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The role of brittle cracking in the development of landslide failure

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In many first time landslides the high strain rate (failure) event can only occur once processes of brittle cracking have allowed the full development of a shear surface upon which sliding can occur. Thus, the processes of brittle cracking are a key control upon the development of a landslide in both time and space. In this paper, an analysis is undertaken of the interaction between microscale brittle cracking and macroscale landslide strain development. Comparison is made between macroscale landslide movement records and experiments undertaken in the laboratory in which the development of failure is simulated under representative stress states. It is demonstrated that patterns of landslide movement during tertiary creep are strongly controlled by the rate and nature of brittle cracking processes occurring in the landslide shear zone. These processes are responsible for the hyperbolic increases in strain rate development that have been observed in many landslides, including for example the Vajont landslide of 1963. Secondary and tertiary creep can hence be seen as phases of damage accumulation within the shear zone in which brittle cracking progressively allows the formation of a sliding plane. The level of damage in the shear zone is dependent upon the strain state of the landslide system, with final failure in brittle first time failures occurring when a critical strain level, corresponding to the required level of damage in the shear zone, has been achieved. The implication is that in landslide systems the analysis of the strain state, both in terms of total strain and strain rate, in addition of course to the stress state, may lead to better prediction of the timing of the occurrence of potentially destructive high strain rate events.