CULTIVATION OF IRON BACTERIA ON THE MARS. K. Giber[1], [1]Városmajori Secundary School, H-1122 Budapest, Városmajor utca 71., Hungary; (chicco@chicco.hu).

Introduction: Starting from the results of the Mars-missions obtained so far - the first question I try to answer with my idea is: which of the living organisms of the Earth would be most suitable to be kept alive and possibly proliferated with the least of energy use under the conditions of the Red Planet (avoiding the risk of inter-planetary infections). The next question: how would it be possible and on what part of the planet to obtain practical information concerning the above on the course of a Mars mission, using the technology which is now available. I outlined some of my ideas for what measurements these could be used on the course of the same mission. Finally I mentioned some further obvious and very important use methods which the success of my suggested experiment might ensure on the long for later Mars missions. These too might serve as persuasive arguments to carry out the experiment - in addition to its theoretical importance: "the first living organisms of Earth on Mars".

Outline of the experiment

Selection of site and subject of the experiment: iron bacterium; creation of experimental conditions

Thanks to the dense dust layer whirled up by dust storms from time to time on Mars the effect of life endangering cosmic rays is hindered already. However 1.5 - 2 metres below the surface these life- destroying effects are negligible: the soil-like formation absorbs or reflects them. It would be possible to ensure the presence of micro-organism in such depth by way of drilling or by using of liquids which erode the soil and evaporate afterwards. Drilling at the ambience of the sixtieth degree of latitude the frozen water ice of the Martian permafrost would be a reachable depth (1.5 - 2 metres)[1,2,3]. Here it would be possible to prepare a circular chamber of 5 - 10 cm diameter (for instance by way of using carefully chosen liquids, possibly acids) which will serve as the site of the experiment: the location of micro-organisms. There would be no light here and no oxygen however it would be possible to melt enough water for one culture and maintain its temperature above 0°C while using minimal amounts of energy. On the course of previous missions greater quantities of magnetite (Fe_3O_4) and FeO [4] were already identified in the Martian surface rock and thus it is highly probable that such components are also present 1.5 - 2 metres deeper (considering that also on Earth the soil forming stone layers do not alter without transition subject to depth). The above mentioned two iron containing compounds contain Fe^{2+} which represents the energy source of the chemoautothrophic iron bacteria (they obtain energy by oxidising Fe^{2+}) [5]. The carbon source of the iron bacteria is carbon dioxide which is present in great amounts in the atmosphere of the planet and thus also close to the surface [4]. Thus it would be possible to conduct carbon dioxide to the site of the experiment e.g. by way of using a drill pipe. Hydrogen source of the iron bacteria is water, which might be available as described above from the permafrost ice on this site. Selecting iron bacteria from the anaerobic representants (e.g. Thiabacillus Ferrooxidans) would ensure that the lack of oxygen does not raise concerns. Nor does it represent a serious problem that at present we have just faint ideas about the pH values of Mars rock [6]: the pH-demand of bacteria can be changed easily and almost without limitation using gene engineering [7]. Using 3 to 4 well selected groups of bacteria of different pH demand it might be possible to find groups which are optimal for the experimental conditions. These different groups can be separately closed into small easily broken spheres each and then forwarded into the chamber (see figure) through a pipe the end of which tilts and can be checked separately. (Once fallen on the ground the spheres are broken and the bacteria which were within in an encapsulated state will immediately interact with the experimental circumstances). At this site under the surface the experiment is also protected from storms and greater temperature variations. It is also advisable to carry out the experiment within the given degrees of latitude and height measured from the zero point in a valley which is relatively protected so as to protect the upper instrument which is fixed at the surface and which is used to carry out drilling and e.g. also sampling.

Safety Measures to Avoid Inter-Planetary Infections

Iron bacteria have to be made dependent by gene engineering methods from a carefully chosen substance which does not exist on Mars. This substance can be added e.g. daily into the melted water of the chamber thus ensuring that the bacteria remain alive. However once the dose stops to be administered the individual bacteria would perish. This prohibits that living or encapsulated bacteria get out of control of the instrument finishing the experiment or suffering some failure.

