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High resolution monitoring of ice-wedge cracking by multiple techniques

N. Matsuoka (1), H. H. Christiansen (2)

(1) University of Tsukuba, Japan, (2) The University Centre in Svalbard, Norway

(matsuoka@atm.geo.stukuba.ac.jp)

Several techniques were combined to detect as precisely as possible the timing and magnitude of ice-wedge cracking in Adventdalen, Svalbard. A polygon trough rimmed by ramparts was instrumented with horizontal extensometers across the trough and across the rampart for measuring horizontal expansion and contraction of the trough and rampart, breaking cables and one-dimensional accelerometers, called shock loggers, for detecting crack generation, an automatic camera for visualizing crack extension and snow depth, thermistors for monitoring ground thermal gradients and TDR sensors for monitoring soil moisture in the active layer. Frost heaving of the rampart were also monitored with a vertical extensometer. All parameters were recorded automatically in data loggers. In addition, crack generation were visually inspected by frequent field visits during winter.

The winter of 2005–2006 was relatively warm. Following a fairly warm January, however, the monitoring site experienced a very cold period from mid February to the end of March, during which rapid ground cooling was assisted by a thin snow cover. All sensors simultaneously detected cracking in March. The extensometers across the ice-wedge trough recorded gradual widening of the trough through March and subsequent closing in early April. Differential extension between two heights across the ice-wedge trough indicates that the trough widening was accompanied by outward tilting of vertical benchmarks across the trough. A breaking cable broke on 18th March. These sensors indicated that following intensive cooling from mid February the trough began expanding in early March and finally cracked when the whole frozen active layer cooled below -10˚C. The rampart did not respond to this cracking event but sensed seasonal frost heave and thaw settlement (of the order of 1–2 cm), as well as the active

layer movement in summer. Significantly increased acceleration of the ground surface in the monitoring polygon was recorded by all the nine shock loggers located in the ice-wedge troughs during several events from mid February to early March. Increased ground acceleration was happening after air temperature drops of 15˚C, down to values at and below -20˚C, with permafrost top temperatures at or below -10˚C.