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EXPERIMENTAL INSTRUMENT ON HUNVEYOR FOR COLLECTING BACTERIA BY THEIR ELECTROSTATIC COAGULATION WITH DUST GRAINS (FOELDIX): OBSERVATION OF ELECTROSTATICAL PRECIPITATED COAGULATED UNITS IN A NUTRIENT DETECTOR PATTERN

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ABSTRACT

Electrostatic coagulation properties of dust above planetary surfaces (CRISWELL, 1972, RHEE ET AL., 1977, REID, 1997, HORÁNYI ET AL., 1998, SICKAFOOSE ET AL., 2001) were studied by FOELDIX instrument of Hunveyor. We developed FOELDIX by a detector unit in order to observe biomarkers on Mars by collecting dust thrown out from dusty regions. The dust collector experiment (FÖLDI ET AL., 1999), with the observation capability of the size dependent dust particles (FÖLDI ET AL., 2002), was developed by fitting a nutrient container detector pattern which can show various types of bacteria in the inner detector-wall of the modified FOELDIX instrument (FÖLDI ET AL., 2001). Coagulation of electrostatically charged dust particles, rare H_2O molecules and suggested extremophile bacteria from the dusty Martian surface is carried out by our experimental assemblage through the space with electrodes. Coagulated grains are allowed to precipitate in the vicinity of some specially charged electrodes (FÖLDI, BÉRCZI, 2001a). If living units form a community, a consortia of bacteria and fungal spores with the attached soil then the cryptobiotic crust (PÓCS, 2002) components of Mars may also be found and distinguished by this measuring technology.

INTRODUCTION

Levitating charged dust particles were measured on Surveyors (Criswell, 1972), Apollo's LEAM experiments (Rhee et al., 1977) and their models were shown (Reid, 1997; Horányi et al., 1998; Sickafoose et al., 2001). Windstorms on Mars are known since old times and were photographed. We also studied levitating dust particle phenomenon in the experiment of FOELDIX where coagulation of lunar quasiatmospheric dust were modelled (Földi et al., 1999, 2001). We placed the FOELDIX instrument among the Hunveyor (Bérczi et al., 1998, 1999) electrostatic assemblage. To search the possibility of life on Mars we developed our instrument with bacteria and spora detector unit.

The FOELDIX detector unit consists of stripes with nutrient containers. They are placed on the inner wall of the dust collector. They form a coordinate system. (In terrestrial conditions the containers can be replaced with other ones.) In principle the detector unit is similar to the Magnetic Properties Experiment of the Mars Pathfinder, where magnetic materials were fixed on a curtain on the surface of the lander. Magnetic materials were arranged in a characteristic pattern of spots. Magnetic forces glued the magnetized particles on the spots. The repeated dust interaction with this curtain amplified the pattern of the colored dust particles attracted on the spots till the visibility of the pattern. Even by camera observation of the curtain the magnetic spot pattern - with various megnetisation strength of the spots in the curtain magnets - allowed estimation of the magnetisation of the dust particles flown by winds (Hviid et al., 2000).

THE SOIL AND BACTERIA TOGETHER

Extremophile bacteria are among the main constituents of the cryptobiotic crust on the Earth. The FOELDIX instrument has a benefit to colllect the fragments of such living consortia in glued and coagulated units. This way not only dust but the glued bacteria or other living units (i.e. fungal spores) can be collected into the instrument's container detector. Selected detecting mechanism is necessary to distinguish the various components of the cryptobiotic type living unit fragments of the windblown dry powder material. Therefore a detecting surface with a selective nutrient stripe arrangement was constructed for the FEOLDIX. On the Hunveyor we measure the CBC collecting capacity of the instrument in the Great Hungarian Plain where dry alkaline grounds can be found, especially in the Hortobágy.

THE MEASURING DETECTOR ARRANGEMENT

In our measuring detector an inner wall-curtain with various nutrients are fixed in the vicinity of special electrodes. These electrodes allow the coagulated dust and bacteria grains (and other complex particles) to precipitate and sediment from the streaming particles in the instrument. The coagulated materials with various bacterial components can grow on the nutrient stripes with different effectivity. Repeated interaction of the precipitated dust-and-bacteria coagulates will change the color and extent of the nutrient stripe regions and amplifies the pattern of the nutrients till the visibility of the arrangement of stripes. Microcamera observation of the detector's stripe pattern will show the types of bacteria (or fungal spores) existing inside the coagulated dust particles.

