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Detection and localization of micro-earthquakes on deep-seated mass movements

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Mass movements in brittle rock geology are expected to produce or enlarge fractures, or to display stick-slip movement along existing shear planes. Both processes generate seismic energy. The volume of the deep-seated mass movements under consideration is > 0.1 km^3, the creep velocities are in the range of 0.01 - 1 m/year. The potential energy release is sufficient to produce detectable seismic events daily or weekly. Since 2001 several passive seismic monitoring campaigns were carried out on three saggings in the Eastern Alps in Austria: Gradenbach (Schober Range, Carinthia), Hochmais-Atemskopf (Ötztaler Alpen, Tyrol), and Niedergallmig-Matekopf (Samnaun Range, Tyrol). Different recording systems have been used, mostly with 3C-seismometers, natural frequency 4.5 Hz. Up to 10 stations recorded simultaneously on one mass movement. Since September 2004 also one broadband seismometer has been operating continuously on Gradenbach. Teleseismic events and local earthquakes were well recorded and served as a quality control of the temporal network. The seismic events produced by the mass movements have frequency contents (above noise level) up to 50 Hz, durations of 10 - 20 s, and magnitudes <1. Some of these events can be well identified by standard signal detection methods and localized exactly because of clear first P-wave arrivals or S-phases. However, events with low S/N ratio or emerging energy cannot be detected by standard localization and detection routines. Alternative methods to detect and localize these events are developed and tested. These methods comprise sonogram-analysis, trace transformations (envelope), 3C and multi-station processing. The relations between seismic activity and state, size and velocity of each mass movement are analyzed.