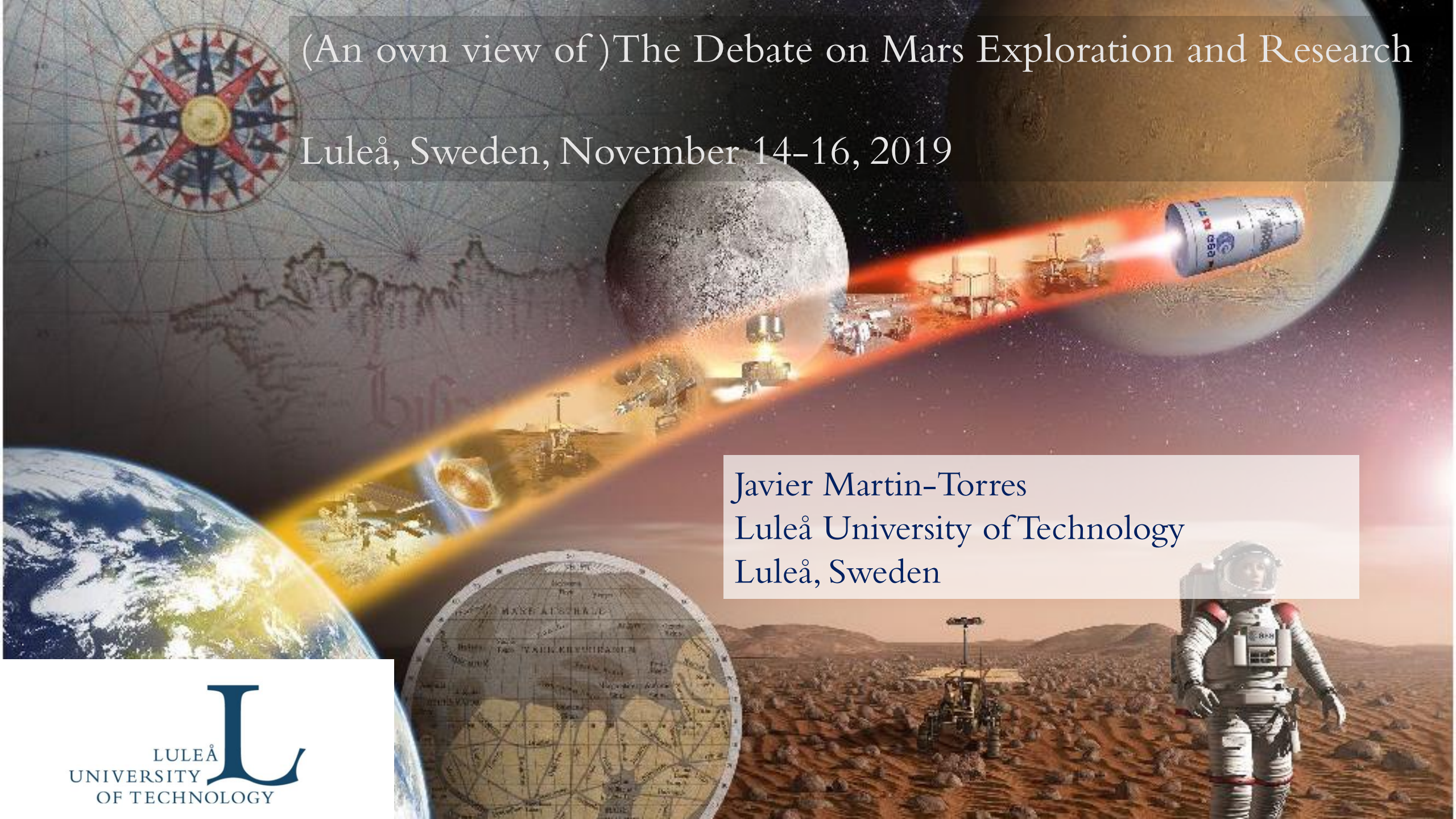
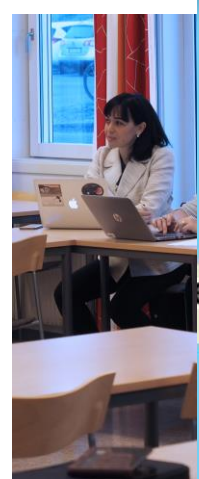


# (An own view of) The Debate on Mars Exploration and Research

Luleå, Sweden, November 14-16, 2019

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Luleå University of Technology  
Luleå, Sweden

