In-situ Detection of organics and biomolecules via native fluorescence. H.D. Smith[1,3] A.G. Duncan[2], R.C. Sims[3], P.L. Neary[4], C.R. Lloyd[5] , A.J. Anderson,[3] and C. P. McKay[1] 1. Space Science and Astrobiology Division, NASA Ames Research Center, Moffett Field, Ca 94035, 2. Desert Systems, Logan, UT, 84341, 3. Biological Engineering Department, Utah State University, Logan, UT 84322, 4. Tricep Engineering, Logan UT, 84341, and 5. Retego Labs, Centerville, UT 84014 6.

Introduction: We report on the use of a portable fluorescent instrument employing four excitation wavelengths combined with four emission wavelengths to analyze microbial soil contents. We used the Mojave Desert soil as an analog for Mars soil in an Astrobiology study. The desert soil was amended with known numbers of bacteria and fluorescent measurements made on a dilution series of the soil to determine the sensitivity of the instrument. We found the fluorescence of the biotic component of desert soils was approximately as strong as the fluorescence of the mineral component of the soils. Using processing algorithms developed to separate the biological fluorescence signal from the mineral fluorescence signal we improved detection limits for soil microorganisms by a factor of 10 to 1000. Fluorescence laboratory measurements using the portable instrument indicated the microbial concentration in the native Mojave Desert soil at 10^7 bacteria per gram of soil, a level confirmed by phospholipid fatty acid analysis. Soil microbial concentrations over a 50 meter area in the Mojave Desert determined in situ using fluorescence show that the number of bacterial populations varied from 10^4 to 10^7 cells per gram of soil. We suggest that this variability is due to self-organized patchiness by analogy with variability in plants in desert environments. Overall, we conclude that fluorescence is a practical method for detecting soil microbes in non-contact applications in extreme environments on Earth, future missions to Mars and Europa [1].

A key goal for astrobiology is the search for evidence of life on other worlds – in particular Mars. In the near term such a search will be conducted by rovers. Experience with the Mars Exploration Rovers, *Spirit* and *Opportunity*, shows that it is difficult for the rovers to obtain samples. For this reason, a method for detecting organic chemicals and/or microorganisms without collecting a sample is needed and UV fluorescence is a strong candidate. Indeed non-contact determination of microbial content using native/intrinsic fluorescence is already in use in the food, pharmaceutical, and water quality industries (*Lloyd et al. 2003*). Non-contact fluorescence-based methods would also be of use in extreme environments on Earth. Traditional methods for determining microbial content in such environments require sample collection followed by laboratory analysis. This procedure disturbs the soil environment, requires time for transit and analysis possibly altering the viable microbial content, and alters the sample as it is analyzed possibly rendering the soil useless for further studies. The capability to directly determine soil microbial content in situ without contacting or disturbing the soil is important when studying fragile or extreme ecosystems on Earth, such as cryptobiotic crusts.

Many molecules found in living cells exhibit characteristic fluorescence. Characterization of fluorescence involves both an excitation wavelength range and an emission wavelength range. The fluorescence energy is always less than that absorbed to relaxation by radiationless transitions. Excitation and emission ranges for biological molecules are broad [25-200 nm] as the molecules are very large and at any one point in time exhibit a range of molecular conformations [and a range of energy levels accordingly]. In biological systems, the emission wavelength range often overlaps the excitation wavelength range, so these ranges must be judiciously chosen. Experimental results suggest emission wavelength is generally 50 to 100 nm longer than the excitation wavelength.The emission intensity is directly related to the amount of the specific biomolecule present and to the intensity of the excitation[1].

References: [1] Smith, H.D et al. 2012. Astrobiology.

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