TRIDENT (The Regolith and Ice Drill for Exploring New Terrain) for the Volatiles Investigating Polar Exploration Rover (VIPER) and Polar Resources Ice Mining Experiment (PRIME-1).

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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 Figure 1, and PRIME1 (Polar Resources Ice Mining Experiment) – see Figure 2 [1].

The primary goal of TRIDENT is to deliver volatile-rich samples from up 1 m depth to the lunar surface [2, 3]. 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. Mission Inertial Measurement Unit (IMU) on VIPER will be able to record seismic shaking induced by both rotary and percussive actions, enabling subsurface sounding.

Figure 1. VIPER mission. TRIDENT is placed in vertical position in the middle of the rover.

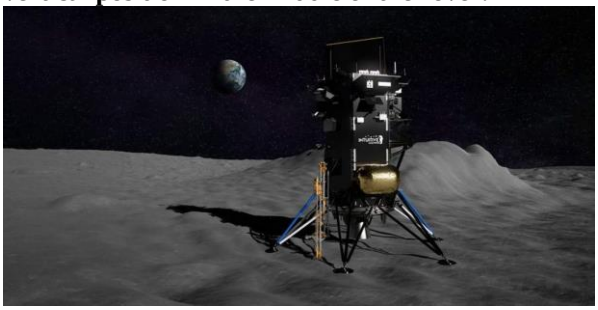

Figure 2. PRIME1 mission. TRIDENT is vertically mounted on the lander.

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 3). The stowed volume of the drill is 20.6 cm x 33.3 cm x 168 cm.

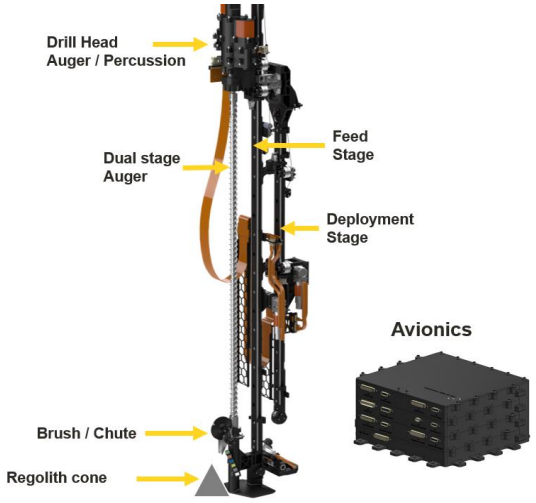

Figure 3. TRIDENT subsystems.

TRIDENT is the only system that interacts with the subsurface regolith. As such, it offers additional information that otherwise would not be possible.

TRIDENT drills have been integrated onto deployment system at Intuitive Machines ahead of PRIME-1 launch in 2024/2025 and VIPER rover.

Engineering Model of TRIDENT drill is currently being used in dirty TVAC chamber to drill under lunar like conditions in regolith simulants having various water content from 0% to above 8%.

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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.