Two compatible physical models for seismic quiescence

Sumio Yoshikawa[1]

[1] MRI

As a physical explanation of seismic quiescence, I propose combination of the models of ’local slip’ and ’frictional restriction’.

In ASC meeting of 2008, I have presented a result of comparison of various theories about the physical background of seismic quiescence. To generate unstable sliding which leads to a large earthquake, reduction of the contact area between fault surfaces is necessary. Considering this necessary condition and reproducibility of the phenomenon, I have concluded that the theory of ’local slip’ is convinced to be a principal mechanism, in which aseismic local slip slowly grows in the circumstances of asperity between fault surfaces and seismic activity is reduced by local release of shear stress (Wyss et al,1981). On the other hand, the model of frictional restriction is also possible, in which seismic activity becomes quiet as a result that sliding was restricted by increase of frictional force acting on a fault plane with increase of normal stress in a wide area, although it does not necessarily soon develop to unstable sliding. These two models are not contradictory but mean that there are different space- and time- scale models for the mechanism of quiescence. In other words, ’frictional restriction’ comparatively deserves to be a model explaining long-term quiescence in wide area, whereas ’local slip’ is a model explaining quiescence of a short term in a focal region and the neighborhood.

Quiescence has been recognized at least 13 cases among 23 events (0.56 in ratio) in the major earthquakes with the magnitude 7.0 and larger in and around Japan since 1948 in JMA catalog, especially 9 cases among 13 events (0.73 in ratio) for the interplate repeated earthquakes in the pacific side of Hokkaido - Tohoku Japan. There is a high possibility that the local slip phenomenon tends to appear before the interplate repeated earthquakes since the same asperities in the plate boundary play a major role. Ohta et al.(2009) is reporting that seismic activation seemed to occur around the quiescent regions in the above earthquakes. This report suggests that increase of shear stress occurs in the adjacent region which may brought by release of shear stress in the focal regions by ’local slip’.

On the other hand, the quiescence along the western coastal area of the Japanese Islands before 1983 Japan Sea earthquake (Yoshida and Aoki, 2002) may be brought by increase of the frictional stresses in the existing faults in wide areas, which can be explained by ’frictional restriction’. We should take an appropriate physical model of two types into consideration to choose domain, magnitude range, period, etc. in order to detect a quiescence before occurrence of a large earthquake.