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SLOW SLİP GENERATED BY SERPENTİNE DEHYDRATİON COUPLED WİTH SLİP-İNDUCED DİLATANCY AND THERMAL PRESSURİZATİON

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We theoretically study the generation mechanism of slow earthquakes assuming a fault in a 1D medium, extending infinitely, saturated with fluid. We assume, in the analysis, a linear theory of thermo-poro-elasticity. Fault slip evolution is assumed to interact with fluid pressure change through Coulomb's frictional stress. We specifically investigate why slow earthquakes occur favorably only at hot subduction zones. In the modeling, we introduce the concept of serpentine dehydration coupled with slip-induced dilatancy and thermal pressurization. Dehydration of antigorite, a main constituent of serpentine mineral, is known to occur at locations where slow slip events are observed at hot subduction zones. The existence of serpentine material is also suggested by seismological tomography studies at source regions of slow slip events.

In the derivation of governing equations, we introduce the dehydration reaction formulated by Brantut et al.(2010) into the model of Suzuki and Yamashita(2009), who investigated competing effects of thermal pressurization and slip-induced dilatancy on the fault slip evolution. In the modeling of reaction, we consider the total reaction of antigorite and assume a first order Arrhenius law in which Le Chatelier principle is implemented. Since the dehydration reactions of minerals are endothermic, the reaction tends to suppress the temperature elevation. The Clapeyron curve of the reaction and thermal gradient expected at hot subduction zones suggest that antigorite dehydration involves a two stage reaction process. The first and second of the reaction are associated with positive and negative volume changes, respectively. The volume change is negative (positive) if the void space created by the reaction is larger (smaller) than the space occupied by the fluid released by the reaction. We numerically solve the governing equations; the solution for slip is obtained by solving the 1D wave equation analytically.

Our calculation shows that the slip velocity evolution can be significantly stabilized when the dehydration reaction is coupled with slip-induced dilatancy. If the volume change due to the dehydration reaction is negative, the slip evolution is much more stabilized than when the dehydration reaction is not assumed. We actually observe slow sustained-slip when the volume change is negative in our numerical analysis. The velocity of slow sustained-slip is found to decrease with decreasing values of volume change. If we do not assume slip-induced dilatancy, slip is accelerated with time soon after the slip onset even if the dehydration reaction is assumed. The above finding suggests that slow earthquakes occur at hot subduction zone because dehydration reaction is coupled with slip-induced dilatancy and the volume change is negative. In other words, our analysis points out that the second stage reaction is associated with the generation of slow earthquakes. We also find that the slip velocity is smaller for smaller values of permeability and stress drop. Requirement of low stress drops is consistent with observed data analysis of slow earthquakes.

The Clapeyron curve of the reaction and thermal gradient expected at cold subduction zones suggests that the reaction at cold subduction zones will also be characterized by negative volume

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change. However, as stated above, our calculation shows that if we do not assume slip-induced dilatancy, slip is accelerated with time soon after the slip onset even if the dehydration reaction is assumed. This suggests that slow earthquakes will not occur at cold subduction zones because of negligible slip-induced dilatancy.

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