Geomorphologic and Geochronological Reconstruction of Glacial Lake Outburst Floods in Iceland: Applications to Mars

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Greta Wells is a PhD candidate in the Department of Geography and the Environment at UT-Austin. She earned an M.A. in Geography from UT-Austin in 2016 and a B.A. in Geology and French Studies from Colby College in 2011. Her research interests focus on geomorphology, hydrology, and Quaternary paleoenvironmental change in glacial landscapes. Specifically, her dissertation project uses geochronological, geomorphologic, and hydraulic modeling techniques to reconstruct a series of Holocene glacial lake outburst floods (jökulhlaups) in southwest Iceland. She is the recipient of a Fulbright-NSF Arctic Research Grant to conduct her dissertation research in Iceland in 2019-2020.

Abstract: Glacial lake outburst floods (GLOFs)—also known as jökulhlaups—have occurred on Earth throughout the Quaternary, from Pleistocene megafloods draining ice-dammed lakes, to contemporary floods triggered by climate-driven meltwater lake expansion. Jökulhlaups leave behind a distinctive suite of geomorphologic features that provide clues to flood timing and dynamics. Analog landforms exist on Mars, as well, and suggest flood events with discharges exceeding their terrestrial counterparts by multiple orders of magnitude (Carling et al., 2009). Iceland experiences more frequent jökulhlaups than nearly anywhere on Earth, and several sites offer promising terrestrial analogs for Martian paleofloods.

As the Icelandic Ice Sheet retreated across Iceland during the Late Pleistocene-Early Holocene, meltwater pooled at ice margins and periodically drained in jökulhlaups. Some of the most catastrophic floods drained from Glacial Lake Kjölur, surging across southwestern Iceland from the interior highlands to the Atlantic Ocean. These floods left extensive erosional and depositional evidence along the modern-day course of the Hvítá River, including boulder fields, cataracts, 70-m-deep gorges, and Gullfoss—Iceland's most famous waterfall. The largest events reached an estimated maximum peak discharge of 300,000 $m^3 s^{-1}$, ranking them among the largest known floods in Iceland and on Earth (Tómasson, 1993).

Yet, all our evidence for the Kjölur jökulhlaups comes from only one publication to date (Tómasson, 1993). My dissertation research employs new methods to better constrain flood timing, magnitude, routing, and recurrence interval at this underexplored site. Results will refine Icelandic deglaciation chronology, help quantify ice sheet response to climatic warming, and advance understanding of GLOF processes and hazard mitigation strategies at ice-dammed lakes worldwide. Furthermore, the Kjölur floods are an ideal case study for the role of extreme events in landscape evolution and bedrock erosion rates. This presentation synthesizes new geomorphologic field evidence and outlines plans for future data collection and analyses, namely hydraulic modeling and cosmogenic nuclide exposure dating. It concludes by discussing potential applications of the Kjölur jökulhlaups and other terrestrial floods to paleoflood reconstruction and geochronology on Mars.

Citations:

Carling, P.A., Herget, J., Lanz, J.K., Richardson, K., Pacifici, A., 2009. Channel-scale erosional bedforms in bedrock and in loose granular material: character, processes and implications. In: Burr, D.M., Carling, P.A., and Baker, V.R. (Eds.), Megaflooding on Earth and Mars. Cambridge University Press, Cambridge, pp. 13-32.

Tómasson, H., 1993. Jökulstífluð vötn á Kili og hamfarahlaup í Hvítá í Árnessýslu. Náttúrufræðingurinn 62, 77-98.