USE OF A NOVEL ROVER-MOUNTED FLUORESCENCE IMAGER AND FLUORESCENT PROBES TO DETECT BIOLOGICAL MATERIAL IN THE ATACAMA DESERT IN DAYLIGHT. S. Weinstein[1] and D. Pane[1], K. Warren-Rhodes[3,4], C. Cockell[5], L.A. Ernst[1], E. Minkley[1], G. Fisher[1], S. Emani[1], D.S. Wettergreen[2], M. Wagner[2], J. N. Cabrol[3,4], A.S. Waggoner[1]. [1]Molecular Biosensor and Imaging Center, Carnegie Mellon University, 4400 5th Ave, Pittsburgh, PA 15213; [2]Robotics Institute, Carnegie Mellon University, Pittsburgh, PA 15213; [3]NASA Ames SST. MS 245-3, Moffett Field, CA 94035-1000; [4]SETI Institute; [5]British Antarctic Survey (BAS), UK.

Introduction: We have developed an imaging system, the Fluorescence Imager (FI), for detecting fluorescence signals from sparse microorganisms and biofilms during autonomous rover exploration. The fluorescence signals arise both from naturally occurring chromophores, such as chlorophyll of cyanobacteria and lichens, and from fluorescent probes applied to soil and rocks. Daylight imaging has been accomplished by a novel use of a high-powered flashlamp synchromized to a CCD camera.

The fluorescent probes are cell permeant stains that have extremely low intrinsic fluorescence (quantum yields less than 0.01) and a large fluorescence enhancement (quantum yields greater than 0.4) when bound to the target. Each probe specifically targets either carbohydrates, proteins, nucleic acids or membrane lipids, the four classes of macromolecules found in terrestrial life. The intent of the probes is to interrogate the environment for surface and endolithic life forms.

Integration into the Rover: The FI and its control were integrated into the design of the Carnegie Mellon University autonomous rover, Zoë. The FI 's field-of-view pointed towards the ground directly under Zoë's chassis. It was mounted on rails to allow two degrees of motion- *x* (side-to-side) and *z* (up-and-down). Positioning in *y* was accomplished by the movement of Zoë itself. The FI was stowed in the chassis while traveling to prevent damage by obstacles.

For the 2004 Atacama field tests, part of the NASA ASTEP "Life in the Atacama" project, the application of the fluorescent probes and any preps was done manually by-hand. All other operations were performed by the computers on-board Zoë.

2004 Field Season in the Atacama: The FI was utilized in both periods of science operations of the 2004 Atacama Desert field tests. Each period of science operations lasted one week, with the science team sending daily command sets to the rover and its suite of instruments to implement search-for-life strategies. A ground truth team and a rover team were in the field to support the science activities.

The first field site. This environment is characterized by desert pavement, where surface soils composed of clays and salts are mantled with rocks of varying size, density, and composition. In several locales, bare surface and embedded rocks were colonized by microbial life, as pictured in figure 1.

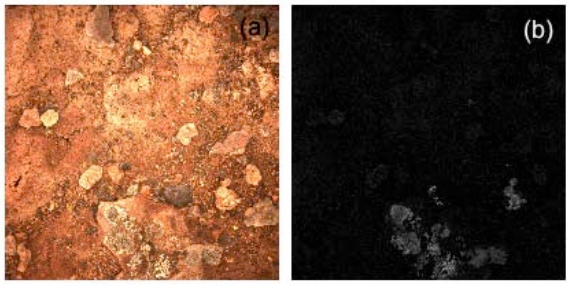

Figure 1: Daylight detection of lichen colonies in the Atacama Desert with the Fluorescence Imager on-board a rover: a) RGB channel and b) chlorophyll fluorescence channel. The field-of-view is 10 cm x 10 cm with a pixel sampling of 100 microns.

The second field site. Desert pavement and hypersaline environments dominated this site. Light-toned mafic rocks observed may support endolithic bacteria, as shown in Figure 2.

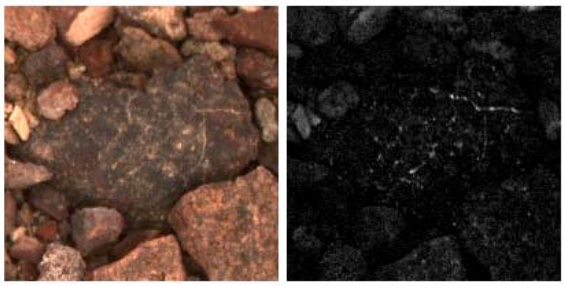

Figure 2: Fluorescence Imager detection of fluorescent probes designed to give signals when bound to specific molecules: a) RGB channel, b) protein fluorescence channel. Images were taken in the Atacama Desert on-board a rover in daylight. The field-of-view is 10 cm x 10 cm with a pixel sampling of 100 microns.

Conclusion: The FI delivered quality RGB and fluorescence images of the desert floor in the field-of-view. Ground truth pending, the FI detected what appears to be both surface and endolithic life. The dyes functioned, although further investigation is needed to improve penetration into surface life forms, such as lichens. Ground truth efforts to distinguish biotic versus mineral fluorescence are also critical and underway.