



Large-scale landslide-induced liquefaction and transport of valley-fill deposits in the Vorderrhein River Valley, Graubunden, Switzerland

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The Flims landslide, located in the canton of Graubunden in the eastern Swiss Alps, is one of the largest Holocene mass movements in the world. About 10-12 km³ of Helvetic carbonate rocks slid away from the north side of the Vorderrhein valley 8900 years ago and crashed onto the valley floor, blocking the Vorderrhein. An important secondary effect of the landslide was the liquefaction and mobilization of about 1 km³ of valley-fill sediments, which resulted in the emplacement of the Bonaduz gravels. The Bonaduz gravels were deposited by a mass flow in front of the Flims rockslide debris, to the east down the Vorderrhein valley, and to the south up the Hinterrhein valley, up to 16 km away. The unit, which is more than 60 m thick and stands in near-vertical faces, consists of upward-fining, well-rounded, poorly sorted gravels that grade into pebbly silt and, locally, silt. Characteristic sedimentological features include “Pavoni pipes” – sub-vertical, tube-shaped dewatering pipes – and large (up to multi-meter) rip-up clasts of lacustrine clayey silt. The mass flow that deposited the Bonaduz gravels rafted masses of rockslide material (“Toma hills”) up to 260 m long and 70 m high for distances of several kilometers. Generations of scientists have explored diverse aspects of the Flims landslide, but questions remain about the emplacement of the Bonaduz gravels and how liquefied valley-fill sediments can travel so far with so much power. We are attempting to better understand the Bonaduz gravels and the sequence of events that produced them through stratigraphic and sedimentological observations, particle-size analysis, and analysis of Lidar imagery. We are incorporating these observations into GIS-based maps of the Vorderrhein and Hinterrhein valleys. Of particular interest are several key field sites within and near the base of the Flims rockslide debris, where atypical facies of the Bonaduz unit interfingering with Flims rockslide debris have been found.