[JJ] Evening Poster | S (Solid Earth Sciences) | S-SS Seismology

[S-SS15]Fault Rheology and Earthquake Physics

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The goal of this session is to integrate theoretical, experimental, observational, and numerical perspectives from various fields such as seismology, geodesy, geology, mineralogy, and so on, to define what is known about earthquake source processes and the physical and chemical elementary processes of faulting. This session welcomes studies that address such issues as pre-, co-, and post-seismic processes, the rheology of seismogenic faults and fault rocks, laboratory experiments on elementary processes, numerical models based on frictional laws, and estimates of the stress field in the seismogenic zones. We also welcome studies on fault-zone drilling projects and in situ stress measurements.

[SSS15-P05]Frictional strength of agate at intermediate slip rates in air and argon atmospheres

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Frictional strength of quartz rocks is known to be extraordinary low at subseismic slip rates ranging from 1 mm/s to 10 cm/s, and this weakening has been ascribed to the hydration of comminuted amorphous material, i.e., silica gel. In order to testify this hypothesis, we conducted rotary-shear friction experiments on agate samples at a normal stress of 1.5 MPa, back ground temperatures (T_{BG}) of room temperature (RT) and 100°C, and slip rates (V) ranging from 1 mm/s to 10 cm/s, in air and argon atmospheres, and compared friction coefficients (μ) at humid and dry conditions.

At V = 1 cm/s, steady-state friction coefficients μ$_{ss}$ at T_{BG} = RT in air and argon are ≈0.65 without noticeable difference, suggesting that moisture-adsorption by wear materials does not affect μ. Thermography shows that the slip surface temperature (T_{SS}) ranges from 50°C to 70°C. In contrast, μ$_{ss}$ at T_{BG} = 100°C in air is ≈0.4, suggesting decreasing μ$_{ss}$ due to increasing T_{SS}. XRD and FTIR analyses show that wear materials after all these experiments are largely amorphous, and contain similar amounts of adsorbed water. This implies that silica gel is formed even soon after the experiments at dry conditions.

At V = 10 cm/s, μ$_{ss}$ at T_{BG} = RT in air and argon as well as μ$_{ss}$ at T_{BG} = 100°C in air are ≈0.3 without noticeable difference. Thermography shows that T_{SS} reaches 170°C when μ reaches the maximum followed by subsequent significant weakening. T_{SS} tends to synchronize with μ, suggesting a feedback so that increasing μ causes increasing T_{SS} followed by decreasing μ and then decreasing T_{SS}. Thus μ is likely controlled by T_{SS} at this V.

At V = 1 mm/s, μ$_{ss}$ at T_{BG} = RT in air is ≈0.8, which is significantly higher than μ$_{ss}$ (≈0.65) at V = 1 cm/s. Thermography shows that T_{SS} is ≈40°C, which is lower than T_{SS}

(50−70°C) at $V = 1$ cm/s. The difference in μ$_{ss}$ between $V = 1$ mm/s and $V = 1$ cm/s is attributable to different amounts of water adsorbed by amorphous wear materials at different T_{SS}. Adsorption of water by amorphous wear materials is known to increase µ.

Thus our results show that agate exhibits significant weakening only when T_{SS} is high, but not due to the presence of silica gel. Additional friction experiment on silica gel gouge at $V = 1$ mm/s and $T_{BG} = RT$ in air also reveals that its μ$_{ss}$ is ≈0.6, similar to μ$_{ss}$ of common rocks and minerals, casting doubt on the lubrication effect of silica gel. The reason for the significant weakening of quartz rocks at V ranging from 1 mm/s to 1 cm/s during which T_{SS} does not exceed 100°C, however, remains unknown.