Kinetics study on stress drop and recurrence interval during stick-slip with dehydration

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It has been found that the phase change of the material and the water generated by dehydration reaction influence the mechanical behavior of the rock. In particular, the frictional stability of the seismogenic zone is considered to change due to friction constant changed by phase-change. Many previous studies focus on instability of slip and localization of strain by the changes in mechanical properties (Proctor and Hirth, 2015). Because the volume of the water generated during the dehydration reaction is generally negligibly small, so that accurate measurement is difficult. For this reason, mechanical behavior is investigated by conducting experiments that controls pore-fluid pressure (Leclere et al., 2016). However, previous study that measures multiple slip events is few. The few studies have been conducted to combine the dehydration with recurrence interval of stick-slip events. In addition, there are few studies that discuss the dehydration not kinetic but mechanical point. In Sawai et al. (2013), kinetic models are applied to describe the dehydration reaction in experiments reproducing the seismogenic zone using serpentinite. Similarly, few studies applied over multiple slip events, and studies have not been conducted on the kinetics of the recurrence interval. When multiple slip events happen with the dehydration reaction, it is possible to describe the recurrence interval in terms of pore-pressure evolution kinetically.
In this study, we analyzed using the data of triaxial compression test made at Sasaki et al. (2016). In the experiment, simulated gouge sample of gypsum hemihydrate, bassanite, between precut gabbro pistons was deformed in high pressure gas medium apparatus at confining pressures of 10 - 200 MPa and temperatures up to 180 ℃. At 200 MPa, 70 ℃ corresponding to non-dehydration condition, samples exhibited stick-slip behavior and the strength of the samples became larger. On the other hand, at 200 MPa, 110 ℃ and higher, likely corresponding to condition for stable anhydrite phase, stick-slip behavior was found to be diminished with the reduction in mechanical strengths with strain.
In this study, we calculate recurrence interval and shear stress drop from data of deformation experiment. We found that recurrence interval and shear stress drop is proportional to confining pressure in experiments with non-dehydration reaction. On the other hand, both recurrence interval and shear stress drop decrease with time despite in an experiment with dehydration reaction. Because the experiment is conducted under constant confining pressure, we consider the decreases in the effective pressure by increasing pore-fluid pressure. From this knowledge, we estimated pore-fluid pressure at time with the effective pressure law. Also, we fit pore-fluid pressure data with Avrami equation. As a result, we found that the evolution of pore-fluid pressure can be described using Avrami equation. From this fact, we consider that by applying the same kinetic approach to different minerals as in this study, it is possible to evaluate the difference of the mechanical properties caused by the dehydration reaction

