Geophysical Research Abstracts
Vol. 15, EGU2013-13702, 2013
EGU General Assembly 2013

Temporal and spatial dynamics of mega retrogressive thaw slumps revealed by 2D/3D geophysics and mechanical implications for the pace of coastal thermokarst on Herschel Island, western Canadian Arctic

Michael Krautblatter (1), Michael Angelopoulos (4), Hugues Lantuit (2,3), Michael Fritz (2), Josefine Lenz (2), Dave Fox (5), and Wayne Pollard (5)

(1) Technical University of Munich, (2) Alfred Wegener Institute for Polar and Marine Research, (3) University of Potsdam, (4) Golder Associates, Montréal, Canada, (5) McGill University, Montréal, Canada

Retrogressive thaw slump are among the most important carbon emitters along the Arctic coastline. Significant increases in their activity in the last 50 years has been demonstrated at multiple locations including Herschel Island. While distribution, size of retrogressive thaw slump and their respective change over time are assessed in a number of projects and publications at the moment, mechanics, spatial and temporal dynamics of retrogressive thaw slumps are still poorly understood.

We have performed direct current (2D/3D) and capacitively coupled (2D) resistivity tomography, refraction seismics (2D) and ground penetrating radar (2D). Longitudinal, transverse and 3D measurements were systematically arranged on a series of mega (several hundred meters length) retrogressive thaw slumps. Using the ergodic principle, we compared thaw slumps in an initial, accelerating, climax and decelerating stage and compared them with sites with proven historical activity at 300 years B.P. and with undisturbed sites. We can rely on multiple validation measurements including exposed ice wedge profiling, chemical composition of ice, permafrost augering, ice wedge and tundra C14 dating and a 50 year sequence of air photography.

The tomographies display remarkable spatial and temporal thaw slump dynamics in all development stages. Already in the initial stage, the tomographies show a large impact of the shoreline an associated warming at the toe of the slumps often extending several tens of meters inland. This could initiate a destabilisation dynamic starting from the toe rather than headwall of a slump, which contrasts previous hypothesis. In the climax stage, bimodal flows act to transport massive amounts of sediments to the shoreline. We can show that both, the accumulation of deep mud pools and the incision of the gully network has a decadal impact on permafrost distribution and mechanics of the thaw slumps. After the climax stage, deep reaching thermal patterns conditioned by bimodal flows and shoreline activity act to persist over hundreds of years and can be clearly distinct from undisturbed tundra slopes. The results are evaluated using the field evidence of ice wedge profiling, chemical ice data, permafrost augering, dating and air photography.

Here we show how the 20-30 m deep reaching geophysical data and associated field surveys, profiles and laboratory data can help to create a better understanding of the temporal and spatial patterns of mega retrogressive thaw slumps and their response to atmospheric and marine forcing.