THE FOOL ON THE HILL: CHASING PINGOS WITH PINGO STARR. K. H. G. Hughson[1*], B. E. Schmidt[1], E. Quartini[1], R. J. Michaelides[2], M. R. Siegfried[2], A. D. Mullen[1], J. H. Bradford[2], A. Swidinsky[2], and H. G. Sizemore[3], [1]Georgia Institute of Technology, School of Earth and Atmospheric Sciences (*khughson7@gatech.edu), [2]Colorado School of Mines, Department of Geophysics, [3]Planetary Science Institute.

Introduction: On Earth, ice-cored hills found in perennially frozen environments known as pingos are important indicators of extant and extinct groundwater systems and hydrogeologic properties. Recent analyses of high-resolution images taken of the surface of Mars and the dwarf planet Ceres show quasi-circular conical hills populating areas suspected of supporting liquid groundwater in the past (e.g. [1] and [2]). These pingo candidates represent unique science targets whose investigation may provide significant insights into the hydrogeological, astrobiological, and *in situ* resource potential of Mars and Ceres. To prepare for the eventual exploration of potential pingo and ground ice analogs we must first understand how to characterize the structure and hydrogeology of these largely under-studied systems on Earth: enter Pingo STARR.

The Pingo SubTerranean Aquifer Reconnaissance and Reconstruction project (Pingo STARR) is a NASA-funded research initiative supported through the Planetary Science and Technology through Analog Research (PSTAR) program. This project is focused on improving our holistic understanding of pingo-forming hydrologic systems by investigating pingos in the North American Arctic using geophysical techniques likely to be employed by future robotic and human explorers throughout the solar system. Pingo STARR's key objectives are to:

1. Use ground penetrating radar (GPR), capacitively-coupled resistivity (CCR), and transient electromagnetic sounding (TEM) to determine the hydrological and geological structure of large pingos.
2. Assemble the largest complementary and comparable geophysical dataset of pingos collected to date in order to generate new insights into planetary periglacial hydrology.
3. Evaluate the advantages and disadvantages of our geophysical methods for investigating ground ice in a planetary analog environment.
4. Test the feasibility of deploying similar instrumentation on planets and asteroids in the future by both human and robotic explorers.

2021 Field Season: Pingo STARR's inaugural field season took place March 18 – April 10. During this initial deployment, the Pingo STARR team performed reconnaissance surveys over four large pingos south of Deadhorse, Alaska. These pingos were at least 8 m tall and 175 m in mean diameter and spanned the full local spectrum of observed pingo morphology, from broad and smooth to craggy and collapsed.

Initial Observations: GPR and CCR data obtained during the 2021 field season clearly identify our studied pingos, easily delineating resistive ice cores or core fragments from the surrounding less resistive permafrost. TEM and CCR data also revealed regions of relatively high ground conductivity underneath morphologically young appearing pingos. This suggests taliks are present at relatively shallow depths even under large pingos inland from the Arctic coast. These observations also indicate that pingo morphology is reflective of internal structure, though not always in intuitive ways.

Figure 1: *A 17 m tall pingo surveyed in spring 2021. 50 MHz GPR antennae are visible in the lower left.*

Looking Forward: Pingo STARR's initial field deployment has demonstrated that 'simple' and complementary off-the-shelf instrumentation can be rapidly deployed over a series of landforms in an analog planetary environment, and that the combination of CCR, TEM, and GPR data can provide insights into the geophysical structure and hydrology of these frozen features beyond what would be possible using any of the aforementioned techniques in isolation.

In 2022, the Pingo STARR team will return to the Arctic to further characterize pingo systems in 3-dimensions using our chosen geophysical techniques.

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References: [1] Dundas C. M. and McEwen A. S. (2010) *Icarus, 205*, 244-258. [2] Schmidt B. E. et al. (2020) *Nat Geo, 13*, 605-610.