EPSC Abstracts
Vol. 5, EPSC2010-420, 2010
European Planetary Science Congress 2010

ExoMars and MAX-C: planning for potential cooperative science using 2-rover mission to Mars

J. Grant (1), F. Westall (2), D. Beaty (3), S. Cady (4), M. Carr (5), V. Ciarletti (6), A. Coradini (7), A. Elfving (8), D. Glavin (9), F. Goesmann (10), J. Hurowitz (3), **G.G. Ori** (11), R. Phillips (12), C. Salvo (3), M. Sephton (13), M. Syvertson (3), J. Vago(8)
(1) Smithsonian Institution, USA, (grantj@si.edu), (2) CNRS, France, (westall@cnrs-orleans.fr), (3) Jet Propulsion Laboratory, California Institute of Technology, USA, (David.Beaty@jpl.nasa.gov), (4) Portland State University, USA, (5) USGS, USA, (6) LATMOS-IPSI, France, (7) INAF, Italy, (8) ESA, The Netherland, (Jorge.Vago@esa.int), (9) GSFC, USA, (10) MPI, Germany, (11) IRSPS, Italy (ggori@irsps.unich.it), (12) Southwest Research Institute, USA, (13) Imperial College, UK

Abstract

ESA and NASA have recently announced the intention to join efforts for the robotic exploration of planet Mars. One of the first outcomes would be a joint rover mission in 2018 to the surface of Mars. We are reporting the results of an International Science Analysis Group convened by MEPAG to define the possibilities for mission scenarios and cooperative science.

1. Introduction

Within the framework of the proposed joint NASA/ ESA 2018 mission to Mars, the 2R-iSAG committee (2-Rover International Science Analysis Group) was convened by MEPAG to evaluate the potential for incremental science return through the cooperative activities of two rovers. In this case, the rovers are specifically ESA's ExoMars, and a NASA-sourced rover concept for which we use the working name of MAX-C. The group was asked to consider collaborative science opportunities both without change to either rover, as well as with some change allowed.

2. ExoMars and MAX-C

The missions, as presently envisaged, ExoMars and MAX-C rovers, would have complementary science objectives and payloads. Initiated in 2002 and currently approved for launch in 2018, ExoMars' science objectives are (1) to search for signs of past and present life, and (2) to characterize the subsurface in terms of physical structure, presence of water/ice, and its geochemistry. The payload selected to achieve its goals is centered around the ability to obtain samples from the subsurface with a 2m drill. The payload includes a panoramic and high resolution cameras and a close up imager (microscope) as well as a ground-penetrating radar to characterise the surface environment and to choose relevant sites for drilling. IR spectroscopy would provide downhole mineralogy. The collected samples will be analysed for mineralogy by IR/ Raman spectroscopy and XRD, whereas LD-GC-MS and pyrolysis GCMS would determine the composition of organic molecules, their chirality and isotopic signature. A life marker chip is designed to test for extant life. The currently proposed objectives of MAX-C are to cache suitable samples from well-characterised sites that might contain evidence of past life and/or prebiotic chemistry in preparation for a potential future Mars Sample Return mission. The emphasis would be on in-depth site evaluation to determine the potential for past habitability and preservation of physical and chemical biosignatures. The strawman payload (which has not been selected) therefore includes instrumentation for surface characterization: an abrading tool, a 5 cm drill, a panoramic camera and near-infrared (NIR) spectrometer, a set of arm-mounted instruments capable of interrogating the abraded surfaces by creating co-registered 2-D maps of visual texture, major element geochemistry, mineralogy, and organic geochemistry, and a rock core acquisition, encapsulation, and caching system.

2. Collaborative scenarios

The complementarity of the to selected payload of ExoMars and the payload model of MAX-C is impressive. Both can concur to a detailed and in-depth evaluation of the landing site and, possibly, to a selection of interesting samples for the Mars

Sample Return. This complementarity is reflected also in the scientific objectives of ExoMars and MAX-C as independent entities. We conclude that these two rovers have two absolutely crucial shared objectives that could, in fact, form the basis of highly significant collaborative exploration activity. We therefore propose the following set of scientific objectives for a 2018 dual rover mission, consisting of both a shared component and an independent component:

a) Evaluate the paleoenvironmental conditions;

b) Assess the potential for preservation of biotic/ prebiotic signatures;

c) Search for possible evidence of past life and prebiotic chemistry.

d) Collect, document, and package in a suitable manner a set of samples sufficient to achieve the proposed scientific objectives of a future sample return mission.

