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ExoMars: ESA's mission to search for signs of life on the red planet

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In the framework of its Aurora Exploration Program, in 2009 the European Space Agency (ESA) plans to launch the ExoMars mission. ExoMars will deploy a high-mobility rover on the Martian surface, carrying a comprehensive suite of scientific instruments —the Pasteur payload.

The ExoMars scientific objectives are: 1) To search for signs of past and present life, underground and within surface rocks, by performing *in-situ* soil sample analysis with a variety of analytical instruments; and 2) To characterise possible surface hazards to human Mars exploration missions (e.g. ionising radiation and dust).

ExoMars must also achieve a number of technological objectives necessary for other missions in the Aurora Programme. These are: 1) To successfully land a large payload on Mars; 2) To demonstrate high surface mobility; and 3) To test rendezvous technologies required for the Mars Sample Return mission. Latitudinal bands between 10 and 45º, both N and S can be targeted for landing, ensuring that the mission is flexible enough to accommodate interesting new sites based on the latest available data. Over its envisioned lifetime of 180 sols, the rover is designed to cover 30 km of ground track over typical Martian terrain. Operations beyond this period will depend on the amount of dust deposited on the rover's solar panels. The available pure instrument mass on Pasteur (without considering structure, cabling, computers and other support services) is 33 kg, half of which is taken by the Drill System and the Sample Preparation & Distribution System (SPDS). The remaining part is divided between three instrument classes: Context, Biomarkers & Organics, and Hazards & Environment. The instrument breakdown will be presented in this paper. ESA issued a Call for Ideas for scientific instruments and investigations to be performed by the ExoMars mission on 14 February 2003. Out of the 50 proposals received, 22 were ranked better than "Very Good" in the first peer review that took place during fall 2003. At least one, and in some cases two, proposals were identified for each major instrument category. A working meeting, with the participation of representatives of all selected proposals, will take place in spring 2004. Three working groups: one for past life, one for present life, and one for hazards to humans, will have to define the targets to be measured, the most appropriate method to perform the analysis, and an integrated instrument complement compatible with the engineering and mission operation constraints. The result of this working meeting will form the basis for the industrial Phase B study of the ExoMars mission.

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Life in meteorite impact-generated HT systems: Perspectives and evidences

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On Earth, meteorite impact events are known causing the local-to-global scale extinctions. However, the impacts can create also new habitable environments. Aside of the (re)colonization of impact carter lakes and surrounding areas, the impact initiated hydrothermal circulation systems within the crater structures are considered as possible new ecological niches for (high-temperature anaerobic) microbial life forms. Although a wide diversity of thermophilic and hyperthermophilic organisms inhabit water-containing terrestrial, subterranean and submarine high-temperature environments (i.e. volcanic and deep-sea HT systems and vents), no approved evidences of microbial activity in an impact-induced HT system has been found in any of the meteorite crater so far. This forwards a question – are the impact HT systems inhabitable/supportive for microbial life?

Mineralogical/geochemical and geothermal modeling data from Kärdla crater [1] suggest that in a small-to-medium size impact crater with insignificant melting, suitable conditions for hydrothermal microbial communities in most part of the crater are established shortly after the impact. However, the central uplift area is inhabitable for a thousand year. At the same, this area retains optimum temperatures (60-80°C) for thermophiles for the longest period of 5 000-to-10 000 years. Mineralogical data suggest higher temperatures also in the fracture zones and suevite pockets at the carter rim (up to 200-300°C), but in these places higher temperatures could have lasted only for few years after the impact.

The abnormally light carbon isotopic composition of hydrothermal carbonates in fractured basement from Kärdla [1] and Lockne craters [2] coincide with the observed ^{13}C and ^{18}O decrease in air-to-soil weathered basalts from Arizona volcanic fields [3], suggesting an organic (light) carbon being involved during the precipitation of these minerals. Recycling of carbon by primitive microbes and light carbon isotopic composition in organic remains are considered as diagnostic feature for high-temperature microbial life. However, the influence of microbial activity is not the only explanation for the observed isotopic shift.

References

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