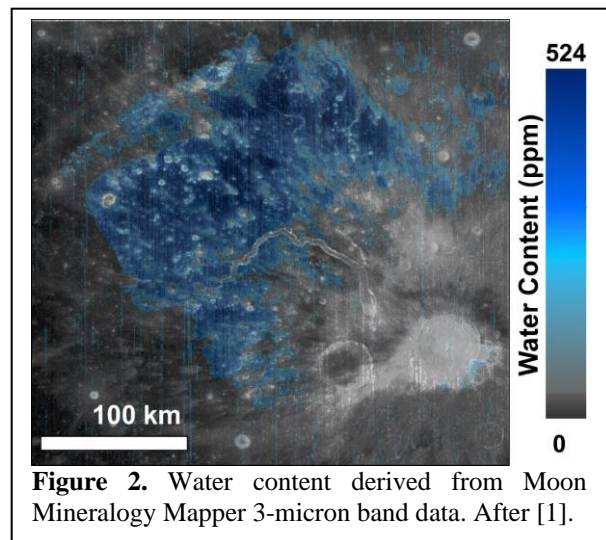
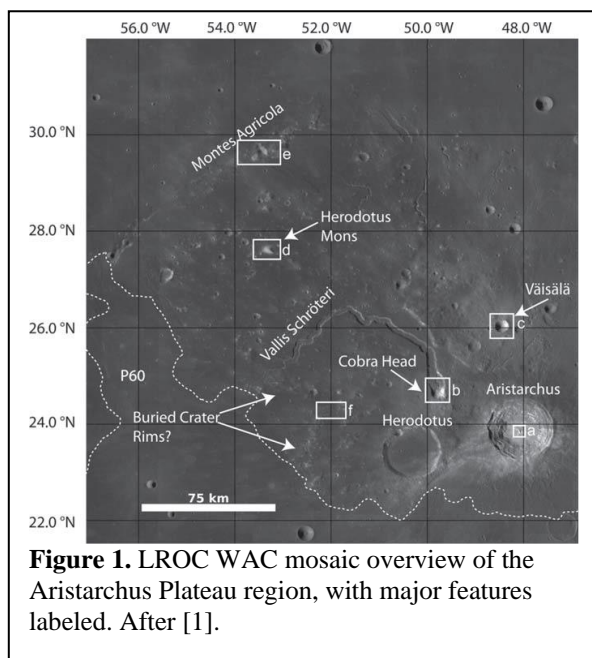


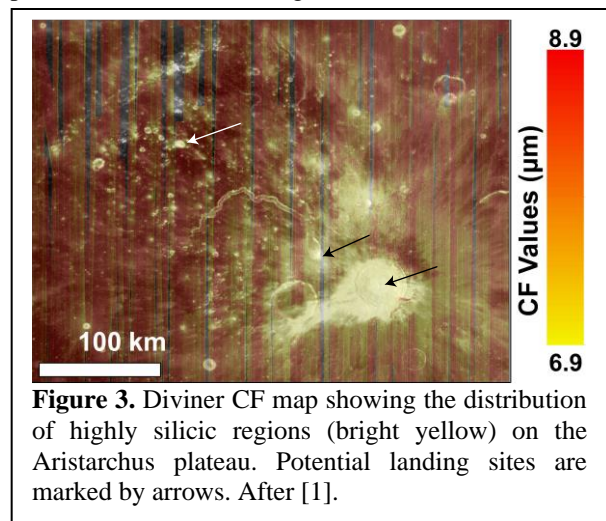
A PROPOSED EXPLORATION CAMPAIGN AT THE ARISTARCHUS PLATEAU. T. D. Glotch¹, E. R. Jawin², B. T. Greenhagen³, J. T. Cahill³, D. J. Lawrence³, D. P. Moriarty^{4,5}, N. Kumari¹, S. Li⁶, P. G. Lucey⁶, M. A. Siegler^{7,8}, J. Feng⁷, L. B. Breitenfeld¹, C. C. Allen⁹, H. Nekvasil¹, D. A. Paige¹⁰, ¹Stony Brook University (timothy.glotch@stonybrook.edu), ²Smithsonian Institution, ³Applied Physics Laboratory, ⁴NASA Goddard Space Flight Center, ⁵University of Maryland, College Park, ⁶Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, ⁷Planetary Science Institute, ⁸Southern Methodist University, ⁹NASA Johnson Space Center, ¹⁰UCLA

Introduction: The Aristarchus plateau hosts a diversity of volcanic features, including the largest pyroclastic deposit on the Moon, the largest sinuous rille on the Moon, and intrusive and extrusive examples of evolved, Th-rich silicic lithologies. The rich diversity of volcanic features on the Aristarchus plateau presents an opportunity for a sustained science and exploration program. We suggest a series of missions to the Aristarchus crater floor or ejecta, the Cobra Head, and Herodotus Mons to investigate the link between pyroclastic, effusive basaltic, and silicic volcanism in the region. Such missions would enable analyses of rocks that may be similar to rare samples in the Apollo collection (silicic fragments) and demonstrate in situ resource utilization of FeO- and H₂O-bearing pyroclastic materials.

Site Overview: The major features of the Aristarchus Plateau are shown in Figure 1 [1]. The plateau hosts the largest pyroclastic deposit [2] and widest and deepest sinuous rille, Vallis Schröteri, on the Moon. The pyroclastic deposit hosts up to 500 ppm of endogenous H₂O [3] (Figure 2), while Vallis



Schröteri terminates in the potentially very young P60 mare basalt unit [4]. Exposed on the plateau are also numerous features with evolved silicic compositions, including the floor and ejecta of Aristarchus crater, the Cobra Head, Vaisala crater, Herodotus Mons, and portions of the Montes Agricola [1,5]. These features



all have anomalously low Christiansen Feature (CF, an emissivity maximum) positions (Figure 3) as measured by the Diviner Lunar Radiometer, indicative of high silica polymerization and, therefore high SiO₂ content.

