ATACAMA ROVER ASTROBIOLOGY DRILLING STUDIES: ROVING TO FIND SUBSURFACE PRESERVED BIOMARKERS.

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Introduction: The Atacama Desert in Chile is one of the most important Mars analog environments on Earth due to its extreme aridity. Geological and soil mineralogical evidence suggest that extreme arid conditions have persisted for at least 10–15 million years [1], but the sedimentary record indicates the region has been arid since late Triassic [2], making it the oldest continuously arid desert on Earth.

Approach: Mobile exploration of the subsurface is essential in achieving future astrobiology goals. Discovery of extant preserved biomarkers and perhaps past or extant life on Mars is unlikely without the ability to access the subsurface. Lightspeed delays for Mars missions (tens of minutes) are much longer than the time required (seconds) to get a drill stuck, so deep space rover drilling operations must be automated and fail-safe, or else risk anchoring the rover. Obtaining subsurface samples of regolith will require the ability to identify a suitable location, transport and emplace a drilling apparatus, and control the operation with high reliability.

Project: The Atacama Rover Astrobiology Drilling Studies (ARADS) project is a NASA Planetary Science And Technology Through Analog Research (PSTAR) project which in 2015-2019 will incrementally build up to a Mars rover analog mission as a field test of an integrated rover-drill system with prototype instruments (Fig. 1) that are themselves flight mission candidates or have flown (WCL). The fourth in a series of 1m-class autonomous rotary-percussive drills by Honeybee Robotics and NASA Ames, and a new autonomous mid-sized rover concept (K-REX) developed by NASA-Ames, will be integrated with four fielded in-situ instruments: the Spanish Signs of Life Detector (SOLID) [3] immunoassay instrument; the JPL Microfluidic Life Analyzer (MILA) [4] capable of extracting amino and fatty acids; a Wet Chemistry Laboratory (WCL) brassboard [5] and the GSFC Laser Desorption Mass Spectrometer (LDMS), a simplified version of the Mars Organic Molecule Analyzer (MOMA) [6] under development for the ExoMars rover mission.

The essential elements to ARADS are: 1) use of an integrated drill and rover at sites in the Atacama Desert in Chile in unprepared "regolith" (such as Fig. 2); 2) field use of in-situ instruments with the rover/drill that are flight prototypes comparable to those planned for ExoMars and Icebreaker; 3) acquire drilled cuttings and transfer to instruments; 4) on-board autonomy and monitoring to support drilling; mission and demonstrate science support (operations and control) for the rover/drill/instrument operations.

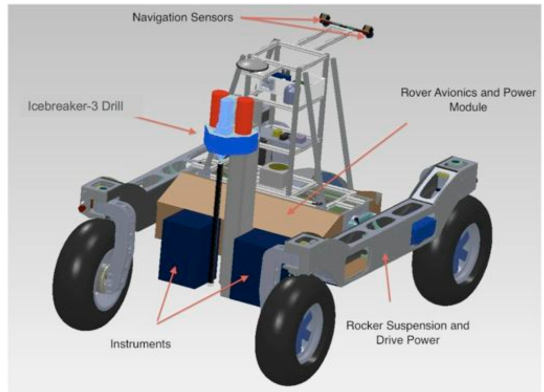

Fig. 1: ARADS integrated drill/rover.

The scientific objective of the proposed research is to understand the mobility and distribution of soluble salts, organic compounds, organic biomarkers, and life in extremely dry soils in the Atacama, as an analog system to Mars, down to the 1-2m depths proposed for exploration with ExoMars or Icebreaker/Red Dragon.

Fig. 2. Field science ground truth sampling from a pit at Yungay Station (ARADS site).

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