Physical and geological entity of brittle-ductile heterogeneous fault zones at transition depth

*Ryosuke Ando[1]

1. Graduate School of Science, University of Tokyo

Worldwide observations clarify slow earthquakes exhibit strong and systematic depth dependences. However the physics governing such phenomenon are yet to be clarified. We aim to understand the physical and geological entity underling such observed depth dependent phenomenon. I developed a simple physical framework based on the brittle-plastic heterogeneous fault model for slow earthquakes by incorporating the depth dependent fault properties. As suggested from experiments and observations, we assume that the fraction of the brittle patches and the rock rheology are certain functions of depth reflecting the brittle-plastic transition of rock forming minerals and thermal activation processes. The geological entity of such heterogeneity may be the different onset temperatures of the plasticity for the constituent minerals; for example in the Greenschist faces around the temperatures of 300-500^{o}C, chlorites become plastically deformed, while amphiboles are still brittle and assembled brittle rocks may exist as packed hard grains in thick suspension.
By considering a simplified one degree of freedom system consisting of a spring, mass, a dash pod and frictional slider, we derive an equation of motion. By assuming the linearity of the system, I obtained an analytical solution of the system. Analyses of the obtained solution show that following phenomenon are natural consequences of interplay between velocity strengthening behaviors and the fraction of the brittle patches as increasing depth and temperature. Such explained phenomenon include recurrence intervals, amount of stress drop, sensitivity to tides, duration of events, and seismic efficiency. Relative depths of megathrust earthquakes, long-term and short-term slow slip events and tremor generating regions, which are puzzling and controversial, are also explained.

Keywords: Slow earthquakes, Brittle-ductile heterogeneity, Model

