TRIDENT Drill for VIPER and PRIME1 Missions to the Moon – 2023 Update. K. Zacny[1], P. Chu[1], V. Vendiola[1], P. Creekmore[1], P. Ng[1], S. Goldman[1], E. Seto[1], K. Bywaters[1], E. Bailey[1], R. Zheng[1], I. King[1], A. Rashedi[1], P. Chow[1], R. Huddleston[1], G. Paulsen[1], A. Wang[1], J. Wilson[1], H. Xu[1], S. Indyk[1], J. Quinn[2], A. Eichenbaum[2], J. Captain[2], J. Kleinhenz[3], E. Rezich[3], T. Colaprete[4], D. Lim[4], Z. Mirmalek[4], D. Lees[4], R. Elphic[4], K. Ennico Smith[4], and TRIDENT, PRIME1, and VIPER teams, [1]Honeybee Robotics, Altadena, CA, KAZacny@HoneybeeRobotics.com, [2]NASA Kennedy Space Center, FL, [3]NASA Glenn Research Center, OH, [4]NASA Ames Research Center, CA,

Introduction: The Regolith and Ice Drill for Exploration of New Terrains (TRIDENT) is an ice mining drill under development for two exploration/ISRU missions to the Moon: Volatiles Investigating Polar Exploration Rover (VIPER) – see and PRIME1 (Polar Resources Ice Mining Experiment) – see Figure 1 [1]. PRIME1 is scheduled to fly to the Moon in 2023 and explore the area outside of Shackleton crater, while VIPER is targeting 2024 launch year, with a goal of exploring terrain near Nobile crater. Both missions are targeting volatile rich deposits.

The primary goal of TRIDENT is to deliver volatile-rich samples from up 1 m depth to the lunar surface [2]. Once on surface, the material would be analyzed by Mass Spectrometer Observing Lunar Operations (MSolo) and the Near InfraRed Volatiles. Spectrometer System (NIRVSS) to determine volatile composition and mineralogy of the material. MSolo will fly on both missions while NIRVSS will fly on VIPER.

Figure 1. TRIDENT on VIPER (left) and PRIME-1.

TRIDENT is a rotary-percussive drill which enables it to cut into icy material that could be as hard as rock. The drill consists of the following subsystems: rotary-percussive drill head for providing percussion and rotation to the drill string, deployment stage for deploying the drill to the ground, feed stage for advancing the drill string 1 m into subsurface, drill string for drilling and sampling, brushing station for depositing material onto the surface (Figure 2).

TRIDENT drill is designed to capture and deliver samples in so-called bites. That is, the drill penetrates 10 cm into subsurface, and then it is pulled out and deposits the 10 cm worth of material onto the surface for analysis by MSolo and NIRVSS instruments. Once the analysis period is complete, the drill penetrates another 10 cm (i.e., from 10 cm to 20 cm depth), and brings up fresh material for the analysis.

To achieve bite sampling approach, the auger is split into two sections. The lower section has flutes designed for sample retention. The upper section is designed for efficient conveyance of material to the surface. This combination allows efficient sampling but inefficient conveyance – the drill should not be used to drill to 1 m depth in a single run as this will lead to increase in drilling power and ultimately heat input into formation.

TRIDENT would also be able to capture geotechnical data such as bearing strength, density, unconfined compressive strength, and temperature.

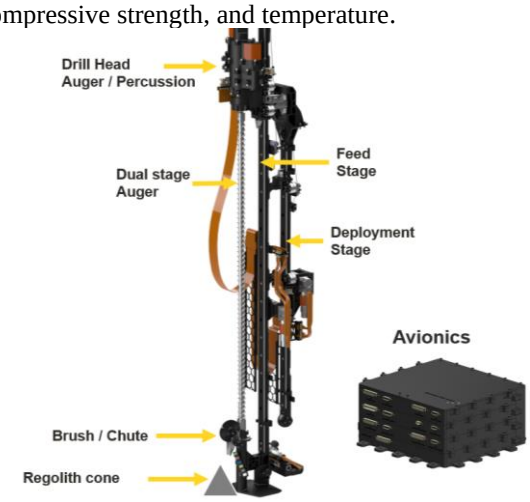

Figure 2. TRIDENT subsystems.

TRIDENT drills and associated avionics have undergone vibration and EMI/EMC testing. PRIME-1 drill has completed TVAC and VIPER drill will undergo TVAC tests in July/August of 2023 (Figure 3).

Figure 3. TRIDENT drills for PRIME1 and VIPER.

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References: [1] Colaprete et al., (2020), LPSC, [2] Zacny et al., (2018), LPSC, [3] Paulsen et al., (2018), Aerospace Mechanisms Symposium.