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Application of active and passive seismic methods for characterizing fracturing processes in an unstable rockmass (Randa, Switzerland)

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Assessments of mountain-slope stability require detailed information on the spatial extent and potential kinematic and dynamic behavior of unstable rock. For this purpose, a range of geological and geophysical measurements were made above the scarp of the huge 1991 Randa rockslide. At this location, a large volume of the mountain slope is moving towards the valley at 1-2cm/year. A 3-D refraction experiment was designed to provide constraints on the boundaries of poor quality rock by mapping locations distinguished by low seismic velocities. The survey, which included five parallel and three perpendicular lines, covered a ∼300 x 300 m area. Shots along the lines were combined with shots at 33 offset locations to yield a high degree of 3-D coverage. Tomographic inversions of traveltimes revealed a broad zone of remarkably low seismic velocities (<1500 m/s) that coincided with a region characterized by major fracture zones and faults. To obtain information on localized displacements within the unstable Randa mountain slope, we monitored the local microseismicity using a small seismic network comprising twelve 3 component geophones located near the bottoms of nine shallow and three moderately deep boreholes. The microseismic network was functional for more than three years between November 2001 and December 2004. In total, 66’440 events (∼1 TByte of data) were registered. These events were analyzed using a semi-automated classification scheme. After identifying and eliminating spikes and "noise" created by human activities in the valley below, the remaining coherent signals were classified as (i) single microearthquakes located within the rock slope, (ii) multiple events that can be also associated with processes within the unstable rock slope,

(iii) unexplained low frequency emergent events, and (iv) regional earthquakes that occurred at considerable distances from the test site. Initial hypocentre locations based on an optimal homogeneous velocity model with station corrections indicated a high concentration of microearthquakes within a small subsurface volume near the edge of the mountain. Markedly improved hypocenter locations were achieved by considering the tomographically derived 3-D velocity model; we were successful in reducing the location errors of calibration blasts from $\pm$ 50m to $\pm$ 15-20m. Current research is focused on possible correlations between the microearthquakes and major fractures and faults. Furthermore, we need to determine whether the microseismic activity can be related to ultra low velocities in the tomographically derived 3-D velocity model.