Session Poster | T4 ［Topic Session］ Deformation and reaction of rocks and minerals activities

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[3poster01-18] T4. Deformation and reaction of rocks and minerals activities

ECS

[T4-P-17] Evolution of mechanical properties, energetics, and microstructures associated with frictional melting during repeated seismic slips on simulated gabbroic faults

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Seismic activity along faults is primarily governed by shear rupture instabilities, leading to deformation within the fault core and adjacent damage zones. These faults, often undergo repeated episodes of seismic slips, during which the structural heterogeneity and mechanical properties of the fault zone evolve. Despite numerous studies, the evolution of fault strength, energy partitioning, and microstructures during such repeated seismic events, particularly under conditions involving frictional melting, remains insufficiently understood.In this study, we conducted controlled high-velocity shear experiments on simulated gabbroic faults to investigate the evolution of mechanical properties and structures under repeated seismic slips. Experiments were performed under dry, room-temperature conditions using hollow cylindrical samples of Belfast gabbro. A slip rate of ~1 m/s and a normal stress of ~4 MPa were applied using the Pressurized High-Velocity Rotary Shear Apparatus (PHV) at JAMSTEC’s Kochi Core Center. Each experimental slip pulse, simulating a single seismic event, involved a displacement of 3.8 meters. Up to five successive pulses were applied to a single sample during the experiment. To evaluate the effects of fault surface healing and its time dependence, four inter-pulse hold durations were tested: 10, 100, 1000, and 3600 seconds. Axial shortening was observed during slip, with cumulative total displacement reaching ~1 mm over five pulses. Infrared thermography revealed significant frictional heating at the slip interface, with temperatures on the fault surface reaching 1100–1300°C. This thermal rise resulted in localized melting of the slip surface. All slip pulses exhibited a two-stage weakening behavior: an initial weakening at the onset of slip, followed by a second weakening phase after the attainment of a secondary stress peak. These behaviors are interpreted to reflect the combined effects of flash heating and the formation/growth of a frictional melt layer. Notably, the critical displacement required for dynamic weakening decreased with each successive pulse, and the peak temperatures also declined incrementally.Post-experiment, the recovered samples were observed using X-ray computed tomography (CT) for characterizing the microstructures and designating melt and damage zones. Scanning Electron Microscopy (SEM) observations ofthinsections revealed melt layers with thicknesses of 100–200 μm were preserved in the recovered samples and exhibit characteristic pseudotachylyte microstructures. In samples subjected to a 100-second

inter-pulse hold time, multiple discrete melt layers were identified, along with evidence of possible melt injection into adjacent damage zones.These results indicate that the energy required for dynamic weakening via frictional melting decreases with subsequent slip events.