The ARADS Project as an Astrobiological Survey Mission Prototype

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An astrobiological survey prior to human arrival will be important for preservation of signs of any existing or past evidence of Martian life, to reduce the risk of unintentional forward contamination of Martian environments in which terrestrial microbes might be able to gain a foothold (e.g., [1]), and to potentially protect the health of any human crews and enable their safe return to Earth. Evaluating for the presence of life and biosignatures may become a critical-path Mars exploration precursor in the not-so-far future, circa 2030-35. The near-subsurface, with its potential combination of volatiles, vapor exchange with the surface, and shelter from surface radiation, will be a primary initial target for in-situ astrobiological investigation.

Sample acquisition, drilling and sample handling are key elements of robotic missions that target the subsurface [2], as well as near-surface ground ice deposits. In the mid 2000s, the Mars Astrobiology Field Laboratory (AFL) was proposed as a follow-on mission concept to the Mars Science Laboratory (MSL)/Curiosity rover mission [3]. The AFL would have included precision drilling to 2m, automated sample handling and remote processing of cores.

However, the AFL concept needed further development and maturation. The Atacama Rover Astrobiology Drilling Studies (ARADS) project concept [4] was in part AFL-inspired. The 2014 ARADS concept included a medium sized rover, with habitability instruments, including the Phoenix Wet Chemistry Laboratory (WCL) [5], and an enhanced version of the ExoMars Mars Organic Molecule Analyzer (MOMA) Laser Desorption-Linear Ion Trap Mass Spectrometer (LITMS) [6]. ARADS likewise included two biosignature detection instruments -- the Signs of Life Detector (SOLID) immunoassay instrument [7,8] and the Chemical Laptop-derived [9] Planetary In-Situ Capillary Electrophoresis System (PISCES), while mitigating Planetary Protection-relevant contamination issues [10].

ARADS project objectives were to demonstrate the potential science return for such a mission in the context of the search for evidence of life, and technically to demonstrate the feasibility of roving with drilling missions to Mars. ARADS technology goals targeted analog-site demonstrations of automated drilling and sampling, integrated with its mobile habitability and biosignature detection instruments. And ARADS science operations goals developed remote science, contamination mitigation, and communications methods to enable simulating AFL-like science operations with time delays, directed by a remote science team[11].

Five subsequent Mars analog site field demonstrations (in Chile’s hyperarid Atacama Desert, 2016-19) provided a step-by-step development pathway for the ARADS platform’s science capabilities and systems integration, culminating in an integrated remote roving mission simulation in the final ARADS year (2019).

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