



ExoHab Pilot Project & Field Tests for Moon-Mars Human Laboratories

Bernard Foing and the ILEWG ExoGeoLab & ExoHab Team

ILEWG & ESA ESTEC/SRE-S, RSSD, Noordwijk, NL (bernard.foing@esa.int, +31 71 565 4697)

We studied concepts for a minimal Moon-Mars habitat, in focussing on the system aspects and coordinating every different part as part an evolving architecture. We validated experimentally the Habitat and Laboratory ExoHab concept constraints during EuroGeoMars campaign in Utah desert research station (from 24 Jan. to 28 Feb. 2009) and EuroMoonMars/DOMMEX campaigns in Nov 2009 and February-April 2010. We discuss from the ILEWG ExoHab concept studies and field simulations the specifics of human exploration, with focus on habitability and human performance. In the ExoHab pilot concept project (supported by ILEWG, ESA NASA), we justify the case for a scientific and exploration outpost allowing experiments, sample analysis in laboratory (relevant to the origin and evolution of planets and life, geophysical and geo-chemical studies, astrobiology and life sciences, observation sciences, technology demonstration, resource utilisation, human exploration and settlement). In this modular concept, we consider various infra structure elements: core habitat, Extra Vehicular activity (EVA), crew mobility, energy supply, recycling module, communication, green house and food production, operations. We review some studies space agencies' architecture proposals, with landers, orbiters, rovers, habitats, surface operations and protocols. We focus on the easiest and the soonest way in settling a minimal base immediately operational in scientific experimentation and exploration, but not immediately autonomous. Through a modular concept, this outpost will be possibly evolved into a long duration or permanent base. We will analyse the possibilities of settling such a minimal base by means of the current and near term propulsion technology, as a full Ariane 5 ME carrying 1.7 T of gross payload to the surface of the Moon (Integrated Exploration Study, ESA ESTEC [1,2]). The low solar rays incidence may permit having ice in deep craters, which will be beneficial for the evolution of the outpost into an autonomous base. After a robotic sample return mission, a human presence will allow deeper research through well chosen geological samples. A polar lunar outpost can serve to prepare for a Mars outpost: system and crew safety aspects, use of local resources, operations on farside with limited communication to Earth, planetary protection protocol, astrobiology and life sciences.

References: [1] Exploration Architecture Trade Report", ESA 2008. [2] Integrated Exploration Architecture", ESA, 2008. [3] 9th ILEWG International Conference on Exploration Utilization of the moon, 2007, sci.esa.int/ilewg [4] Schrunck et al , The Moon: Resources, Future Development and Colonization", 1999. [5] The Moon as a Platform for Astronomy and Space Science", B.H. Foing, ASR 14 (6), 1994. [6] Boche-Sauvan L., Foing B (2008) MSc/ESTEC report.

Co-authors, ILEWG ExoGeoLab & ExoHab Team:

B.H. Foing(1,11)*#, C. Stoker(2,11)*\$, P. Ehrenfreund(10,11), L. Boche-Sauvan(1,11)*, L. Wendt(8)*, C. Gross(8, 11)*, C. Thiel(9)*, S. Peters(1,6)*, A. Borst(1,6)*, J. Zavaleta(2)*, P. Sarrazin(2)*, D. Blake(2), J. Page(1,4,11), V. Pletser(5,11)*, E. Monaghan(1)*, P. Mahapatra(1)#, A. Noroozi(3), P. Giannopoulos(1,11) , A. Calzada(1,6,11), R. Walker(7), T. Zegers(1, 15) #, G. Groemer(12)# , W. Stumptner(12)#, B. Foing(2,5), J. K. Blom(3)#, A. Perrin(14)#\$, M. Mikolajczak(14)#\$, S. Chevrier(14)#\$, S. Direito(6)#\$, S. Voute (18)#\$, A. Olmedo-Soler(17)#, T. E. Zegers(1, 18)#, D. Scheer(12)#, K. Bickert(12)#, D. Schildhammer(12)#, B. Jantscher(1, 11, 12)#, MECA Team(6)#, ExoGeoLab ILEWG ExoHab teams(1,4,11) EuroGeoMars team(1,4,5);

1)ESTEC/SRE-S Postbus 299, 2200 AG Noordwijk, NL, 2)NASA Ames , 3)Delft TU , 4)ESTEC TEC Technology Dir., 5)ESTEC HSF Human Spaceflight, 6)VU Amsterdam, 7)ESTEC Education Office, 8)FU Berlin, 9)Max Planck Goettingen, 10)Leiden/GWU , 11)ILEWG ExoHab Team, 12)Austrian Space Forum (OEWf Innsbruck); 14) Ecole de l'Air, Salons de Provence, 15) Utrecht U., 16) MECA Team, 17) Olmedo Knowledge Systems S.L.;

* EuroGeoMars Utah crew , # ILEWG Eifel crew, \$EuroMoonMars/DOMMEX Utah crew.

