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Stress field in the middle part of Kyushu, Japan and detecting weak zone in the crust

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In the upper crust of Kyushu district, Japan, an area with high seismic activity is found in the middle part. This area is called Beppu-Shimabara graben because of existence many normal faults in this region. Many active volcanoes exist (i.e. Unzen, Aso, Kuju, Beppu), and historical large earthquakes occurred in this region. However, it is not always confirmed whether this region behave as a graben formation or not from other evidence. In addition, there is an active fault system at the south of the graben. The name of this is 'Futagawa-Hinagu Fault system'. The seismicity along the fault is highest among parts of Kyushu. The major mechanism of earthquakes around the system is strike slip type. Peoples is concerning with occurrence of large earthquake on the fault. Generally, extensional (minimum principal) stress is in north-south direction in Kyushu. Only direction of maximum principal stress changes region to region. It is key to understand interaction between this fault system and Beppu-Shimabara graben for probability evaluation of earthquake occurrence on the fault.
Recently, Nakao et al. (2005) estimated spatial distribution of strain rate field in Kyushu area from GPS data. The area in which higher strain rate dominates not in extension but share is found in Beppu-Shimabara graben. This can explain high seismic activity in this region. They also revealed notable contraction in east-west appear around Aso volcano. High strain rate can be seen around Aso volcano.
On the other hand, information about stress field is also important to understand deformation of the crust. Elastic and anelastic feature of crust could be inferred from both of stress and strain field. We performed stress tensor inversion by using polarity data of first motion at direct P wave arrival. The data were obtained at stations operated by NIED, JMA and Kyushu University. In addition, we deployed more than 20 temporal seismic stations around the graben in order to determine the stress field. Directions of principal stresses are obtained at spatially distributed grid points every 20 km interval. At each grid point, we collected polarity data of events occurred nearer than 10 km apart from grid point and carried out the stress tensor inversion. The minimum axes of the principal stress are generally oriented in NNW-SSE direction. The maximum axes are almost in WSW-ENE direction. The stress rates are greater than 0.75 at most of the point, implying the maximum stress is close to the moderate principal value. The maximum stresses in Beppu-Shimabara graben incline toward vertical direction while those have direction in east-west at most of points. It implies normal faulting would dominantly occur in Beppu-Shimabara graben. In addition, the minimum axes in the graben rotate counterclockwise. This stress field change requires a mechanism either relaxing the stress in east west direction or vertically loading in this region. Strain rate field by GPS observation also show the similar pattern and support the existence of the relaxing mechanism. This could be interpreted by existence a 'weak body' in the crust. The area would be contracted by regional stress field. This could explain the strain rate distribution. And stress in east-west could be relaxed so that second principal stress in vertical direction would be maximum one. This simple model is qualitatively reasonable as an explanation

for the results. For further study, variation of stress field in vertical direction should be discussed in detail.

Keywords: Kyushu, Beppu, Aso, Shimabara, stress, strain