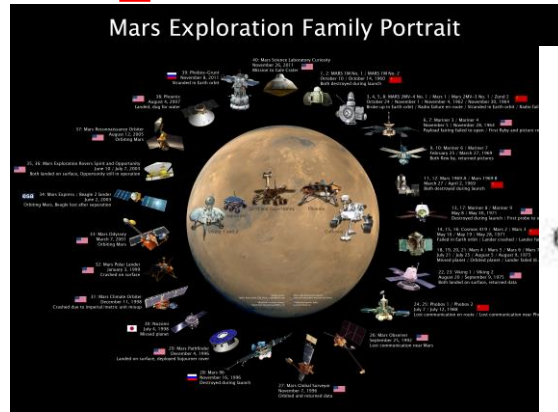




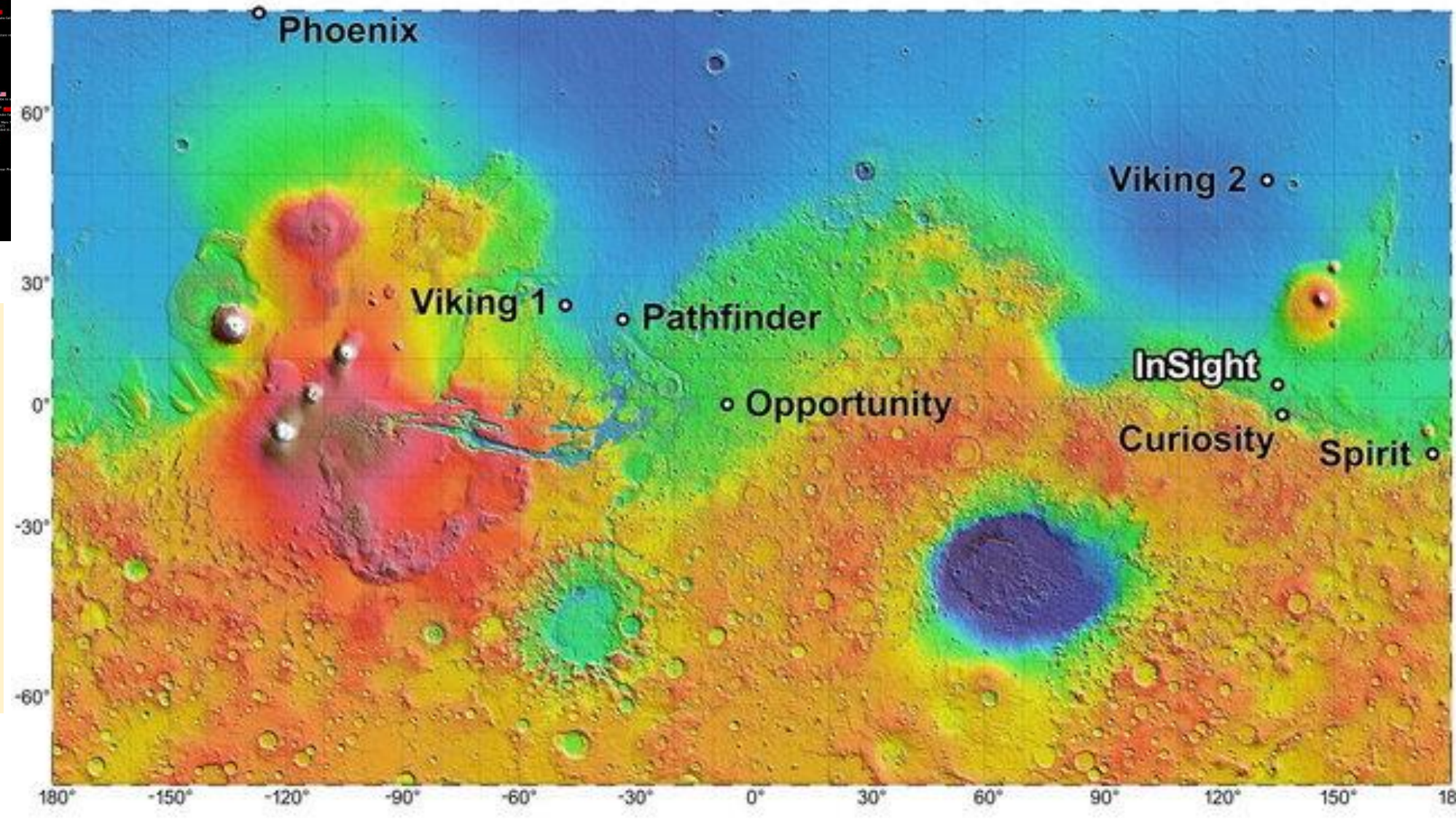


# Topic 1. Where on Mars ?

What are the local resources that we should visit with landed platforms (water? minerals? organics?)?  
Are there wet markers on Mars? Regions to visit or to avoid?



