Slip behavior and fault-rock analysis at initial-break point, case study in landslide

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The nucleation of rupture at a specific site has been observed during rock frictional testing in the laboratory. A spatially fixed initial break point has been recognized for large earthquakes by seismic observation, but the cause of this spatial fixation is still uncertain. A landslide is a midscale rock-friction event, in between a laboratory compressional experiment on a small test piece and a seismogenic fault. The landslide area studied is a pore-fluid-induced normal fault system that undergoes episodic slip during rainfall events.

We monitored dynamic processes of this fault system in detail during slip and analyzed the fault rock at the initial break point immediately after slip events. Dilation and slip were initiated in an area with a high groundwater level, and the rupture propagated into the surrounding. A similar process was recognized repeatedly in 2003 and 2004, and the rupture initiated in the same area both years. The frictional heterogeneity seems to be spatially fixed and may depend on the hydrologic structure. At the initial break point, a high water content was found in a fracture zone under a low-permeable gouge layer. The fracture zone may act as a conduit for fluid, and the gouge, which originated from shear grinding, may have sealed in the pore fluid, causing high fluid pressure. Historical fault-rock development and the consequent hydrologic structure formed may reach a stationary state with maturation of the slip system, causing the initial break point of repeated slip events to be in the same area.