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Gravitational slope deformation and catastrophic landslide controlled by the incision of a paleosurface

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Huge landslides have been occurring in tectonically active mountains, where uprising and river incision form gravitationally unstable state in mountain slopes. In particular, when a paleosurface is incised, large volume instability is likely to be induced, because convex, projecting slopes are consequently made. We found large gravitational slope deformations induced by these processes in several locations, particularly in the upstream area of the Totsu River in the Kii Mountains in the outer belt of Southwest Japan, the Dahan River catchment, and the Chishan River in Taiwan. Our study includes chronological development history. Fluvial incision of a paleosurface makes a knick point, which recesses upstream, cuts the foot of side hillslopes of paleosurface, destabilizes the slopes, and then gravitational slope deformation starts on outfacing slopes.

We identified a paleosurface with an average slope of 33 degrees in elevations higher than about 650 m, which paleosurface is incised by a river to form inner valleys with a maximum height of 250 m of side slopes. This paleosurface is not a peneplain proposed by Davis but is steep with moderate relief. On the infacing slopes of inner valleys, convex slope breaks have been made, and on the outfacing slope, gravitational deformation has been induced by the undercut. Our reconnaissance study suggests that similar slope development occurred in the outer belt of Southwest Japan in Shikoku and Kyushu, where have similar tectonic background. Large landslides, which were induced by the 2005 rainstorm in the Mimi-River catchment in Kyushu, occurred in the inner valleys incised in the Shimanto terrain

We found paleosurfaces in higher elevations of the Neogene area in the Dahan River catchment. They are incised by rivers to form convex slope breaks and inner valleys. The distribution of gravitational slope deformations and landslides are closely related to the slope breaks, suggesting that they are controlled by the slope development as stated above. The Shiaolin landslide, which was induced along the Chishan River by the typhoon Morakot in 2009 in Taiwan, also occurred on the gravitationally deformed slope along the edge of a paleosurface.

Keywords: paleosurface, incision, gravitational slope deformation, landslide, slope failure