

Scientific significance of searching living cells on Mars surface by Life Detection Microscope (LDM)

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Past trial of direct detection of life on Mars by 1970's Viking mission ended up with a negative conclusion [1]. Whereas, numbers of new finding provided by Mars exploration missions in the last decade indicate that there are good reasons to perform another life detection program. The sensitivity of the gas chromatograph mass spectrometer onboard the Viking mission was not very high, and was not able to detect the microbes 10^6 cells in 1 gram clay [2,3].

Recent findings on Mars tend to support the possible presence of living microbes near the surface of Mars. MSL Curiosity has found organic compounds [4], the temporal increase of methane concentration in Martian atmosphere [5] and reduced sulfur compounds such as pyrite in Martian soil [6]. Methane and reduced sulfur compounds can be energy sources to support the growth of chemoautotrophic microbes [7]. Possible presence of liquid water at Recurring Slope Lineae has been supported by the detection of hydrated salts [8]. These evidences tend to support the possible presence of living microbes near the surface of Mars and indicate that another life detection program is necessary.

The Life Detection Microscope (LDM) that we have proposed [7, 9] has the potential sensitivity much higher than the Viking instrument. Microscopes directly image life forms and identify their shapes, sizes, and other morphological structures and have the potential to detect a single cell in field of view. Therefore, the sensitivity can be as high as desired just by increasing the volume of sample to be scanned in a reasonable duration of experiment. LDM scans about 1 mm^3 and detects less than 10^4 cells in 1 gram soil at a spatial resolution of $1 \mu\text{m}$ [9]. LDM differentiates among organic compounds surrounded by membranes or with enzyme activity by staining the samples with fluorescent pigments. This technique is especially useful for the detection of living microorganisms.

The search for living microorganisms is important not only for scientific interest but for planetary protection. Before future human missions begin, surveys investigating the presence of living microorganisms should be conducted to mitigate the risk of human contact with Martian microorganisms, which may be harmful to human health. Scientific significance the development of LDM will be addressed in this report.

References

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