the viscosity is less than 10^{18} Pas. In this case, however, viscoelastic relaxation exceeds the observed displacement at the Japan Sea side.

In the case of the viscosity of 10^{19} Pas, our viscoelastic model predicts eastward velocity of 5 cm/yr in the Tohoku district for the first a few years. This eastward velocity lasts at least more than 30 years.

Keywords: Tohoku-Oki Earthquake, postseismic deformation, viscoelastic relaxation

SSS34-03 Room:201B Time:May 23 16:45-17:00

Deformation of the Nankai forearc sliver and Median Tectonic Line

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The Nankai forearc sliver in southwest Japan, which is bounded by the Nankai Trough plate boundary in the front and the right-lateral Median Tectonic Line (MTL) in the rear, has suffered from interseismic crustal shortening in the direction of plate convergence and long-term lateral movement along the MTL. In the east of the forearc, the arc-arc collision between northeast Japan and southwest Japan seems to drive the forearc lateral movement forward. In contrast, there is no driving force for the forearc movement in the west of the region because the plate boundary rotates counter-clockwise off eastern Kyushu and an obliquity in the direction of plate motion against the strike of the plate boundary disappears. As a result the forearc lateral movement is transformed into a block rotation in the eastern and southern parts of Kyushu. Thus the lateral movement of the Nankai forearc sliver characterizes the long-term crustal deformation field in southwest Japan and the MTL is related to the major deformation sources. In addition the MTL itself has a potential to generate a large inland earthquake in the future. We think it is important to understand subsurface structure and current slip/locking pattern of the MTL fault plane.

Recent seismic reflection survey has revealed a gently northward-dipping geological structure around the MTL (Ito et al., 2009). Horizontal displacement field from dense GPS networks across the MTL has shown a right-lateral relative motion between southern and northern blocks across the MTL but a transition zone of the displacement field is located 20-30 km north of the MTL (Tabei et al., 2002). These patterns are well explained by a forearc lateral movement affected by a shallow locking and a deep aseismic slip on a northward-dipping MTL fault plane. In contrast, there is another observation result that is inconsistent to an interpretation of the dipping fault plane. A series of earthquakes have aligned 20-30 km north of and parallel to the MTL and most of them show a right-lateral slip on a nearly vertical fault plane. Unfortunately station distribution of the nationwide seismic and GPS networks is rather sparse in the north of the MTL because of the existence of the Seto Inland Sea. In this area we have deployed supplementary 10 seismic stations equipped with short-period, high-sensitivity seismographs and 3 GPS stations with dual-frequency receivers and collected continuous data since November 2010.

We propose that several vertical right-lateral fault systems exist above the northward-dipping fault plane of the MTL and they act as s shear zone between the Nankai forearc sliver and the inner zone of southwest Japan. The width of the shear zone is estimated as 20-30 km from the GPS displacement field, which is consistent with the zonal distribution of characteristic P-axis directions of earthquakes but about half of the width of the Setouchi shear zone proposed from a geological point of view (Tsukuda, 1992).

Keywords: Median Tectonic Line, Nankai Trough, crustal deformation, GPS

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Recent crustal movements obtained by dense GPS network in the Tokai District

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As the slow slip event was found by the GEONET observation conducted by the Geospacial Information Authority of Japan, in the Tokai District where a huge earthquake was expected to occur in the near future, JUNCO also made another dense GPS network there. We have reported some observation results such as the difference of crustal deformation during and after slow slip event and the detection of very small movements by the short-term slow skip events in the JpGU meetings.

We re-processed all data from 2004 in a unity condition by using GAMIT software and analyzed the characteristics of the recent crustal movements in the Tokai District.

1. Not only crustal movement velocities but also dilatation velocities were changed during and after the slow slip events. We had already reported that we could obtain the place of asperities on the surface of subducting Philippine Sea Plate by the forward calculation. The similar results were obtained by the inversion method.

2. We divided the duration from the end of the Tokai slow slip event to the 2011 Tohoku earthquake into two periods and investigated the crustal movement difference between the two. Smaller southward movements were obtained in the second period comparing in the first one referring to ITRF 2008. This would show that the coupling between the Philippine Sea Plate and Amurian Plate became stronger according to the time duration after the end of Tokai slow slip event.

3. We obtained the exponential components and linear trend ones in the movements after the 2011 Tohoku Earthquake. The co-seismic movements at the Earthquake had larger difference between north part and south one in the present investigation, comparing with these components. The exponential components are thought to be the influence of after-seismic fault motions and the linear trend ones are to be visco-elastic deformation effects, and therefore we think this difference shows the areal differences that areas of the after-seismic faulting and the visco-elastic deformation are wider than the Earthquake fault.

4. We obtained the dilatation velocity distribution after the 2011 Tohoku Earthquake. We can see the dilatant area in the north part and contract one in the south part of the investigation area. Eastward movements are large in the northeastern part and they are smaller in the northwestern part, but they are almost constant in the south part because of the coupling between the subducting Philippine Sea Plate and Amurian Plate.

Keywords: GPS, Tokai District, dense, slow slip, Tohoku Earthquake

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Shallow slow-slip event detected by leveling survey at the central part of the Longitudinal Valley fault, eastern Taiwan

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Precise leveling survey was conducted across the central part of the Longitudinal valley fault, eastern Taiwan to discuss the detail deformation of the transition zone between the fault creeping area and asperity area. In order to focus on the relationship between the fault creeping area and rich melange distribution in the transition zone, we have established three leveling routes at the Yuli, Chike-san and Reishuei areas. The Yuli route is just located in the northern end of the rich melange distribution, but both Chike-san and Reishuei routes were established in the area where no rich melange exists. In the Yuli route, an uplift rate of about 30 mm/year has been detected from 2010 to 2012, suggesting the aseismic fault creep might be continuing with long-term. In the Chike-san route, the vertical deformation rate of about 8 mm/year was detected in the period from 2010 to 2011. However, there was the huge deformation with uplift rate of about 40 mm/year detected in the period from 2011 to 2012. In the Reisuei route, we detected the deformation of about 8 mm/year in the period from 2011 to 2012.

As explanations for the huge change of the deformation rate in the Chike-san route, we believe that the detected deformation has been resulted from a slow-slip event. Also since the significant deformations were not detected in leveling and GPS around Chike-san route, the slow slip event was localized to a small region just around the Chike-san route. Such a slow slip event might be triggered by the M 5.3 earthquake on June 14, 2012 because the number of micro-earthquakes in the Chike-san area rapidly increased after the M 5.3 earthquake.

We propose that the northern limit of the stable creeping area may be in the Yuli area and the slow slip event occurs in the transition zone between the fault creeping area and asperity area. The boundary between the creeping area and the slow slip area is basically consistent with the northern limit of the rich melange distribution.

Keywords: Taiwan, Longitudinal Valley fault, slow-slip, Precise leveling, fault creep, rich melange