Current status of the development of LDM (Life Detection Microscope) for in situ analysis of Mars surface

（火星表面探査のための生命探査顕微鏡（LDM）開発の現状）

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ABSTRACT

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 10^6 cells of microbes in 1-gram clay [2,3]. Here we propose Life Detection Microscope (LDM) that has much higher sensitivity than the instrument onboard Viking.

Resent observations on Mars have found the evidences of past water activities. MSL Curiosity has found the temporal increase of methane concentration in Martian atmosphere [4]. The presence of reduced sulfur

compound such as pyrite in Martian soil was also detected by MSL [5]. Methane and reduced sulfur compound can be the energy source to support the growth of chemoautotrophic microbes [6]. Possible presence of liquid water at Recurring Slope Lineae has been supported by the detection of hydrated salts [7]. The presence of organic compounds of Martian origin has been reported [8]. These evidences tend to support the possible presence of living microbes near the surface of Mars.

Physical and chemical limits for terrestrial life have been major foci in astrobiology [9], and are summarized in ref. [6]. Combining the environmental factors, anywhere in the Martian environment where we can find the three components, water molecules, reducing compounds and oxidative compounds could be an environment where life can be sustained for long periods of time, if other factors such as temperature, pressure, UV and other radiations permit [6]. Among these factors, most of the factors including ionizing radiation can be endured by terrestrial extremophiles. Only UV can kill the most UV-resistant microbes within minutes. However, UV can be shielded by a-few-centimeter soil layers. These evaluation lead to the conclusion that the Martian soil under a few cm can be the place to support the growth of microbes, if the water activity is higher than 0.6.

We propose to search for cells from a depth of about 5 - 10 cm below the surface, which is feasible with current technology. LDM could detect less than 10^4 cells in 1-gram clay [6]. LDM has the sensitivity that is two orders of magnitude higher than the one onboard Viking. LDM is capable of identifying what we think to be the most fundamental features that a cell should possess to constitute life. Our Investigation Goals are the followings. 1) Identify cell-like structure in which organic compounds are enveloped by membrane, which may represent Martian life. 2) Search for any type of organic compounds in Mars surface samples: cells, other biological materials, and abiotic polycyclic aromatic hydrocarbon (PAH). 3) High- resolution characterization of regolith and dust particles.

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