COAGULATION OF PARTICLES CONTAINING DUST + BACTERIA + WATER MOLECULES

On the inner surface of the electron tube, even in the case of hypervacuum, a monomolecular water molecule layer can be found (Tungsram Factory, Bródy and Palócz, 1953). These water molecules are small negative ions and have far longer lifetime then that of the small positive ions (Israel, 1957).

In the vicinity of a dusty planetary surface there exist a space charge of electron cloud. The rare water molecules will act as if they were negatively charged and they preserve their charge. The negatively charged water molecules frequently collide with particles of a positively charged dust cloud producing a complex coagulated particle. This particle is a loose aggregate of ions, has great mass and has lower velocity compared to the small mass particles. While colliding with a negatively charged water molecule the water molecule will attach to the larger one. This process enlarges the complex aggregate larger and larger (we measured coagulation up to 450.000 times mass in the FOELDIX instrument). The living units are embraced and included into this coagulated large particles. Living units are shielded by the dust components from UV and other radiations, and the presence of water allows to continue their life activity, too.

LOCATION OF PROMISFUL OBSERVATION CHANCES FOR MARTIAN LIVING ORGANISMS: SOUTH POLE

On the MOC MGS images there are promisful regions where to land in order to observe Martian life components of bacteria or fungal spores with dust. In winter these dark dunes are covered with frost. Dark dune spots are formed in late winter and early spring. They show a characteristic defrosting pattern on the frost covered surface where the soil material is partially exposed on the surface activity (Horváth et al., 2002a). The frost-free uncovered region is the dark spot itself. In these periods wind blows out the dark dune material from the spots and the ejected dark dust forms a thin layer on the surface of the frost cover.

On the basis of the analyses of the dark dune spots (DDSs) morphogenetics DDSs were estimated as probable sites for biogenic activity (Horváth et al., 2001, 2002a, 2002b). The Hungarian group suggested that Martian surface organisms (MSOs) are the main agents of the DDS phenomenon, and they were considered as promisful candidates of the recent life on Mars. If the MSOs exist, then they must be flown out from the dark dune spots by the strong winds during the late winter and early spring period of the DDS activity. Dark wind-streaks emanating from DDSs can be observed in these seasons.

PRESENCE OF WATER ON DDS SITES

As we referred earlier the water molecule content of the atmosphere helps the electrostatic coagulation of the dust particles (Földi and Bérczi, 2001b). The Southern Polar region of Mars where the DDS sites were found and studied is therefore promisful source for the FOELDIX experiment because Mars Odyssey also found higher concentration of