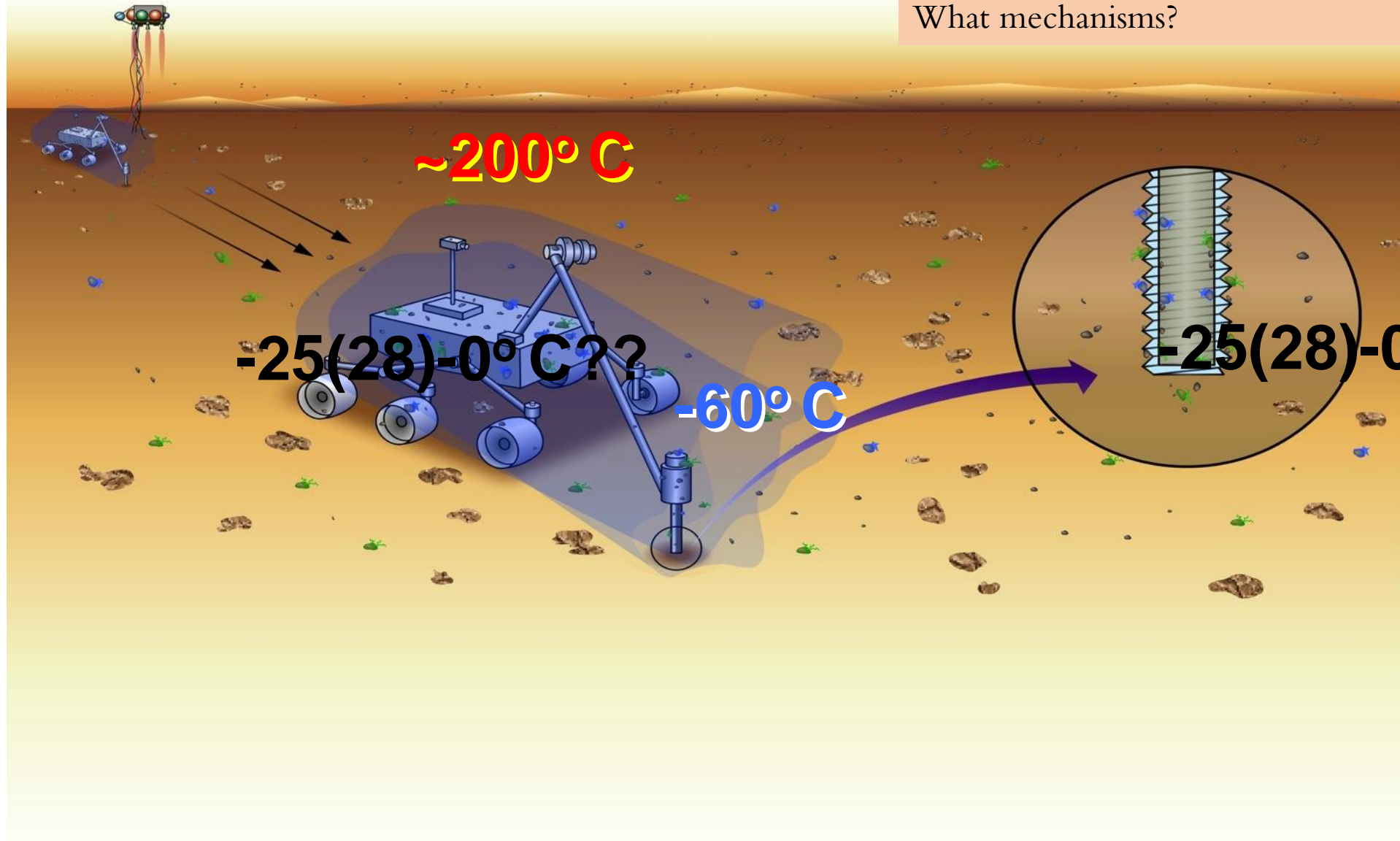
- Scientific objectives + Engineering/budgets constraints
- Take into account existing missions
- PP special regions



# Topic 2. Planetary Protection

## Protocols

Should we reinforce/reduce Planetary Protection protocols?  
Should we adopt global policies on planetary exploration?  
What mechanisms?