Measurements Detecting Proliferation and/or Life Symptoms

Once the bacterium groups arrive separated into the chamber we can observe within short whether their

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life proceedings and proliferation started or not and which of the groups shows the most intensive growth (bacteria are able to multiply by division at intervals of 20 to 30 minutes). We might check these using different means: thus we might use a small telescopically lowered camera in the chamber to find out whether the size of some of the colonies increased and to which extent. We might increase the effect by marking the different groups with indicator colours. It is thinkable to make sensitive resolution heat measurements with the camera because within the chamber it is but the bacteria which produce energy: thus the growth of their heat area indicates proliferation. Finally growth of the iron bacterium cultures can also be followed by regular sampling: if the overall Fe^{3+} content of the samples increases the bacteria are growing, because on taking up energy they oxidise Fe^{2+} and release Fe^{3+}. This is the end of the first phase of experiments.

Other Measurements Possible on the Course of this Experiment

The second phase can give place to further studies. Thus the pH value of the soil-like formation is found once the best growing bacterium is determined. Observation of some weeks natural selection [8] of the bacteria is also a worth while to study, and the kind of materials they take up, because we might follow from these what composition the rocks under the surface possess and perhaps even on the site and quality of life which took place or might take place on the Planet Mars. This site which unites so much life conditions [9] might ensure the greatest chance for specifically resistant Martian micro-organisms to possibly survive.

Long-range Applicability of the Experiment in Case of Success

If we found that gene-engineered variations of iron bacteria were able to survive in the outlined Martian environment using so little technical support and energy sources - then they could be used in later Martian experiments e.g. as indicator organisms to analyse samples, to study life possibilities or they might serve as biological energy carriers and producers (specifically if the bacteria are able to proliferate!).

There also might be a number of further applications of them, as the first representatives of Earth life on Mars.

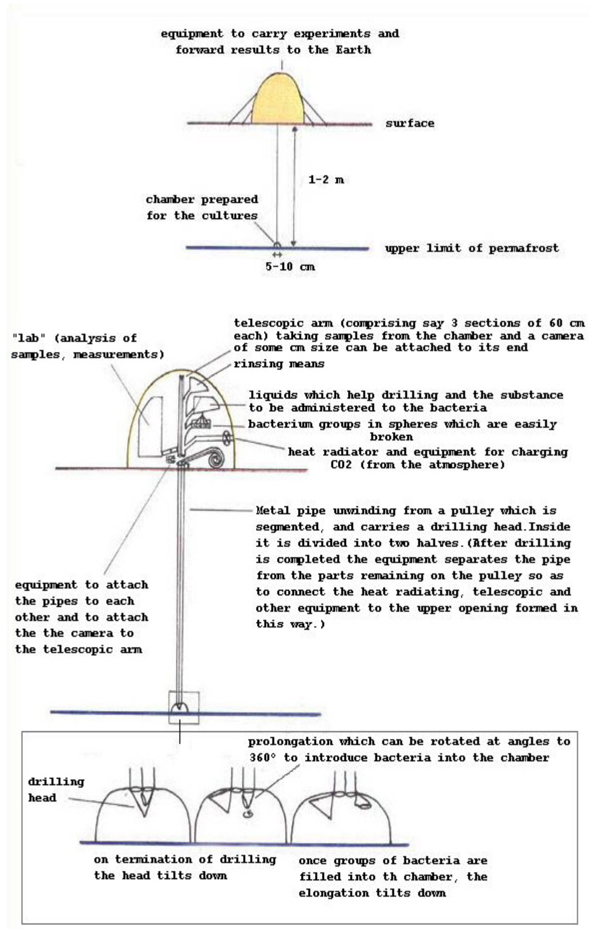

Figure: Mechanism of the experiment

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