UTILIZATION OF NANO-VIBRATION FOR MICROBIAL LIFE SENSING

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Introduction: In 1977 and 1984, the infamous Alan Hills meteorites were first discovered in Antarctica. In addition to being spiked with biogenic minerals and organic materials, it also contained mineralized filamentous, coccoidal forms of iron-oxidizing bacteria [1]. Since then, there has been ongoing innovation in technology to detect the presence of microbial life in meteorites. Many forms of spectral techniques (fluorescence, gamma, Raman, etc.) have been developed for microbial biomass detection in the martian regolith, rocks, ice, and permafrost. These techniques rely primarily on elemental composition analyses for identification of biomarkers that can discriminate the presence of microorganisms. However, this may not always be useful as it requires the sample to be transported, which can lead to contamination and a loss of sample integrity.

Proposal: Our group has previously examined the use of nanoscale vibration sensors for the detection of microorganisms within Martian regolith [2]. We hereby propose the extension of this technology for its use in meteorite sampling and detection of bacterial life. These sensors utilize a cantilever to detect motion. The cantilever is comprised of an arm anchored at one end for structural support and functionally interacts with the specimen at the other. Inspired by the atomic force microscope that uses cantilever vibrations to image surface atoms, the sensor works on the assumption that microbes in the sample that are alive will predictably move, e.g. beat its cilia. The functional end has to be initialized with a linker molecule based off the level of specimen immobilization desired. Ultimately, this can enable the detection of nanoscale vibration unique to bacterial lifeforms.

Limitations: Unfortunately, this technology still has a number of limitations that must first be taken into account prior to its use. First, mineralization of bacteria may result in lower scale nanovibrations than detectable by these sensors. As only a limited sample of meteorites with microorganisms have been sampled, it is difficult to assess if the sensitivity of these sensors provide sufficient resolution. Second, the quality of meteorites is characterized by a greater density when compared to Martian regolith. As such, a proof-of-concept is required prior to the implementation of this technology.

References:

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