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Application of multi-channel GPR to explore permafrost structures on the Qinghai-Tibet Plateau

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The thickness of the active layer in permafrost regions can be locally variable since it depends e.g. on exposition, soil type, vegetation and albedo. Standard methods for mapping the depth of the permafrost table are primarily based on the interpolation of point measurements obtained from drillings or soil profiles. Due to its high sensitivity on changes in dielectric properties ground-penetrating radar is a geophysical method that is well suitable for mapping the transition between unfrozen and frozen ground. The drawback of standard single-channel GPR measurements so far was, that the measured travel times could not easily be transferred to depth information. In addition to the measured travel times the calculation needs values for soil dielectric permittivity. Therefore, in most surveys that use standard single-channel measurements, a constant dielectric permittivity is assumed for a rough estimation of reflector depth. However, changes in soil dielectric permittivity alter the shape of the reflections below and interesting phenomena may remain undiscovered or misinterpreted.
Multi-channel ground penetrating radar allows the simultaneous measurement of several radargrams in the profiling mode at different antenna separations. The data is analyzed as a kind of "mini-CMP" measurement which allows a fast and direct mapping of reflector depth and additionally average water content of the active layer over distances of several hundreds of meters to a few kilometers. We present the application of multi-cannel GPR at permafrost sites on the Qinghai-Tibet Plateau. The measurements show the potential of the method as a tool for a more quantitative understanding of permafrost processes.