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Understanding microbial preservation and the relevance for life detection

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Future planetary exploration not only involves the search for habitable environments on extraterrestrial plantary bodies, but also the search for evidence life. There is consensus in the community that this search would have to include the detection of evidence of microbial life, extinct or extant. Consequently, undrestanding microbial diagenesis and identify means to detect such diagenitic products has high implications in life detection strategies in plantertary exploration.

In this paper we discuss initial results from studies on microbial diagenesis in both, laboratory controlled experiments, as well as from natural fossil bacterial biofilms. Artificial fossilization studies help us understand the processes involved in microbial diagenesis, particulalry focussing on macromolecular diagenesis, poibly allowing inferences to natural environments to be made, where microbial preservation is presently ongoing. Conversely, studying fossil bacterial biofilms for their full molecular inventory of organic compounds demonstrates what organics are in fact preserved after millions of years. The combination of both types of data provides valuable information to the design of life detection stratgies in planetary exploration and helps conceptualizing and testing instrumentation to fulfil this task.

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Astrobiotechnology

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The growth of biotechnology in the last twenty years has been staggering and the sheer number of new techniques and procedures can be disorientating. With the birth of Astrobiology a natural interface between biology and therefore biotechnology, space and geological sciences has been formed. For scientists from all of these disciplines the speed of development of new instrumentation has been difficult to keep abreast of. This short review seeks to bring together a cross section of the latest research and development in biotechnology instrumentation and in particular biosensors that are relevant in a solar system exploration context.

Obviously the development of these techniques would fulfil a unique purpose in exploration terms, the detection and more importantly potential characterisation of life on other solar system bodies. Why use biotechnology? The answer is very simple; the techniques that have been used for solar system exploration (SSE) have been ambiguous or failed completely to detect life. In the case of the debate on relic biogenic activity in the Martian meteorite ALH84001, many traditional techniques such as amino acid analysis, C-isotope analysis and gas chromatography – mass spectrometry (GCMS) all concluded that no life was contained within the meteorite [1,2,3,4]. However, some if not this entire meteorite was colonized by terrestrial microbiota [5]. Whether through reasons of sample selection, choice of technique or detection sensitivity, this organism was not found by the techniques traditionally associated with life detection in the solar system and being developed for flight instrumentation. A further example is the ambiguity associated with the Viking lander results [6]. Recent re-evaluations of these experiments have revealed that the sensitivity of the GCMS was simply inadequate for the task and would have missed the organic material produced by approximately 10^7 bacteria per gram of Martian regolith [7]. This ambiguity must be prevented from re-occurring in future exploration efforts.

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