# Topic 3. Mars Exploration and Research Advantages of Sample Return



**Assume: Sample Context Well Documented**

International MSR Objectives & Samples Team



Regional, Planetary Context

Local Context

Detailed Analytic Data

**INTEGRATE**

**EXTREMELY important to returned sample science.**

**Most Complete Science answers**

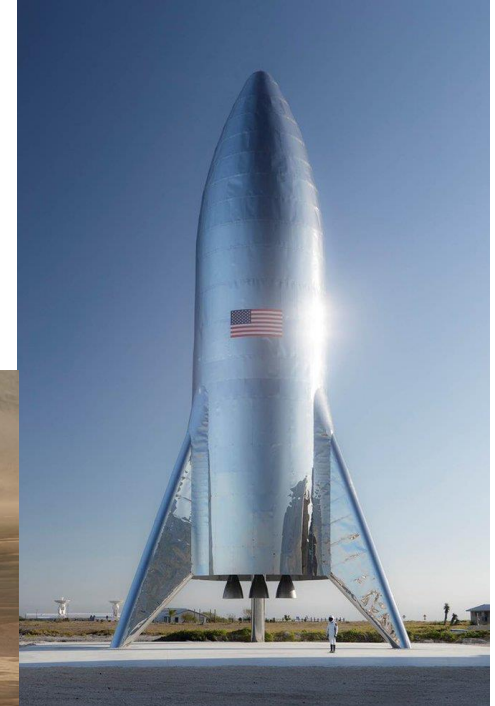
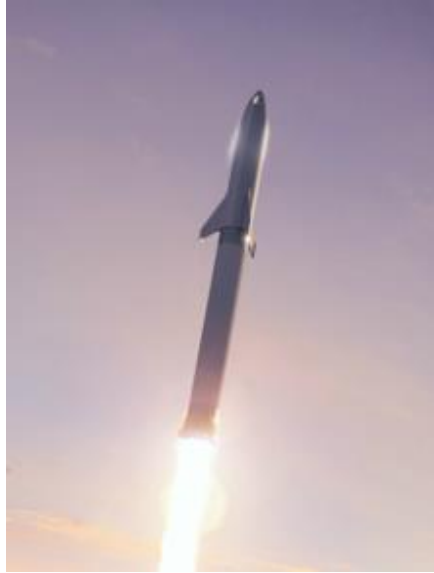
Do we need more robotic missions before humans are on Mars?

Before Mars Sample Return ? What kind of missions?

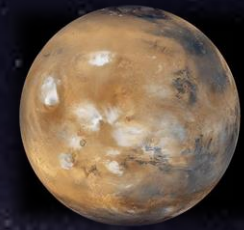
What are the scientific goals that justify Mars exploration in the next decades?

# Topic 4. Space agencies/government funds vs private initiatives

How the space exploration pie should be divided between Space Agencies and private companies (on planetary protection, resources and exploitation, policies, technologies, UN space treaties, market, return of samples, space junk..) ?



# Topic 5. Moon and Deep Space Gateway before Mars



Benefits/Dissadvantages: Would that cause a delay to Mars Exploration and Research?





# MARS EXPLORATION AND RESEARCH

Pre-conference work

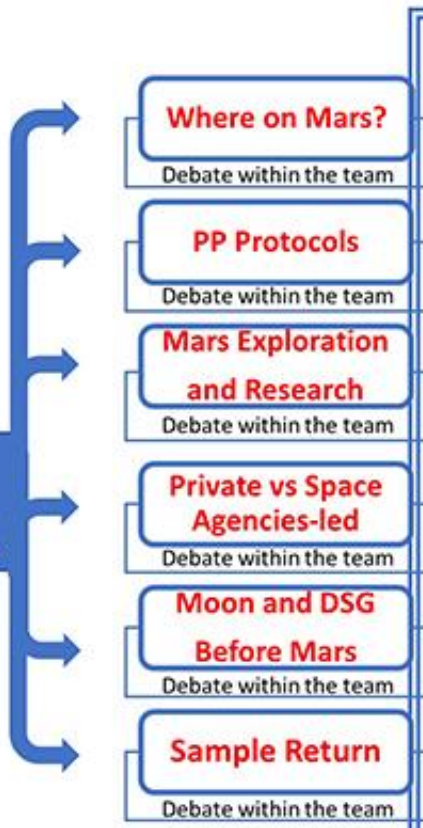
At the debate in Luleå

Outcome



**Invitees**

Each participant will join to at least one discussion group



Transversal discussion led by the team's Chairs



**Debate**



**Future exploration guidelines**



Transcendent questions to be inquired



Definition of appropriate procedures



Planetary protection issues

Papers for a monographic issue of *Astrobiology* Journal

**Astrobiology**

Mars Sample Return: a giant leap for Mars science



# Assessment Matrix

What can we observe and visit with a landed platform?

