THE 2016 *MOONWALK* SIMULATION CAMPAIGN IN RIO TINTO (SPAIN): HUMAN-ROBOT EVA TRAINING FOR MARS EXPLORATION. V. Parro[1], P. Weiss[2], V. Taillebot[2], T. Gobert[2], A. Prost[2], J. Gómez-Elvira[1], M. García-Villadangos[1], J. M. Manchado[1], B. Imhof[3], D. Urbina[4], J. O. Dalseth[5], K. R. Fossum[5], M. Mcdowell[6], A. Nottle[6], M. Hoeckelmann[7], W. Hoheneder[3], T. Vögele[7], and the MOONWALK team, [1]Centro de Astrobiología (CAB, INTA-CSIC), Torrejón de Ardoz, Madrid, Spain (parrogv@cab.inta-csic.es), [2]COMEX, Marseilles, France, [3]Liquifier, Vienna, Austria, [4]Space Applications, Brussels, Belgium, [5]NTNU, Trondheim, Norway, [6]AIRBUS, Newport, UK, [7]DFKI, Berlin, Germany.

Introduction: The European FP7 *MOONWALK* Project objectives pursued the developing new tools and procedures for human-robot interactions in EVA (Extra-Vehicular Activities) exploration and refining them simulating mission concepts in Mars and Moon relevant environments. Here we show the results and lessons learned during the 2016 human Mars exploration simulation campaign in the Rio Tinto Mars analogue. A habitable module, an astronaut and a gesture-controlled small rover followed the procedures and executed the EVA scenarios, developed during the MOONWALK project, to achieve the mission objectives: (i) finding a safe and secure site for human settlement, (ii) finding resources as water or material for contractions, and (iii) searching for signs of live around the landing site.

The Rio Tinto analogue for human Mars exploration: The arid landscape of the old mining areas of Río Tinto can be considered as a field tests for Mars simulation studies. The main analogies with Mars includes: i) the impressive resemblance to the martian landscape, with plains, trenches, canyons, caves, even dune-like field, and aggressive dust; ii) the Fe-S based mineralogy resembling the one identified in Meridini Planum [1] and; (iii) the unique microbiology thriving under extremely low pH and high heavy metal concentration [2] in the water or dealing with minerals and minimal resources in the deep subsurface [3].

Methods: The site called "Las Zarandas" is a natural mock-up for astronaut and robot EVA training. During MOONWALK project, we implemented the COMEX' Gandolfi-2 space training suit, the small, gesture-controlled, robot YEMO, including sampling tools and a communication system with time delay, to execute the newly developed EVA procedures and feasible scenarios for Mars exploration. Additionally, the so called SHEE (shelf-deployable habitat for extreme environment) habitat prototype equipped with a suit port and an astrobiology laboratory was used as the base habitat for astronaut. The ExoMars raman instrument prototype as well as the SOLID (Signs Of Life Detector) supported the astrobiological research.

Results: More than 50 EVA accounting for a length of 12.3 km and 14.5 h of real simulations scenarios were carried during the simulation campaign. During EVA simulations involving astronaut-robot or only astronauts, the tools, procedures, and scenarios developed during MOONWALK project were tested and executed, including scouting, sampling, or exploring inaccessible sites (e.g. a cave) by any of them separately. A 7-minute delay communication was simulated between the mission control center (MCC) in Brussels and the astronaut-robot team and martian base. Seven-minutes delay video images either from the astronaut or the robot were observed and analyzed by the Science Team and were crucial for new making new decisions. The obtained information and samples by the Astronaut-robot team during the Mars exploration simulation allowed mapping the landing site, identification of resources, and finding minerals with raman and microbial markers as true evidences of life with SOLID in the astrobiology laboratory. Finally, extensive outreach and dissemination of the campaign both in the field and through press, TV, radio, both national and international accounted for the strong interest of the general public in the human space exploration.

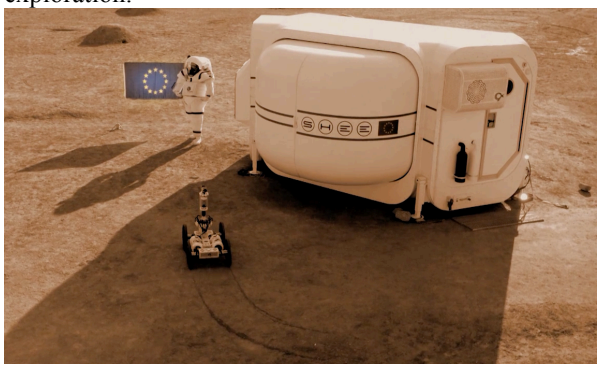

Figure 1. The 2016 MOONWALK simulation campaign main elements: Gandolfi2 space suit, robot YEMO and the SHEE habitat fully deployed in Rio Tinto (image courtesy: Cinquieme Reve).

Consclusion: Three scientific-technological fields met in a single planetary exploration simulation campaign: the human exploration, the robotic technology, and the astrobiology science. Our experience demonstrated that these three fields have to strengthen the collaboration among them to prepare future manned planetary exploration missions.

References: [1] Fernández-Remolar D.C. et al. (2005) *Earth Planet. Sci. Letter.* 240, 149-167, [2] González-Toril et al. (2003) *Appl. Environ. Microbiol.* 69, 4853-65, [3] Fernández-Remolar D.C. et al. (2008) *Astrobiology*, 85, 1023–1047. **Funded** by EU FP7 MOONWALK project GA no. 607346