Achieving these shared objectives would result in greater science return than would be likely using a single rover. The two rovers has been developed independently and in different timeframes. Therefore, they may perform different scientific activities: ExoMars will characterize the stratigraphy of ancient rocks and the aqueous/geochemical environment as a function of depth in the shallow subsurface (up to 2 m depth), and search for possible signs of present life; and MAX-C will characterize exposed sequences of geological units across a lateral extent of several km, and to document geological and geochemical variation at scales from 10^3 down to 10^{-5} m. The proposed payloads for ExoMars and MAX-C rovers have complementary capability. Most obviously, ExoMars has vertical exploration capabilities via a drill not present on MAX-C, and MAX-C would have better horizontal mobility and rapid reconnaissance capabilities. This complementarity, and the scientific objectives of the two separate missions, provide direct suggestions of a number of ways in which cooperative exploration activity can be implemented.

For instance, MAX-C could enhance the science value of ExoMars drilling operations by exploring and gathering data both to help choose drill sites and to better characterize the geologic context of the drill samples. If some hardware or operational change is allowed, even more important scientific value could be added through cooperative action. Moreover, modifications to the rovers could be implemented so that one or more ExoMars subsurface samples could be added to the MAX-C sample cache.

<table>
<tr><th>Scenario</th><th>Phase 1 Checkout</th><th>Phase 2 Travel</th><th>Phase 3 1st target</th><th>Phase 4 What's next?</th><th></th><th>Phase 5 Cache</th><th>Phase 6 Ext. Mission</th></tr>
<tr><td>1</td><td rowspan="7">Checkout systems and calibrations (~4 wks)</td><td rowspan="5">Travel to Same 1st Target Area (0-6 months)</td><td rowspan="3">Independent Exploration</td><td>Cooperate at discovery site</td><td rowspan="7">Repeat n times</td><td rowspan="7">Cache Delivery via MAX-C from discovery site</td><td rowspan="7">TBD</td></tr>
<tr><td>2</td><td>Travel, scout next site</td></tr>
<tr><td>3</td><td>Independent Exploration</td></tr>
<tr><td>4</td><td rowspan="2">Coop. Explor.</td><td>Travel, scout next site</td></tr>
<tr><td>5</td><td>Independent Exploration</td></tr>
<tr><td>6</td><td rowspan="2">Drive to different 1st targets</td><td rowspan="2">Independent Exploration</td><td>Cooperate at discovery site</td></tr>
<tr><td>7</td><td>Independent Exploration</td></tr>
</table>

Figure 1: Two-rover scenario planning. A wide range of operational scenarios could be envisaged.

The potential 2018 mission would land NASA's MAX-C and ESA's ExoMars rovers together on a pallet using the "Sky Crane" concept developed for the Mars Science Laboratory (reference here?). This mission would be launched in May 2018 on a NASA-supplied Atlas V 531–class launch vehicle on a Type I trajectory and would arrive approximately 8 months later in January 2019, near the end of the martian dust storm season.

3. Conclusions

Carrying out cooperative 2-rover science activities would imply making certain compromises by each rover. The most important consequences of carrying out cooperative activity include: 1) less time available for pursuing each rover's independent objectives, 2) the need to share a landing site that may not be optimized for either rover, 3) and some hardware modifications. Nevertheless, the cooperative added value of these activities exceeds by far the consequences. Moreover this joint activity may set a standard for the future exploration of the Solar System and make more possible the human collaborative missions.

References

MEPAG 2R-iSAG (2010). Two rovers to the same site on Mars, 2018: Possibilities for Cooperative Science, 42 pp., posted May 2010, by the Mars Exploration Program Analysis Group (MEPAG) at http://mepag.jpl.nasa.gov/reports/