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# Rain-induced rock avalanches with sliding surfaces along low-angle-thrusts in accretionary prisms

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Recently, extreme weather related to global warming occurs frequently all over the world; there have been many record-setting rainfall events. Accordingly, potential of rain-induced rock avalanches increases. Examples of recent rain-induced rock avalanches with tens or more than a hundred of fatalities are a rock avalanche in Philippine Leyte in 2006, a rock avalanche in Shiaolin village, Taiwan by Typhoon Morakot (in 2009), and rock avalanches induced by typhoon Talas (in 2011) in Japan. However, the method to predict potential sites of rock avalanches is not established. Geological causes of rock avalanches are site specific and they must be clarified for each case.

Typhoon Talas induced more than 50 rock avalanches in the outer belt of the Southwest Japan, where is underlain by Cretaceous - lower Miocene accretionary complexes. We performed thorough geological mapping in the Akatani area, where two huge rock avalanches occurred with volumes of 2 million and 8 million $m^3$ respectively.

As a result, we found that these two rock avalanches had their sliding surfaces along a low-angle-thrust with dip 29 to 40 degrees extending more than 5 km, which fault we name the Kawarabi thrust. This thrust has a fracture zone of 1.5 m in the maximum width, composed of clayey fault breccia with a few layers of black gouges. These fault materials are very weak and impermeable, so the fracture zone is expected to prevent the groundwater filtration and build up the pore pressure. This thrust had been exposed along the riversides at the foot of the two rock avalanches, which suggest that the slopes on the thrust had been destabilized by the undercutting of long-term river incision. The destabilization induced gravitational slope deformation with small scarps before the catastrophic failure. In addition to the Kawarabi thrust, we found that the failed slope of the Akatani rock avalanche was cut by high-angle faults along both sides of the slope. Such a high-angle fault could be also assumed in the Akatani-E rock avalanche.

Our finding suggests that locating a large-scale low-angle thrust is essentially important to predict potential sites of rock avalanches as well as interpreting the internal structure of gravitationally deformed slopes. In addition, the combination of low-angle thrust faults and high-angle faults may be a common basic cause of gravitational slope deformation and catastrophic failure in mountains of accretionary complexes.

Keywords: rock avalanche, accretionary prism, thrust