|                     | Liquid Water (incl. brine)  | Ice   | Vapor   | Chemistry   | Shelter   | Exposure   |
|---------------------|---|---|---|---|---|--|
| Atmosphere          | Not likely  | Cloud ice (?)   | Track humidity, diurnal/seasonal variations   | Detection of trace gases, hard to localize sources  | UV flux, radiation detection  | Difficult  |
| Sfc/Atm. Boundary   | Good, if it exists and right locations are selected. Probably transient | At higher latitudes only                                    | Measure vapor exchange from atm. to surface layer (wind+vapor)                                      | Key questions tied into liquid water search? Difficult to do trace gas flux                                     | UV flux, radiation detection  | Difficult  |
| Surface Layer       | Less likely below surface   | Direct sample of excess ice, ice chemistry                  | Indirectly through examination of regolith properties (?)   | Electrochemistry, spectroscopy, identification of minerals/salts  | Change in chemistry with depth (?). Extant life not likely at these depths  | Isotopic composition of ice, D/H   |
| Sfc/Subsfc Boundary | Not likely  | Ice layer may indicate depth of this boundary               | Will not penetrate solid ice. Calculate vapor exchange between atmosphere and subsurface ice layer. | Presence of remnant salt deposits (leaching) from prior climate?  | Change in chemistry with depth (?). Extant life not likely at these depths. | Isotopic composition of ice, D/H   |
| Subsurface          | Drill, GPR or other sounder   | Drilling to depth can expose layers, reveal climate history | Probably of negligible importance.  | Change in redox conditions at depth. Perform sample science (spectroscopy, mass spec, EGA) on retrieved samples | Distribution of organics with depth? Core sampling, downhole measurements   | Composition of bedrock, can it tell us anything about evolving conditions? |

# Some general agreement

- We are living the Golden Age of Mars Exploration and Research
- We should continue visiting Mars, and focus on:
  - studying current conditions on Mars
  - In-Situ Resource Utilization instruments (both Moon and Mars)
- We detect a concern from space agencies about raising expectations for discovery of 'life' and perception of failure if life is not found → Look for biomarkers

If conclusion of life searching mission is that there is no life on Mars, then it is not entirely a negative news because it opens for human exploration

# Some disagreements

Should we follow a life detection instead of follow the water approach?

Are we overprotecting Mars with hard Planetary Protection protocols or is the other way around ?

# Topic for UN-COPUOS discussion

## PLANETARY PROTECTION

- How can this be regulated in the future ? How things would change if precious metals, rare elements are found on Mars ?
- How to force industry to accomplish with PP protocols ?
- Is there the risk that Private companies will establish themselves in the countries with best return ?

### In the case of the Moon:

- We want to avoid contamination of the Moon by, for example, bringing Mars samples for example because if you make a mistake then the moon is contaminated.

# PRIVATE COMPANIES

- Companies not represented in iMOST and similar. Maybe they should be.
- Space exploration = booster for technology. One of very few peaceful topics where money is invested without expecting immediate return. Companies have role in helping small countries that can not afford space program on their own.  
Should UN promote industries as a motor for world equality ?
- Space exploration can be done by analyzing data, does not require actually making the instruments. Enables research from any country.
- Currently some progress and technical information can be shared. However, private companies have other issue: For example a company X will not want to share technical solution with other company.

## RESOURCES in SPACE

- How to manage internationally resources in space ?
- Should UN promote private actors for mining resources in space?
- What private companies should UN partner ? Quality/ethics/compromise control ?
- Resources should not be appropriated as state or industry: how to solve the conflict ?

## MARS SAMPLE RETURN

- Curation and examination facilities on Earth, need to be discussed, where, what actions, how will planetary protection be applied. There has to be principles and protocols of use for returned samples. INTERNATIONAL COLLABORATION is needed. Should this be coordinated by UN ?



## LIFE on MARS

- If life is detected during the course of a mission, how UN should react ?
- UN agreement for colonies on Moon or Mars? A legislation will be needed, including the case of private companies. Human rights on a colony
- It may be not-ethical but it could be practical to select humans that are less prompt to suffer cancer for instance or get infectious for Moon/Mars colonization ? In general, human factors have to be considered very seriously. Other environments like nuclear power plant, admit to select people to maximize security.

# We should not delay actions in Moon/Mars exploration legislation

An example:

Nobody likes planetary protection officers because they are considered like dentists: Consider future goals with regards to PP.... PP can seem inconvenient, it is like brushing teeth – effect is only seen on long term.

Nevertheless PP is probably the only time in human history where precautionary measures have been internationally agreed on.



Special issue on the journal **Astrobiology**

More information about The Debate:

*[atmospheres.research.ltu.se/mars\\_debate](http://atmospheres.research.ltu.se/mars_debate)*