Experimental investigation on the frictional behavior of granular materials: Implications for better understanding landslide mobility

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The frictional properties of granular materials provide fundamental insights into geophysical processes such as landsliding and earthquake faulting. Some previous experimental studies have shown that the mineralogy of constituent materials plays a first-order control on the transitions of mechanical behaviors, including sliding stability or instability. Moreover, other laboratory investigations have demonstrated the importance of shear rate as a primary control on the strength properties, leading to rate-strengthening or rate-weakening. Despite these efforts, however, neither the knowledge of general relationships among mechanical conditions, material properties and frictional behavior nor the underlying processes are well understood. Here we report on a suite of ring-shear experiments designed to investigate the influence of grain interfaces on the granular frictional behavior over a wide range of shear rates. Samples, consisting of granular halite and mixtures of granular halite and silica sand, were sheared at room temperature and constant normal stress of 400 kPa, and we varied the proportions of halite by weight. The same loading procedures were adopted during each experiment, and the acoustic emissions (AEs) were monitored with a sampling rate of 1.0 MHz. We found that: (1) the pure halite sample shows stick-slip instability, but the pure silica sand sample exhibits stable-sliding; (2) inclusion a low concentration of halite is strongly to modify the frictional behavior and specifically to reduce its ability to sustain stable-sliding for silica sand sample; (3) the stress drop and recurrence time of instability events increase with increasing halite contents, but the occurrence of plastic deformation increases the recurrence time. Ultimately, we discussed the related energy dissipation process considering the released acoustic energy to evaluate the landslide mobility.

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