NASA'S LUNAR TRAILBLAZER: MAPPING KEY TARGETS FOR LUNAR WATER, GEOLOGY, AND EXPLORATION. B.L. Ehlmann[1], R.L. Klima[2], J. Dickson[1], J.K. Miura[1], and the Lunar Trailblazer team. [1]Div. Geological & Planetary Sciences, Caltech, Pasadena, CA, [2]JHU Applied Physics Lab, Laurel, MD

Introduction: Selected in 2019, Lunar Trailblazer is a PI-led NASA SIMPLEx smallsat mission to the Moon, led by Caltech and managed by JPL with industry partner Lockheed Martin Space providing the spacecraft and integrated flight system. Two science instruments acquire data simultaneously in pushbroom mode: the High-resolution Volatiles and Minerals Moon Mapper (HVM^3) visible/shortwave infrared imaging spectrometer and the Lunar Thermal Mapper (LTM) multispectral infrared camera (Fig. 1; Table 1). Lunar Trailblazer passed its Critical Design Review in July 2021, is presently in build, and the flight system will be delivered by the end of 2022 (NASA has currently manifested Trailblazer for launch in 2025).

Primary Science Objectives and Targets: Trailblazer is optimized to make targeted measurements of the infrared properties of the lunar surface to (1) detect and map water on the lunar surface at key locations to determine its form (OH, H_2O, or ice), abundance, and distribution as a function of latitude, soil maturity, and lithology; (2) assess possible time-variation in lunar water on sunlit surfaces; (3) map the form, abundance, and distribution of water ice in the PSRs; and (4) measure surface temperature to quantify local gradients and search for small cold traps. Over the ≥1-year primary science mission, the ≥1000 targets to satisfy Level-1 mission requirements [3] include sites of distinctive composition viewed at multiple times of day, targets along latitudinal gradients in areas of homogeneous composition, and permanently shadowed polar regions.

Table 1. Current best estimate Lunar Trailblazer science observing parameters from 100±30 km orbit, >1000 cubes, footprint per image: 14-28 km width x 28.5 km length.

HVM^3
Spatial Sampling: 50-90 m/pixel; **Spectral Sampling:** 0.6 – 3.6 µm @ 10 nm sampling; **SNR** >100
LTM
Spatial Sampling: 40-70 m/pixel; **Thermal:** Temp. retrieval 110-400K (± 2 K), 4 broad bands, 6-100 µm; **Composition:** 11 channels; < 0.5 mm, 7-10 µm

Additional Priority Data for Lunar Science and Exploration: Lunar Trailblazer's instruments will provide the highest resolution visible/shortwave infrared spectral and thermal data at the Moon, complementing Diviner and M^3 global datasets (Table 1). The team's summer 2021 decision to add a medium-gain antenna means that Lunar Trailblazer also has margin against its data volume budget. On 21-22 October 2021, Lunar Trailblazer held community targeting workshops to solicit priority targets-of-interest from the broader lunar community so that these can be acquired on an as-possible basis. Key additional priority science and exploration data include:

(1) landing site reconnaissance for maps of water, composition, and thermophysical properties at actionable scales for traverse planning (<100 m/pixel) for both robotic and human missions;
(2) zonal targets for comprehensive surface and thermophysical properties mapping for ISRU reserve assessment (extractability, surface exposure for sampling, operational use cases);
(3) fundamental lunar science by mapping soil and rock composition (mineralogy, space weathering).

Lunar Trailblazer anticipates being able to downlink >~500 targets beyond its baseline to focus on these community objectives that accomplish additional priority science and exploration at the Moon.

Acknowledgements: Thanks to the NASA HQ and PMPO offices and the entire Lunar Trailblazer team. For more information, see trailblazer.caltech.edu. Lunar Trailblazer is funded under NASA contract #80MSFC19C0042. **References:** [1] Thompson et al., LPSC 2020, abs. #2052 [2] Bowles et al., LPSC 2020, abs. #1380. [3] http://murray-lab.caltech.edu/LunarTrailblazer/webmap/

Figure 1. The Lunar Trailblazer spacecraft acquires simultaneous images from its two instruments for mapping the form distribution and abundance of water, mineral composition, and thermophysical properties at <100 m/pixel from all orbits (100 ± 30 km).