ExoMars Rover Mission Overview

P. Baglioni, L. Joudrier, ExoMars Rover Team, *ESA ESTEC-The Netherlands*

***Abstract*— This extended abstract describes the status and progress made on the various elements of the ExoMars Rover mission being developed by the European Space Agency (ESA) in cooperation with the Russian Space Agency (ROSCOMOS) as main partner. The mission aims to explore Mars surface and subsurface with a rover carrying a suite of scientific instruments in search for traces of past life. The launch date is planned for May 2018 with a Russian launcher and surface operations on Mars are then planned to start early 2019.**

I. Introduction

The ExoMars program of the European Space Agency (ESA) started already a few years ago. While figuring programmatic difficulties in settling international cooperation, the initial mission has been split into two. First mission is the Trace Gas Orbiter (TGO) Spacecraft that will be launched in 2016. It will carry scientific instruments to study the Martian atmosphere and will carry a European landing technology demonstrator. The TGO will serve as data relay orbiter to the future Martian surface assets. This mission is now running in full implementation phase. The second mission is the rover mission planned to be launched at the following favorable Martian launch opportunity in May 2018. The specificity of this rover mission is to carry a suite of instrument aiming at searching for traces of past life under the surface where it is believed to be best preserved from cosmic radiations. See [1] for further details about the scientific objectives of the ExoMars rover mission. The mobility system carries a drill system allowing to acquire a sample up to 2 meters below the surface. This sample is then post processed into the analytical laboratory and analyzed with a suite of scientific instruments (imagers and spectrometers). The mission is currently under definition with the Russian Space Agency following an agreement of international cooperation. It will include a Russian launcher, a European cruise stage, and a Russian descent and landing module from which the rover will egress. The rover development has already quite progressed and advanced procuring phase is now pursued in parallel to the mission study. This paper provides additional details about the rover subsystems progress.

II. The 2018 Rover Mission

A. The Reference Mission

A reference Mission has been defined to support the development of the rover. It defines the main steps intended to be followed by the rover on the Martian surface after landing and egress of the landing platform.

First, the rover will move away from the landing platform to avoid contaminants from the landing system propulsion. It will them run a blank analysis to verify the cleanliness of the sample acquisition and analysis chain (Planetary Protection requirements are quite stringent for this mission so to avoid detecting life brought from Earth). Then the scientists, based at the Rover Operation Control Center (ROCC) in Turin-Italy will command the rover to drive autonomously to an interesting site. The rover will image the site with its color panoramic wide angle cameras, the PanCam. Other survey instruments will contribute to study the geology of the site, like the infrared spectrometer, called ISEM, and the high resolution color camera of the PanCam instrument, called HRC and the high resolution microscope close-up imager called CLUPI.

During the drive, the ground penetrating radar, WISDOM, and the neutron spectrometer ADRON, will provide a first understanding of the nature of the subsurface and specifically about the presence of water ice down to 3m below the surface.

The scientists will be looking for an outcrop where a sample can be acquired with the drill system. The WISDOM penetrating radar will be used to map precisely the subsurface of a promising site and the rover will be commanded to drive and drill to a specific location on this map. During drilling, an infrared spectrometer called Ma_Miss fitted in the drill rod will perform initial in situ measurements.

The acquired sample will be fed into the laboratory where it will be crushed and material prepared for analysis by the imaging spectrometer called MicrOmega, then by the Raman spectrometer called RLS and then by the Laser Desorption Mass Spectrometer MOMA-LDMS. Finally, an oven will be filled and the Gas Chromatograph Mass Spectrometer MOMA-GCMS will be used.

These basic steps are called Experiment Cycles (EC) and the mission aims at performing 6 of such ECs with also 2 Vertical Surveys (VS) within 218 sols of nominal mission. A Vertical Survey aims at analyzing the subsurface as function of depths. The overall mass of the rover is in the 300kg range.

III. The Subsystems development progress

A. The Rover Vehicle System

The rover vehicle provides the basic functionalities (power, thermal, data handling, communication) for the instruments and the sample acquisition and conditioning system. The rover is powered with solar arrays and needs battery power in addition to a few Radio-isotope Heating Units (RHUs) to survive the Martian nights. The rover provides obviously as main characteristics the mobility functionality.

The rover, fitted with six flexible wheels of about 25 cm diameter, is an all steering-all driving light vehicle with passive suspension enabled by three bogies. It incorporates in addition six deployment actuators providing self-rising capabilities on the landing platform. These actuators enable as well wheel-walking or peristaltic capabilities to escape from difficult terrains.

The rover will be commanded nominally with autonomous planning functionalities based on long ago demonstrated concepts [2] [5]. Visual odometry will be the nominal mode of operation to drive safely the distance of 100m per sol (along the path) – thanks to the dedicated co-processor. The rover vehicle elements and sensors are being procured and rover mobility algorithms are well advanced.

B. The Drilling System

An elegant Engineering Qualification Model of the drill system has been built and is being further upgraded. A number of tests have been successfully conducted drilling 2 meters into representative materials in Martian conditions.

C. The Analytical Laboratory System

The Analytical Laboratory Drawer (ALD) is composed of the Sample Preparation and Distribution System (SPDS) and of the analytical instruments themselves (MicrOmega, RLS, MOMA). An SPDS engineering model has been developed and successfully tested end-to-end. Further tests in Martian conditions are foreseen this year.

D. The Instruments

Two instruments of the ALD have been removed from the initial Pasteur Payload suite so to account for evolving ALD constraints. However, two new Russian instruments with high level of heritage have been integrated: ISEM on the mast and ADRON within the rover body. All the instruments are proceeding into their development phases.

E. The ROCC

The Rover Operation Control Centre [3] will be locate in Turin and will host the scientists during the surface mission. It will support the tactical and strategic rover activities planning processes [4]. The commands and telemetry will be routed via the TGO twice a day.

IV. CONCLUSION

ExoMars rover development is proceeding in an advanced procurement phase while international mission is being actively studied for launch in May 2018.

ACKNOWLEDGMENT

The presented work is the result of activities performed by European Industry under ESA ExoMars Project. The Prime Contractor is Thales Alenia Space - Italy, The Rover Vehicle is developed by Astrium Ltd - UK, the drill system is developed by Selex - Italy, the SPDS is developed by Kayser-Threde - Germany, the ROCC is developed by ALTEC - Italy. The instruments are individually funded by many national space agencies.

REFERENCES

[1] A. Elfving, “ExoMars”, ICRA 08 Planetary Rover Workshop

[2] R. Rastel et al. “Autonomous Navigation : a development Roadmap for ExoMars”, ASTRA’06

[3] R. Trucco et al. “ExoMars Rover Operation Control Centre Design Concept and Simulations”, ASTRA’08

[4] L. Joudrier et al, “ESTEC-CNES rover Remote Experiment#2 with PanCam, Wisdom and Clupi” iSairas 2012

[5] L. Joudrier et al, “Challenges of the ExoMars Rover Control” infotech@aerospace 2009