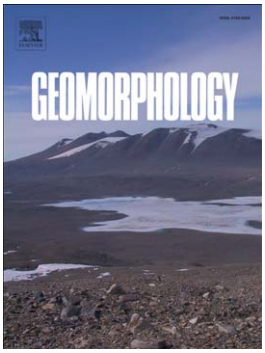

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Marc Ostermann, Diethard Sanders

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The Benner pass rock avalanche cluster suggests a close relation between long-term slope deformation (DSGSDs and translational rock slides) and catastrophic failure

Marc Ostermann* and Diethard Sanders

Institute of Geology, University of Innsbruck, Innrain 52, A-6020-Innsbruck, Austria

* Corresponding author. E-Mail: marc.ostermann@uibk.ac.at

Abstract

In mountain ranges deep-seated gravitational slope deformations (DSGSDs) and extremely rapid mass wastings of rock >10^5 m³ in volume (catastrophic rock-slope failures, CRF) are present, yet their mutual relation is poorly documented. Near the Brenner Pass (1370 m asl) in the eastern Alps, five catastrophic rock-slope failures of medium- to high-grade metamorphites are clustered ('Brenner Pass Cluster'; BPC), and three of them are related to DSGSDs. The catastrophic rock-slope failures involved volumes from 12 to 110 Mm^3 and show fahrboeschung angles of 10–27°. Numerical dating (^{14}C, $^{234}U/^{230}Th$) suggests that all catastrophic slope failures of the BPC occurred between ≤13.5 and 6.2 ka. Three of the CRF events may have occured during the Younger Dryas (12.7–11.7 ka), whereas two events occurred during the Holocene. Backwater basins dammed up by the CRFs range from 2.5 km^2 (Ridnaun rock avalanche) to 15.5 km^2 (Stilfes rock avalanche).

Three of the catastrophic rock-slope failures are associated with and developed as a partial failure of a DSGSD. This suggests that progressively slow deformation of slopes ultimately exceeded a stability threshold, resulting in catastrophic rock-slope failures. The initial kinematic mechanisms of failure vary between large-scale toppling, wedge sliding, and planar sliding and are strongly controlled by the structural setting of the slopes.

A direct connection of catastrophic mass wasting with specific palaeoclimatic conditions (e.g., phases of enhanced precipitation) is not indicated; however, this does not exclude