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Shear fracture strength of faults (VI): Relation between GPS velocity fields and seismic activity

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INTRODUCTION: In this study, the following two problems will be discussed. First, GPS velocity represents the velocity at which constituents of the crust moves. Crustal movements are considered to be caused by the non-uniform motion of the crustal materials. The GPS velocity field is non-uniform even in the intra-plate. In the south Kanto district, the direction of the GPS velocity actually varies from SW to NW as the observation point becomes south. One of the purposes of this study is to discuss the depth where the driving force of the crust is acting. Next, after the 2011 off the Pacific coast of Tohoku Earthquake (2011/3/11, Mw9.0), the seismic activity is high in the east side of either of the lines, the NW-SE line passing through near Kinkazan and the NE-SW line passing through near Iwaki. The similar pattern of the seismic activity is observable off the Ibaraki prefecture and off the Boso peninsula, as well. The other purpose is to make the meanings of the boundary line clear.

THE METHOD AND ITS BACKGROUND: A model of fault zones proposed on the basis of the results of in-situ stress measurement suggests that the strength of a fault is about 10 MPa in the upper crust. This means that the strength is very small, or faults are weak. This implies that a fault plane is nearly parallel to one of principal planes of stress. The comparison of the orientation of the horizontal stresses with the direction of GPS velocity in GRS80 system has revealed that the direction of the largest or the smallest horizontal stress can be approximated by the direction of GPS velocity. Therefore, we can expect that the direction of a fault strike is nearly equal to that of GPS velocity, if one of the principal stresses lies horizontal.

On the basis of the above results, the strike direction of a fault will be compared with that of GPS velocity, using the earthquakes occurring at various depths. This is available for discussing the driving force of the crust. In order to make the meaning of the boundary line clear, it is the first step that the direction of the boundary line is compared with that of GPS velocity.

RESULTS AND CONCLUSION: Focal mechanism solutions have been preliminarily compared with GPS velocities. From this comparison, it is seen that at least one of strike directions and their perpendiculars determined as the focal mechanism solution is close to that of the GPS velocity (1997-2007), even at depths larger than the crust. This suggests that the crust moves together with the upper mantle.

The GPS velocity (1997˜2007) lies in SW direction at the GPS stations between Kinkazan and Choshi along the coast of the Pacific Ocean. The boundary line passing through Iwaki is almost parallel to the GPS velocity, and the boundary line passing through Kinkazan is almost perpendicular to it. An earthquake (2011/4/11, Mw 7.1) occurred near Iwaki. Although the strike direction of the nodal plane is determined with wide variety, the direction is almost perpendicular to the GPS velocity. These enable us to think the direction of the GPS velocity as one of the principal directions of stress. The boundary line passing through Kinkazan is almost perpendicular to the GPS velocity (1997-2002) at OSIKA. These suggest that the boundaries of the seismic activity are the boundaries of the crustal structure like as a tectonic line.

The following data are used:
GPS Velocity; GSI, http://mekira.gsi.go.jp/project/f3_10_5/ja/index.html
Seismic activity; NIED, http://www.hinet.bosai.go.jp/
Focal mechanism solution, NIED, http://www.fnet.bosai.go.jp/event/search.php?LANG=ja, and USGS, http://earthquake.usgs.gov/earthq

Keywords: weak fault, GPS velocity, Seismic activity, focal mechanism,, direction of fault strike, tectonic line