

A possible climate signal in the surface morphology and internal structure of Galena Creek Rock Glacier, Wyoming

Eric Petersen (1), John Holt (1), Joseph Levy (1), Cassie Stuurman (1), Stefano Nerozzi (1), Benjamin Cardenas (2), James Pharr (3), Dan Aylward (2), Logan Schmidt (1), William Hoey (3), Parvathy Prem (3), Jackie Rambo (2), YeJin Lim (2), and Kian Maharaj (2)

(1) University of Texas Institute for Geophysics, University of Texas at Austin, United States of America, (2) Jackson School of Geosciences, University of Texas at Austin, United States of America, (3) Dept. of Aerospace Engineering and Engineering Mechanics, University of Texas at Austin, United States of America

Galena Creek Rock Glacier (GCRG) has been shown in previous studies to be a debris-covered glacier (e.g. Ackert, Jr., 1998), and is thus a target of interest as a record of climate and an element of the mountain hydrological system. The goal of this study was to investigate possible relationships between surface morphology and internal structure and composition of GCRG. This was achieved using ground-penetrating radar (GPR), time-domain electromagnetic sounding (TEM), and photogrammetry to produce digital terrain models (DTMs).

We acquired 6 longitudinal GPR surveys at 50 and 100 MHz, 2 common midpoint GPR surveys, and 28 TEM soundings on GCRG from the head to the toe, and ground-based photogrammetry data were collected to produce a DTM of its cirque at 10 cm resolution. TEM soundings locally constrained the bulk thickness of GCRG to 26-75 meters. Common midpoint and hyperbola analyses of GPR surveys produced dielectric constants in the near subsurface of 4 in the upper glacier to 5-9 in the middle and lower glacier. These are consistent with clean ice and a mélange of rock with air and/or ice, respectively. GPR revealed a pervasive shallow reflector at 1-2.5m depth that we interpret to be the interface between the surface debris layer and glacier ice. There is increased structure and clutter in the GPR data beneath this interface as one moves down glacier.

Observations were additionally made of a 40m wide, 4-5m deep circular thermokarst pond located on upper GCRG in the cirque. The walls of the pond revealed a cross-section of the top several meters of GCRG's interior: a dry surface layer of rocky debris 1-1.5m thick overlying pure glacier ice. An englacial debris band was also observed, roughly 50 cm thick and presenting at an apparent up-glacier dip of ~30 degrees, intersecting the surface near a subtle ridge resolved in the photogrammetry DTM.

A GPR transect conducted near the pond over 6 similar ridges imaged 6 corresponding up-glacier dipping reflectors that intersected the surface at 15-35 degrees at each ridge. Each of these reflectors is interpreted to be a debris band similar to the one observed in the thermokarst pond. These debris bands are hypothesized to represent climatic "tree rings:" they are formed in interglacial periods as rockfall accumulates and preserves underlying ice and then buried by subsequent ice deposition in the accumulation zone during positive mass balance periods. The up-glacier dip is the 2D expression of "nested spoons" morphology, expected from glacier flow.

The potential connections between surface ridge morphology, englacial debris bands, and regional climate-driven ice accumulation make GCRG a prime candidate for further investigation.