Geomorphic Signatures of Catastrophic Glacier Detachments

Mylène Jacquemart1*, Matthias Leopold2, Ethan Wet5, Lisa Lajoie6, Mike Loso7, Kristy Tiampo5

1 Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder; 2 School of Agriculture and Environment, University of Western Australia; 3 Institute for Arctic and Alpine Research, University of Colorado, Boulder; 4 National Park Service

Motivation

In two large detachments in 2013 and 2015, Flat Creek Glacier in Alaska’s St. Elias Mountains lost roughly 50% of its area. Ice and debris reached the White River, 12 km downstream.

Recent observations from Russia7, Tibet8, Argentina9 and China10 suggest that large-scale glacier detachments are becoming more frequent.

To assess the frequency of such events over longer time periods, we need to understand the signs they leave in the landscape.

We investigate the deposits left at Flat Creek to assess whether such deposits can be distinguished from other glacio-fluvial deposits.

Methods

To characterize deposits at the landscape level we use image analysis and DEM differencing.

We fingerprint the deposits’ internal structure with electrical resistivity tomography (ERT), and analyze how their grain size distributions and orientations differ from other glacio-fluvial deposits in the area.

Preliminary results

Relative to the surrounding landscape, event deposits are characterized by a higher content of fines < 1 mm.

The samples lack the expected sorting that leads to a higher content of fines with increasing distance from the source.

The abundance of grains oriented vertically relative to the surface of the deposit indicates a rapid and chaotic emplacement of the debris.

The remaining glacier has spread out rapidly, filling the trough left by the detachment, masking it almost completely.

Discussion

Comparison of our results against other documented glacio-fluvial deposits will show how well large-scale glacier detachment deposits can be identified in the field.

The quick response of Flat Creek Glacier shows that on the glacier, the detachment may quickly be masked. We will use DEMs and satellite images from Tibet and Russia to investigate the larger-scale landscape responses following detachments.

Deposits left by large-scale glacier detachments may be distinguishable from other glacio-fluvial deposits by the lack of grain-size sorting and grain orientation.

References:

2. Falaschi et al. 2019. Collapse of the 4 Mm

4. Rea et al., 2003. Maximum collapse of a large-scale glacier in the transverse range of Tibet.
8. Loso et al., 2013. Giant ice-rock avalanches and large-scale glacier detachment.
10. Kizito et al., 2018. Geomorphological and glacial deposits from the Flat Creek Glacier detachment.

Figure 2: Difference of July 2016 and August 2019 DEMs generated using structure-from-motion. b) Orthophoto mosaic from August 30, 2019. The dashed line indicates the location of the Flat Creek Glacier.

Figure 3: Grain orientations at sites O1 (sample A & B) and O2 (sample C). Sample A is from the original hillside, samples B and C are from the event deposit. The red circles indicate the number of grains oriented near-vertical with respect to the deposit surface. The blue circle indicates the number of grains that lacked a longitudinal axis.

Figure 4: ERT lines across the Flat Creek deposits. Blue-green colors indicate high conductivity, red colors indicate high resistivity interpreted as remnant ice.

Figure 5: Grain orientation scatter plots. a) Proximal, ice free deposit; b) large melting ice bodies and associated slumping; c) ice-sediment conglomerate found further downstream; d) scablation deposits from local ice melt.

Contact: mylene.jacquemart@colorado.edu

Acknowledgements: We acknowledge funding for this work through NASA’s Earth and Space Science Fellowship for MJJacquemart as well as the National Park Service for funding the field work and the SfM survey flown by Chris Larsen.

Scan the QR codes to read more about the Flat Creek Glacier detachments.