IN-SITU SOIL MICROBIAL DETECTION USING NATIVE FLUORESCENCE

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For this research project we designed an instrument to detect bacteria via biomolecular fluorescence. We introduce the current understanding of astrobiology, our knowledge of life beyond Earth, and the commonality of Earth life as it pertains to the search for life on Mars. We proposed a novel technique for searching for direct evidence of life on the surface of Mars using fluorescence. We use the arid region of the Mojave Desert as an analog of Mars. Results indicate the fluorescence of the biotic component of desert soils is approximately as strong as the fluorescence of the mineral component. Fluorescence laboratory measurements using the portable instrument reveal microbial concentration in the Mojave Desert soil is 10^7 bacteria per gram of soil. Soil microbial concentrations over a 50 meter^2 area in the Mojave Desert, determined in situ via fluorescence, show that the number varies from 10^4 to 10^7 cells per gram of soil. We then designed an instrument for detection of biomolecular fluorescence, and considered also fluorescence from polycyclic aromatic hydrocarbons and minerals on the Martian surface. The majority of the instrument is designed from Mars surface operation flight qualified components, drastically reducing development costs. The basic design adapts the ChemCam instrument package on-board *Mars Science Laboratory* rover *Curiosity* to detect organics via fluorescence. By placing frequency multipliers in front of the 1064 nm laser, wavelengths suitable for fluorescence excitation (266 nm, 355 nm, and 532 nm) will be achieved. The emission system is modified by the addition of band pass filters in front of the existing spectrometers to block out the excitation energy. Biomolecules and polycyclic aromatic hydrocarbons are highly fluorescent at wavelengths in the ultra violet (266 nm, 355 nm), but not as much in the visible 532 nm range. Preliminary results show minerals discovered, such as perchlorate, fluoresce highest when excited by 355 nm. Overall, we conclude the fluorescent instrument described is suitable to detect soil microbes, organics, biomolecules, and some minerals via fluorescence, offering a high scientific return for minimal cost with non-contact applications in extreme environments on Earth and on future missions to Mars.