Campaign Landing Sites: We propose a campaign of exploration at the Aristarchus Plateau composed of no fewer than 3 CLPS missions targeted to the Aristarchus Crater floor, the Cobra Head, and the Herodotus Mons/pyroclastic deposit boundary. Each site has low slope regions for safe landing, although the Cobra Head and Herodotus Mons sites would require the capability to traverse steep ($> 25^\circ$) slopes (Figure 4). Survive-the-night capability would enable long-term mission planning and exploration of

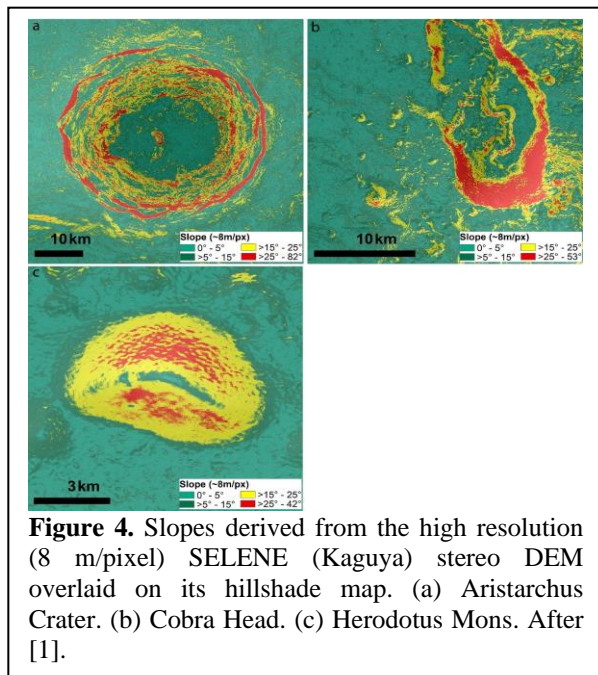


Figure 4. Slopes derived from the high resolution (8 m/pixel) SELENE (Kaguya) stereo DEM overlaid on its hillshade map. (a) Aristarchus Crater. (b) Cobra Head. (c) Herodotus Mons. After [1].

each site. While mobility would substantially enhance the science return from each mission, sample return would enable transformational science focused on materials that are rare or absent in the Apollo sample collection.

Nominal Scientific Payload: Given the dual goals of characterizing material from the largest pyroclastic deposit on the Moon and characterizing compositionally evolved silicic rocks, we suggest that any landed mission to the Aristarchus plateau should include a core science payload of a TIR hyperspectral imager and a gamma ray and neutron spectrometer (GRNS). These instruments would be supplemented by a panchromatic or multispectral stereo imager for context imaging and traverse navigation. A multi-spectral micro-imager would enable morphologic and compositional characterization of the regolith at the grain scale. Furthermore, depending on the size and scope of the mission, it would be useful to co-manifest this payload with a hyperspectral VNIR point spectrometer or imager for characterization of mafic mineral/glass content and H_2O associated with the pyroclastic deposit and a remote Raman spectrometer for correlative mineralogical analysis.

Motivating Science Questions: Motivating science questions for the Aristarchus Exploration Campaign include, but are not limited to: (1) How are large-scale granitic/rhyolitic compositional features on the Moon generated in the absence of plate tectonics? Do they reflect hot-spot processes as seen on Earth? (2) Is there any field evidence for a relationship between the basaltic and silicic materials? What petrologic processes would indicate that they could or could not be related, and what do these inferences imply about the lunar interior? (3) Is there a gradation in silicic compositions that is not discernible from orbit due to limited spectral and/or spatial resolution? What lithologies are represented by the silicic material (e.g., trachytes, syenite, potassic granite, potassic rhyolite)? Are there intermediate compositions? (4) What do the correlations between SiO_2 content, Th, and/or H_2O tell us about lunar interior composition and evolution? (5) Are there coatings on the pyroclastic materials that can tell us about volatiles (other than H_2O) in the lunar interior? (6) How do the textures, crystallinity, and compositions of the pyroclastic materials and basaltic lava flows in the region differ, and could they have been sourced from the same eruptive center(s)? Each of these questions could be addressed through analyses of pyroclastic, basaltic, and silicic materials on the Aristarchus plateau by one or more missions.

Conclusions: Of the identified silicic features on the Moon, Aristarchus appears to be unique in that the silicic materials exposed by Aristarchus crater suggest the presence of a large subsurface silicic pluton [5]. A series of missions to the Aristarchus plateau offers the opportunity to address numerous questions related to the generation and evolution of silicic magmas, their relationship to basaltic volcanism, and their expression on the lunar surface. A mission to the Aristarchus crater floor or silicic ejecta would offer the opportunity to sample likely plutonic silicic rocks that may be similar to silicic fragments in the Apollo sample collection. A mission to the Cobra Head would enable the first direct examination of possible bimodal volcanism on the Moon, while a landed mission in the vicinity of Herodotus Mons would characterize both silicic and pyroclastic material.

References: [1] Glotch, T. D. et al. (2021), *PSJ*, 2, 136. [2] Gaddis, L. R. et al. (2003), *Icarus*, 161, 262. [3] Milliken, R. E. and S. Li (2017), *Nat. Geosci.*, 10, 561. [4] Hiesinger H. et al. (2011), *GSA Special Paper* 477. [5] Glotch, T. D. et al. (2010), *Science*, 329, 1507.