Geophysical Research Abstracts
Vol. 13, EGU2011-3412, 2011
EGU General Assembly 2011

The Gradenbach Observatory - monitoring in-stationary deep-seated gravitational creep by geodetic, hydrological, and seismological methods

Ewald Brueckl (1), Fritz K. Brunner (2), Erich Lang (3), Stefan Mertl (1), Martin Mueller (2), and Ulrike Stary (3)

(1) Institut of Geodesy and Geophysics, Vienna University of Technology, Vienna, Austria (ebrueckl@mail.tuwien.ac.at), (2) Institute of Engineering Geodesy and Measurement Systems, Graz University of Technology, Graz, Austria (fritz.brunner@tugraz.at), (3) Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), Department of Natural Hazards and Alpine Timberline, Vienna, Austria (erich.lang@bfw.gv.at)

The Gradenbach mass movement is an example of deep-seated gravitational creep in crystalline rocks of the Eastern Alps. It affects a slope of 1100 m height and comprises an area of 1.7 km2. Based on seismic and borehole data a structural model of the creeping rock mass was generated and a volume of 0.12 km3 determined. The Gradenbach mass movement attracted alertness by active phases in 1965 and 1966 which caused massive erosion at its toe and catastrophic debris flows. Thereafter, geodetic, geotechnical, and hydrological monitoring started. Another active phase affected the whole slope during the period 1974-75, when maximum displacements of ∼6m were observed. Total displacements of ∼ 22 m were derived from aerial photographs of 1963 and 1996 by a photogrammetric technique. An analysis of this data also showed that the mass movement has already reached a state of shear strain concentration at a basal sliding surface and block movement. The Gradenbach deep-seated gravitational creep is presumed to have been initiated by the retreat of the ice age glaciers. However, about 50% of the total displacement at the basal sliding surface or zone took place during the last 50 years. This general scheme of recently increasing activity together with the observed acceleration phases classifies the Gradenbach mass movement as a candidate for transition to tertiary creep and catastrophically rapid sliding.

GPS-measurements started in July 1999, just at the beginning of a new acceleration phase, which stopped abruptly in summer 2001, after producing a total displacement of 1.7 m. Thereafter a phase of stationary creep with a rate of ∼0.05 m/year followed. During spring 2008 the latest acceleration phase with maximum velocities of ∼ 8 mm/day and a total displacement of ∼0.4 m interrupted stationary creep for about 2 months. Additional data on deformation are supplied by rod extensometers, an embedded strain rosette based on fibre optics, and local conventional geodetic deformation networks. The hydrological monitoring at Gradenbach comprises precipitation (3 stations), water equivalent of snow cover (measured at snow courses at altitudes between 1400m and 2100m), discharge (at open gullies, drainage system), borehole gauges, air and water temperature. Some data series which are gained by automated monitoring stations reach back to the year 1996, the last upgrade and completion took place in 2008. Installation of a permanent seismic monitoring network at Gradenbach started in summer 2006. The current network comprises 6 three-component stations at the mass movement. One nearby reference station and additional sound sensors support discrimination between seismic events caused by the creeping rock mass, very near earthquakes, and surface or atmospheric sources. Location of hypocentres is based on a local 3D seismic velocity model. The stationary creep phase since 2006 and acceleration in spring 2008 was observed. Acceleration and deceleration were accompanied by significant changes of the seismicity pattern, partly preceding the observed geodetic signal. Local earthquakes are excellently recorded by the Gradenbach network. The potential of this data to monitor water content and changing elastic parameters of the creeping rock mass is currently being tested.

Besides research on deep-seated gravitational creep, the causes of acceleration and deceleration, and the possibility of a transition to rapid sliding, the monitoring at Gradenbach is being developed as a warning system. Experts and decision makers are informed about the research at Gradenbach and the data produced. GPS data are available real time and suitable for warning at an early stage. In case of emergency, extensometer, strainmeter, hydrological and seismological data can be actualized within 1 week.