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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 13 stations recorded simultaneously on one mass movement. Since December 2006 a permanent seismic monitoring network containing of 5 3-component stations has been operating continuously on Gradenbach. Teleseismic events and local earthquakes were well recorded and served as a quality control of the seismic monitoring networks. 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 detection and localization routines. Spectrogram and image processing routines are used to automatically detect and classify the recorded seismic events. Localization routines based on amplitude distribution are used to localize events with no clear first P-wave arrival.