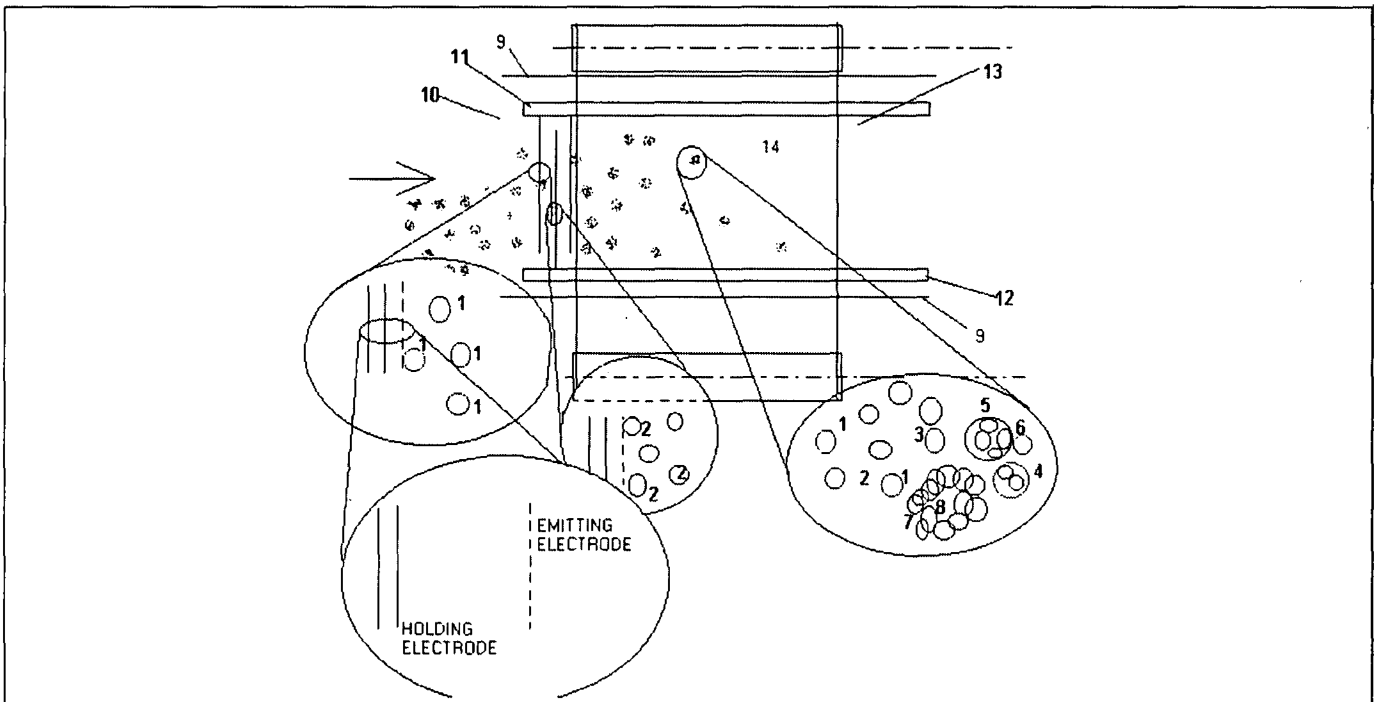

Fig. 1. Hierarchic explaining model of the measuring arrangement of FOELDIX instrument. The locations inside the instrument are the followings: 1. Dust (or aerosol) particles with positive charge; 2. Dust (or aerosol) particles with negative charge; 3. Coagulated dust (or aerosol) particles; 4. Coagulated dust (or aerosol) particles with positive charge, 5. Recharged coagulated dust (or aerosol) particles with negative charge; 6. Recharged coagulated dust (or aerosol) particles with positive charge; 7. Multiple coagulated, cluster-like dust (or aerosol) particles, (max. 540.000 times mass); 8. Bacteria or virus (or other particles with biologic information) inside the multiple coagulated, cluster-like dust (or aerosol) particles; [in this location these bacteria, etc. are shielded for UV radiation]; 9. The wall of the box of the instrument; 10. The entrance gate for the dust (or aerosol) particles; 11. Electrode with positive potential; 12. Electrode with negative potential; 13. Discharging and sedimenting electrode; 14. Nutrient containing zero potential electrode surface.

water in this region (Mitrofanov, et al., 2003; Kuzmin, et al., 2003; Horváth et al., 2003a). Although the 2003/2004 Mars missions will not go to the polar regions, a more detailed imaging may reveal special sites with extensive wind activity in the given late winter early spring period (Córdoba-Jabonero et al., 2003; Horváth et al., 2003b).

THE HUNVEYOR EXPERIMENTAL SPACE PROBE MODEL

Hunveyor experimental university space probe model - a Surveyor-like lander - has been first constructed on the Eötvös University, Budapest, (Department of General Technology) in 1997 (Bérczi et al., 1998). Next year we made planetary geology park around Hunveyor-1 1997 (Bérczi et al., 1999), and the Pécs University group also began to build his Hunveyor-2 (Hegyi et al., 2001). The minimal space probe was built with camera and robotic arm. Since that first instrumentation various new experiments were improved like soil analyzer and measuring unit, spectrometer, opto-chemical sensor unit, electrostatic unit. A Martian desert landscape study was also carried out. The Hunveyor-3 (Kovács et al., 2001) and Hunveyor-4 (Hudoba et al., 2003) are also built in the Berzsenyi College, Szombathely and the Kandó College, Székesfehérvár, respectively. The recent development of FOELDIX instrument is a great step forward a real space instrument constrution on Hunveyors.

CONCLUSIONS

The new FOELDIX instrument with the bacteria and spore detector unit is capable to observe various Martian living units coagulated by the instrument and deposited by special electrodes on nutrient containing stripes of the detector. The growing spots can be observed by microcamera units built into the FOELDIX instrument. Such detector can measure not only bacteria but the soil type which is glued with the bacteria. Therefore it is probable that components of the cryptobiotical crust (Pócs, 2002) units may be discovered by this measuring technology.

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