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Investigation on Thawing and Freezing Processes Using High-frequency Ground Penetrating Radar in Amdo catchment, Central Tibetan Plateau

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We have applied 250MHz ground penetrating radar (GPR) to investigate subsurface thawing and freezing processes in Amdo catchment, central Tibetan Plateau. Also, the topography and geography environments were surveyed to better understand the regional thaw/freeze cycles. Generally, the GPR images clearly illustrated the development of thawing and freezing events, which would be learned from the CMP soundings and reflection profiles.

Our results showed that a strong lower EM velocity of upper layers was detected in the thawing conditions, while a rather higher velocity could be monitored in the frozen grounds, which was mainly based on the large contrast in dielectric permittivity between liquid water and ice. In addition, on the north-facing slopes, the EM velocity was smaller than that of sunny slopes in thawing and freezing periods on the whole, which illustrated that the average soil moisture in the upper subsurface was higher in north-facing slopes than the opposite side. Furthermore, during the thawing periods, both of the velocity and thawing depth decreased as the slope became deeper on the south-facing slope basically; on the shade side, the velocity increased slightly when the slope got sharper, but the thawed depth had no obvious trend. As for the freezing periods, both the velocity and frozen depth were not found clear tendency on both sides. Moreover, the subsurface thawing and freezing developments were significantly affected by local surface environments (e.g, stream, grassland or bare soil) though in similar topographic conditions.

In all, the non-invasive GPR technique allowed the interpretation of spatial and temporal thaw/freeze processes, which played an important role on hydrothermal regimes in cold regions.