MARS ANALOGS AT RAMON CRATER REGION: D-MARS. H. Rubinstein[1,2], R. Sorek-Abramovich[1,4], A. Shikar[1,3], M. Zagai[1],3, H. Nevenzal[1], Y. Finzi[4], A. Babad[4], Y. Yair[5], S. Mauda[1], Y. Porat[1], R. Naor[1,6], and O. Aharonson[6], [1]Desert Mars Analog Ramon Station (D-MARS, connect@d-mars.org), [2]Ben Gurion University of the Negev, [3]Technion, Israel Institute of Technology, [4]Dead Sea and Arava Science Center, [5]Tel Aviv University, [6]Weizmann Institute of Science.

Introduction: A unique portable analog research station, D-MARS (Desert Mars Analog Ramon Station), was established and tested during February 2018 in the Ramon Crater region. Interaction between two teams of astronauts on Mars was simulated during the D-MARS01 four-day mission, in collaboration with the AMADEE-18 analog mission [1], executed by the Austrian Space Forum (OeWF). The mission scenario included ten minutes time delay for communication between the habitat and the mission control Earth. Demonstration and tests of the prototype will continue during 2019, and establishment of a permanent research station is expected during 2020.

Analog Site: In the south part of Israel at the Negev desert there are several erosional craters. The erosional crater ("makhtesh") is a unique natural phenomenon in which a valley surrounded by cliffs forms at the crest of an anticline [2]. The Ramon makhtesh is the largest and Most developed erosional crater-like valley in the world. At the Ramon makhtesh long sequence of geological periods are exposed starting from the Triassic period (250 Ma years ago), resulting in high diversity of rock types that include magmatic rocks, both plutonic and volcanic that are exposed at ancient volcanos and igneous intrusion. The analog site also includes different kind of sedimentary rocks – sandstones, carbonates rocks, evaporites and chert. Furthermore, the makhtesh area contains metamorphic rocks and variety of ore deposits. The geodiversity and harsh climate conditions gave rise to the formation of fragile ecosystems with endemic plants and animals that have adapted to local lithologies and landforms.

Design: The design Concept of our habitat is based upon three major aspects: deployed portable structure, scalable habitat unit, and spatial indoor enhancement. We created a 15 square meters portable structure that can be deployed and more than triple its size to 50 square meters, this allowed us to simulate the mission narrative as a whole, from launch to deployment and future expansion. This design allows us to explore aspects of reusability and scalability of the habitat unit. This unique approach can allow the exploration of more complex interactions among multiple habitat units in different configurations, allowing for experimentation around resource sharing, communication protocols as well as various psychological experiments.

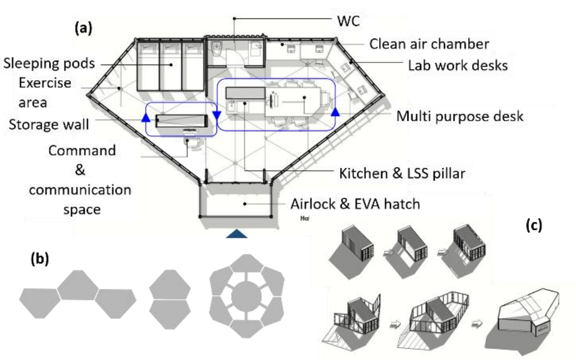

Figure 1: (a) internal design, (b) several units configurations, and (c) deployment mechanism of the habitat.

Summary of Scientific Investigation: The experiments chosen for a 4-day Mars research simulation included an examination of mechanical properties of materials to create 3D printer binder "ink" (Exp-1) [3][4], characterization of biological agents and bioactivity in a hyper-arid environment (Exp-2) [5]. Also it consists of a set of 2 experiments on Human Factors such as: Performance and Stress in Isolation: Testing of a new instrument for language analysis (Exp-3) and Human Factors Debriefing (Exp-4) [6]. Finally, cosmic ray flux measurements in two different locations on Earth, simultaneously (Exp-5). Soil characterization was carried out using Soil Texture Calculator of the Natural Resources Conservation Service (NRCS) soil, under the US Department of Agriculture (USDA). Exp-1 included 3 sites (two silty-clay, one clay soil type) with martian simulant soil as control, a total of 64 soil samples were analyzed during the mission itself. Results showed that some of the treated soil samples were able to dry overnight, at 4-10°C, but none survived a simple mechanical stress testing, performed within the habitat. Exp-2 included deployment of HOBO v2.3 sensors for relative humidity and temperature measurements at selected sites. Ten samples of desert varnish were collected from a site ~200 m from habitat location, but in 4 days, in-depth characterization of biological agents and bioactivity was not done. For both Exp-3 and Exp-4 mission duration and number of astronaut participants was insufficient for valid statistical analysis. Exp-3 took ~6 hours each day of the mission (total 24H), and Exp-4 took 1.5H per day (total 6H). Exp-5 measured the cosmic ray flux in two locations: D-MARS01 and AMADEE-18 (Oman, with the OeWF). This experiment used a set of plastic scintillators and a data acquisition system. Data from the two locations was stored in a remote database and accessible via a dedicated website which displayed real time data.

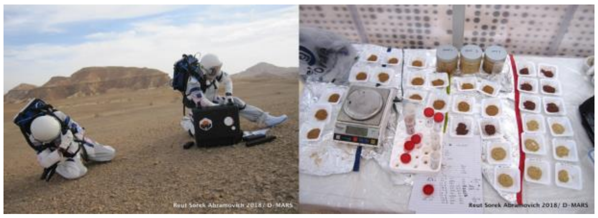

Figure 2: Cosmic radiation experiment deployment (left). Soil basic characterization (in jars) and preparation of 3D samples in weight boats, for overnight incubation and downstream mechanical stress analysis.

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Exp-2 PI Dr. Reut Sorek-Abramovich, Dead Sea & Arava Science Center.
Exp-3 PI MD. Alessandro Alcibiade, University of Pisa.
Exp-4 PI Dr. Ing. Irene Schlacht, Politecnico di Milano.
Exp-5 PI Prof. Guy Ron, The Hebrew University.

Summary and Future Work :
The goals of D-MARS01 were to test the infrastructure and procedures, to perform scientific experiments relevant for Mars exploration, and to prepare for a Mars analog mission completed by high-school students, and was executed on April 2018. The second field campaign will happen in Feb-Mar 2019, and will include a longer (ten days) analog mission as well as several few-days missions, coupled with diverse scientific, educational, and outreach activities.

References: [1] Sejkora N. et al. (2018) *EPSC2018-442, 12*. [2] Finzi Y., Ryvkin I. (2016), Negev, Dead Sea and Arava Studies, 8(4),126–138. [3] Kading B. and Straub J. (2015) Acta Astronautica, 107, 317-326. [4] Müller M. et al. (2018), SpaceOps Conference, 2410. [5] Hungate, B. et al. (1987) Canadian Journal of Microbiology 33(10), 939-943. [6] Alcibiade, A. et al. (2018), International Conference on Applied Human Factors and Ergonomics, 183-194.

Additional Information:
D-MARS website: https://www.d-mars.org/
The Minerva Center at Weizmann Institute:
http://www.weizmann.ac.il/ExtremeLife/overview
AMADEE-18 mission website:
https://oewf.org/en/portfolio/amadee-18/
Dead Sea & Arava Science Center
http://www.adssc.org/en

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