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The search for *in situ* signs of past life on Mars

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The *in situ* search for past life on Mars requires a global strategy in which general geological, micropalaeontological and geochemical expertise are paramount. A correct understanding of the geological context of the landing site, from a global to macroscopic scale, is fundamental before detailed observation and geochemical analyses on specific rocks can be made. We have been using an Early Archaean, 3.46 Ga-old chert formation from the Pilbara as a terrestrial analogue for potentially fossiliferous sediments of Noachian age on Mars [1]. The terrestrial analogue material perfectly coincides with the kind of rocks that would have been formed on Early Mars, *i.e.* volcaniclastic sediments deposited in shallow water to littoral environments that were subsequently silicified by hydrothermal fluids. In the Early Archaean environment, microbial mats formed macroscopically visible layers at the surfaces of the volcaniclastic sediments. These layers are represented by domical and stratiform stromatolites. Our test sample contains several microbial mat layers, one of which, a 2 mm high stratiform stromatolite layer, can be traced laterally for several meters in the field. We used a camera identical to that mounted on the Beagle 2 lander to study these sediments and the stromatolite layer. Imaging was performed using wavelength-selective filters at 60 cm distance and black/white imaging using a close-up lens at 8 cm distance (resolution 50µm/pixel). The images clearly documented sedimentary structures, such as cross-bedding, as well as the mini-stromatolite layer. Further textural detail provided by the on-board microscope, combined with geochemical spectra from the rock layers, can provide sufficient information to chose such a sample for additional organic geochemical analysis (*e.g.* GC-MS, Raman) that would provide strong compositional and isotopic indications of past life.

References

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Life detection on a chip

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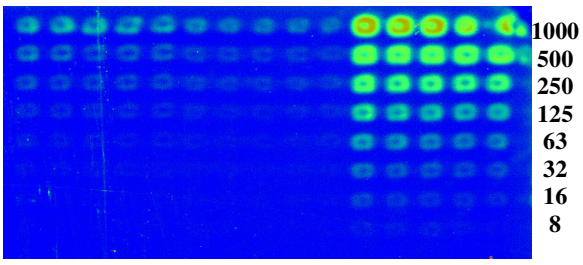
A prototype life-detection "chip", a thumbnail-sized antibody microarray [1], was used to capture and detect the following biological markers: DNA, L-glutamate, PAH, chaperonin 60, β-galactosidase, peptidoglycan, lippolysaccharide, *Escherichia coli* and *Mycoplasma.* These target molecules fall into a hierarchy of 4 categories: Broad e.g. DNA (all organisms), Intermediate e.g. peptidoglycan (gram-positive bacteria), Species-specific e.g. *E. coli*, and Contaminant e.g. *Mycoplasma* or mammal-specific proteins (not presented here). Antibodies were printed on a glass surface, producing a 3mm^2 15 × 12 grid of "features" or spots (each 200µm in diameter). The surface was blocked to prevent non-specific binding, incubated with sample, washed, incubated with fluorescent-tagged antibody mix, washed again and scanned at 635nm (total time: 2 hours). Figure below: Anti-LPS (**A**), anti-PAH (**B**) and anti-chaperonin 60 (**C**) antibody printed in quintuplicate at concentrations from 1000 to 8ng/spot. Sample spiked with chaperonin 60 only.



A potential mission scenario is for in situ analysis of regolith on the Martian surfcae with a pre-printed chip, followed by data uplink to Earth. Antibodies are suitable for such a mission, they retain function for several years [2], beyond the 8-9 month Earth-Mars transit period, and are less susceptible to radiation damage than DNA. Incubation/wash steps function well in Martian gravity and microgravity [3]. Detection of organics/life on the Martian surface will only be conclusive when a negative control test for life is performed in space during transit to Mars and before Mars EDL.

References

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