SCG08-P01 Room:Convention Hall Time:May 23 18:15-19:30

Upper mantle rheology of Sea of Japan inferred from postseismic displacements of the Tohoku earthquake

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The 2011 Great Tohoku earthquake struck the Pacific coast of northern Honshu, Japan almost two years ago. It generated huge co- and postseismic crustal displacements and deformations in the near-field zone. However, the western part of the far-field zone represented by the Korean Peninsula, northeastern China and the south of the Russian Far East were also being affected by coseismic offsets and have still been demonstrating appreciable postseismic movements. It is obvious that the nature of these deformations is connected not only with the earthquake source geometry and processes but also with Sea of Japan and northeast Asia lithosphere and upper mantle structure and rheology. In this study we determine and analyze the far-field postseismic crustal displacements and deformations induced by the 2011 Great Tohoku earthquake using different GPS data sources in the south of the Russian Far East and Kunashir Island (IGS data, continuously and periodically observed regional geodynamic GNSS networks and other GNSS observations applicable for this study). The maximum value of first-year postseismic displacements exceeded 30 mm in the continent, which is about 60% of the appropriate coseismic offset value. In contrast to the continental stations, the postseismic displacement on Kunashir Island located northward from the rupture has already exceeded its coseismic offset (about 10 mm) more than twice. To explain the observed postseismic displacements we adopted the viscoelastic relaxation mechanism and constructed the lithosphere-upper mantle model consisting of elastic lithosphere layer of 50 km thick and two viscoelastic layers of 200 and 265 km thick with Maxwell rheology. We varied the viscosity of the upper viscoelastic layer from 10ˆ17 to 10ˆ19 Pa s to fit the calculated postseismic deformations to their observed values. Our approach gives the astenosphere viscosity of 5-10*10ˆ17 Pa s which is relatively low with respect to previous estimates. However, the recent study of Kogan et al., 2011 devoted to determination of the mechanism of postseismic deformation triggered by the 2006-2007 great Kuril earthquakes presented a similar viscosity value. The obtained astenosphere viscosity value allows us to adequately explain the far-field postseismic displacements in our GNSS network but fails to explain the first 50 days after the mainshock. Thus, a question about wide variability and time dependency of Japan Sea and northeast Asia upper mantle viscosity should be carefully investigated in the nearest future.

Keywords: lithosphere-upper mantle model, the far-field postseismic crustal displacements, GNSS observations, The 2011 Great Tohoku earthquake, astenosphere viscosity

SCG08-P02 Room:Convention Hall Time:May 23 18:15-19:30

Focal Mechanism Solutions of the Tohoku-Oki Earthquake Sequence and Their Geodynamical Implications

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The stress state around Japan Sea region and the evolution of Japan Sea are both concerned by Geoscientists. In this paper, we study the stress state around Tohoku-Oki area by analyzing Harvard CMT solutions of the Tohoku-Oki Earthquake Sequence, which may be divided into four groups. The first one includes low-angle thrust events, which are similar with the main shock. They mainly occurred on the interface between the Pacific Plate and the North American Plate, concentrating on deeper depth of the main rupture zone as well as its north/south ends. The second one contains normal-fault earthquakes with principal extensional direction roughly pointing W-E direction. Most of these earthquakes located in the fore-arc uplift region of the Pacific plate. Some others occurred in the fore-arc accretionary wedge. The third one encompasses normal-fault earthquakes too although their principal extensional directions are roughly parallel the Japan Trench. They occurred in the fore-arc accretionary wedge too. The fourth one includes reverse fault earthquakes whose principal compressional directions are roughly parallel the Japan Trench. They took place mostly in the middle of the main rupture zone as well as its south side. We find that the focal mechanisms of the event sequence occurred in the fore-arc accretionary wedge are obviously different from the foreshocks. Tohoku-Oki Earthquake Sequence has released most of accumulated elastic stress. As a result, Pacific Plate and North America Plate has decoupled in the main rupture zone. Moreover, it might lower the E-W compress stress level in Japan Sea and Northeastern China. We conclude that the release of accumulated stress in regions around Japan Sea and Northeastern China could lower the seismic risk and enhance the volcanic activity, especially in Honshu, where may have volcanic eruption in the near future. However, the Pacific Plate and North American Plate near Honshu are not completely decoupled, even though their stress level is low as yet. Whether the stress state of the fore-arc accretionary wedge can be restored to the stress state before the Tohoku-Oki Earthquake Sequence, how long it will take, as well as if Japan Sea might further expand mostly depend on concrete boundary conditions which need further observation.

Keywords: 2011 Tohoku-Oki Earthquake, Back arc basin, Subduction zone, Japan Sea, Focal Mechanism Solution