FSP-HABIT and SALACIA: Characterizing Martian salts prior to the ExoMars 2018 mission

Finding water on Mars

Introducing FSP-HABIT and SALACIA

One of the major remaining question about Mars is its habitability - if the requirements necessary to allow for life are presently fulfilled.

The most relevant ingredient for life, as we know it, is water. Indirect evidence of transient liquid water on Mars has been retrieved from both rover (Martín-Torres et al., 2015) and orbiter (Ojha, et. al. (2015).

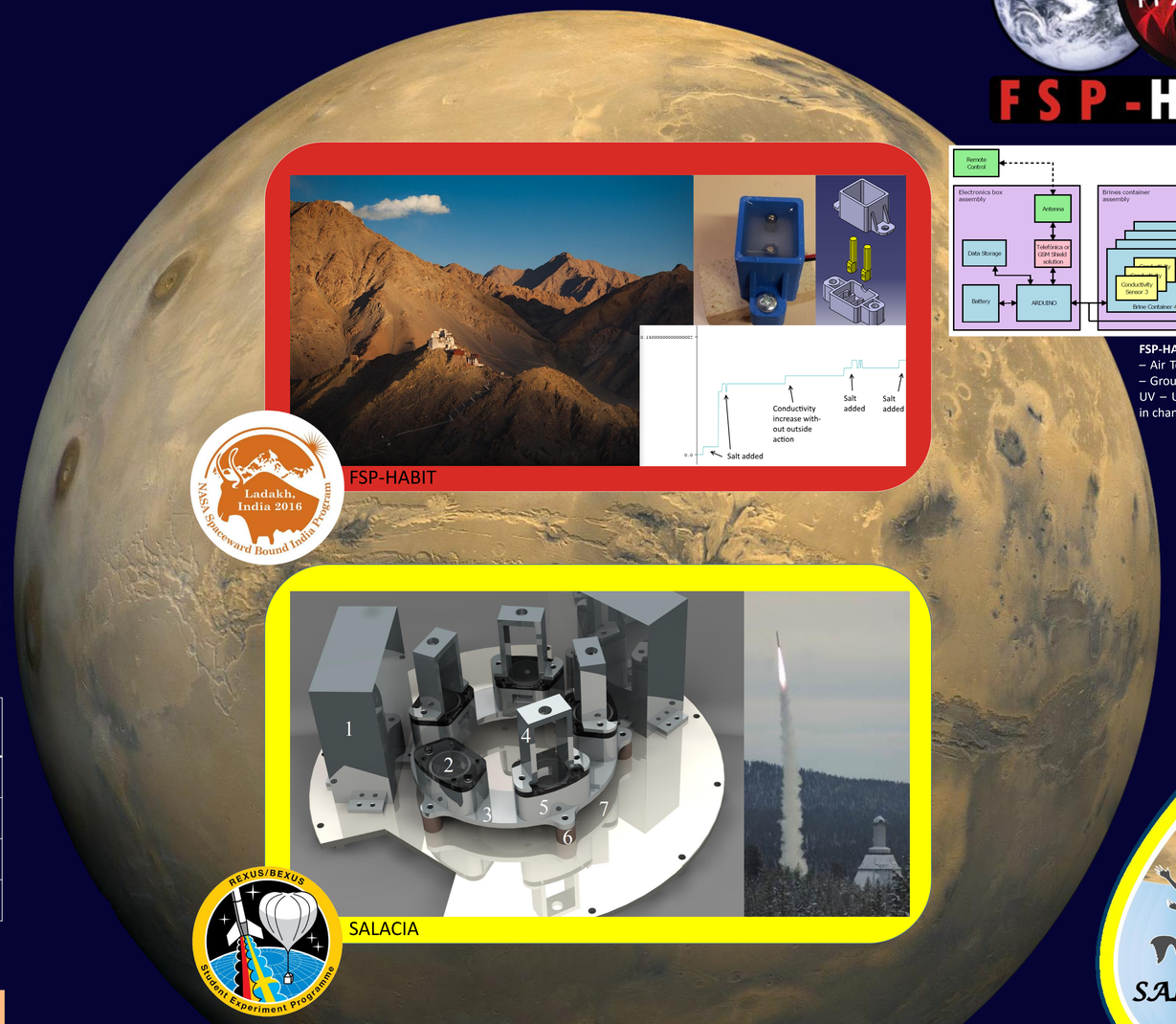
Martín-Torres et al. (2015) inferred the existence of an active water cycle, driven by chlorate and perchlorate salts. These salts are commonly found on the Martian surface and absorb atmospheric water to form stable hydrated compounds and liquid solutions.

