SEISMIC AND GRAVIMETRIC MONITORING OF DEEP CREEP IN ROCK SLOPES

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Deep creep of rock slopes is frequently observed in high mountain areas. Over a time span of some thousand years many of these slopes developed according the pattern of a "Sackung" and obtained a stable equilibrium at present. However, there are also examples of deep creep changing unexpectedly to a rapid and catastrophic sliding motion. The intention of the seismic and gravimetric monitoring presented here is dedicated to the prediction of this change from deep creep to rapid sliding.

During IDNDR several mass movements were investigated in Austria by geodetic (Brunner et. al., 2000), geophysical (Brückl, 2001) and remote sensing methods (Rott et. al., 2000). For the monitoring program we selected two of these rock slopes, which represent deep creep in an active and rather early state (Gradenbach, Carinthia and Hochmais-Atemskopf, Tyrol). Even there is no imminent danger, we cannot exclude a transition to a rapid and catastrophic rock slide for these slopes in future time. The two rock slopes are also monitored by geodetic methods by other organizations.

Deep creep in rock slopes is accompanied by the development of cracks and may generate low magnitude earthquakes. The monitoring of these events supplies significant and unique information about the state and process of deep creep. The monitoring time we realized on the two rock slopes (Gradenbach and Hochmais-Atemskopf) comprises a total of 30 d with up to 10 seismic stations. At an average about one event per day was detected and localized. Magnitudes and seismic moments of the events and their pattern in space-time will be shown. Irreversible displacements associated with the seismic events are compared with the displacements measured by geodetic methods and the seismic efficiency is estimated.

The ground water level belongs to the most important factors influencing the process of deep creep in rock slopes. Although it can be measured in boreholes, there are good reasons to develop and apply appropriate geophysical monitoring methods. We
decided to observe gravity changes which can be related to the change of the total water content in the fractured rock mass. From synthetic models we may expect gravity changes up to 1 gu. On the site of Gradenbach a gravity network for relative gravity measurements has been installed comprising 14 stations, 5 thereof on the mass movement. From August 2000 to October 2002 seven gravity campaigns were carried out in this network with an accuracy of +/- 0.03 gu. The gravity changes due to mass changes in the subsurface are up to 0.2 gu. From the seismic exploration of Gradenbach we have estimates of the porosity-depth profile. Implementing this data the gravity changes are modeled by variations of the ground water table.

Up to now, the seismic and the gravimetric monitoring programs had the character of pilot studies. The extension of these pilot studies to a continuous, long time monitoring including phases of accelerating movements is an essential task for the future.

References: