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 material, i.e., silica gel formation (e.g., Goldsby and Tullis, 2002; Di Toro et al., 2004; Hayashi and Tsutsumi, 2010). If so, frictional strength of quartz rocks at dry conditions would not significantly decrease at those slip rates, because the hydration of comminuted material would be prevented. In order to testify this hypothesis, we conducted rotary-shear friction experiments on agate samples at a normal stress of 1.5 MPa and intermediate slip rates of 1 cm/s and 10 cm/s, i.e., at the same conditions as those of experiments done by Hayashi and Tsutsumi (2010), but in humid-air and dry-argon atmospheres, and compared frictional strengths in humid and dry conditions.
At a slip rate of 1 cm/s, frictional strength in both atmospheres did not change much with displacement so that friction coefficients after displacements of ≈180 m were as high as ≈0.7. In contrast at a slip rate of 10 cm/s, frictional strength in both atmospheres significantly decreased with displacement, and friction coefficients after displacements of ≈250 m became as low as ≈0.25, although significant fluctuations in frictional strength were observed throughout the experiments. Thus our results show that frictional strength of agate at a given slip rate does not differ between humid and dry conditions, and therefore cast doubt about weakening of quartz rocks caused by the hydration of comminuted material. Since we observed flashes along the slip surface during experiments at a slip rate of 10 cm/s, significant weakening of agate at this slip rate is likely due to the flash heating of asperities. We monitored thermal images during experiments in air at both slip rates of 1 cm/s and 10 cm/s, and will also report the relationship between frictional strength and the slip-surface temperature.

Keywords: frictional strength, agate, in air, argon atmosphere