The instrument **Ha**bitability: **B**rines, **I**rradiation, and **T**emperature (HABIT) will be part of the ExoMars Surface Platform's payload of the ESA/Roscosmos/IKI ExoMars 2018 mission to Mars. It is currently being built by LTU and Omnisys and will study the following salts on the surface of Mars:

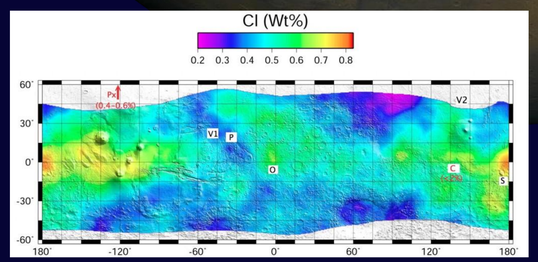
Salt	Formula	Eutectic Temperature Te [K]
Magnesium Perchlorate	$Mg(ClO_4)_2$	206
Calcium Perchlorate	$Ca(ClO_4)_2$	196
Sodium Perchlorate	$NaClO_4$	236
Calcium Chloride	$CaClO_2$	226

*Mars average temperature $T_{avg} = 210.1\ K$

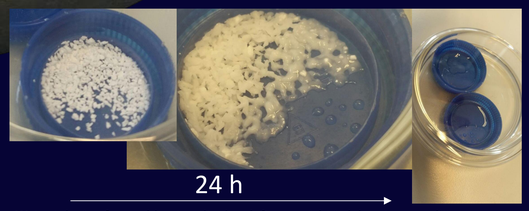
Illustration of the inferred water cycle on Mars: During night-time, when the ambient temperatures are cold and the relative humidity (RH) is high, perchlorates and chlorate salts bind atmospheric water to form brines (solutions of water in salt). During day-time, when the temperatures rise and RH lowers, the water evaporates back into the atmosphere. Credit: Martín-Torres and Zorzano Mier (2015)



FSP-HABIT block diagram. ATS – Air Temperature Sensor; GTS – Ground Temperature Sensor; UV – Ultra Violet light sensors in channels ABC, A, and B



Equatorial and mid-latitude distribution of chlorine within the top 1 meter, measured by Mars Odyssey Gamma Ray Spectrometer. The global concentration of Cl is similar to the measured concentration of ClO_4^- at Phoenix and Curiosity landing sites, suggesting that ClO_4^- could be globally distributed. Credit: Keller et al. (2006)



Water take-in of a perchlorate salt when left over night in laboratory conditions

The **F**ield-**S**ite **P**rototype for **HABIT** (FSP-HABIT) will be the first prototype of HABIT to be deployed during a field-site campaign. The campaign will take place during summer 2016 as part of the NASA Spaceward Bound India Program in Ladakh, Himalaya.

FSP-HABIT will bring a selection of perchlorate and chlorate salts to the campaign for characterization. The salts will be characterized by their conductivity as liquid brines are good conductors, hydrated salts are poor conductors, and dehydrated salts are insulators.

The measurements of FSP-HABIT will be used to characterize the near surface environment and will be compared with microbiological studies of water, ices and soils to characterize the habitability of the explored site.

FSP-HABIT will consist of two main parts: The brines container assembly (brines container and sensors for conductivity, UV dose, ground temperature, air temperature). The electronics box assembly (ARDUINO as a controlling unit, battery for power, data storage, and a GSM solution for remote connectivity).

To battle corrosion, the conductivity measurements will be done with alternating current (AC). This, however, introduces a frequency dependency of the measured impedance which will be adjusted for.

FSP-HABIT is currently being built by Johannes Güttler of the LTU Atmospheric Science Group.

FSP-HABIT's **primary** objectives are to:

1. measure the changes in conductivity of selected salts
2. measure environmental parameters to quantify the changes in conductivity
3. do all of the above autonomously, with an own, re-chargeable, power source

The **SA**line **L**iquids **I**n the **A**tmosphere (**SALACIA**) student experiment will study the properties of the Martian salts during a rocket flight through different atmospheric layers.

At the scheduled launch in March 2017 from Esrange Space Center in northern Sweden, an improved Orion sounding rocket (REXUS) will bring the instrument up to a maximum altitude of 90 km.

Pressure, composition, humidity and temperature will change at different altitudes, with some of the altitudes representing Mars-like conditions in these aspects. SALACIA will help to identify and understand critical behaviors of the salts during a real-world rocket flight.

The water-content of the salts will be characterized by their conductivity while additional sensors record the ambient conditions. Several cameras will be used for spatial information of the salt distributions during the flight. After reaching a set altitude, the rocket will be de-spun. From this point onwards, the only outside force acting on the salty solutions will be a spin of approximately 30°/s and the salts will experience about 2 minutes of micro-gravity.

The REXUS/BEXUS program is realized under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB). The SALACIA team consists of 16 students from Luleå University of Technology.

More information: **atmospheres.research.ltu.se** and **salacia.se**

Further reading: F. Javier Martín-Torres et. al. Transient liquid water and water activity at gale crater on mars. Nature Geoscience, 2015. doi:10.1038/ngeo2412.

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