Revolutionizing Access to the Mars Surface

A workshop hosted by the *W.M. Keck Institute for Space Studies* led by:

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International Planetary Probe Workshop

Mars Exploration Session

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Keck INSTITUTE FOR SPACE STUDIES

Motivation

Many key science goals can only be accomplished *in situ*

and

many benefit enormously from surface mobility

Science Goal Mission Element	M-Arc	SSc	DSc	NFc	FLG
Orbit-based characterization of atmospheric circulation, transport processes	3,4				
Transport of dust/aerosols and their relationship to atmospheric escape and climate	4				
Low-altitude global magnetic field survey, gravity mapping	2				
Environmental transitions in the ancient record by high resolution orbital imaging spectroscopy	1				
In-situ geophysics (subsurface ice/water w/ resistivity, GPR; seismo., magnetism)	2				
In situ surface-atmosphere boundary layer interactions (trace gas measurements)	4				
In situ, mobile geological explorers for characterizing ancient habitable environments, environmental change, organics detection	1				
Global orbital radar mapping of ice reservoirs	3				
In situ mid-latitude ice sampling for characterization	3				
In situ polar layer deposit climate record determination	3				
In situ geochronology for Martian and solar system chronology	1,2,3				
In situ life/organics detection in Martian ice, deep subsurface	1,2,3				

possible or partial priority science at this class — achieves priority science at this class

MASWG Nov. 2020 Report
https://mepag.jpl.nasa.gov/reports/MASWG%20NASA%20Final%20Report%202020.pdf

Motivation

1. Can we fit PI-competed surface missions in Discovery/small spacecraft mission classes, including mobility systems?
2. Can **small sat** approaches and technology feed forward to Mars?
3. Can **CLPS** approaches and technology feed forward to Mars?


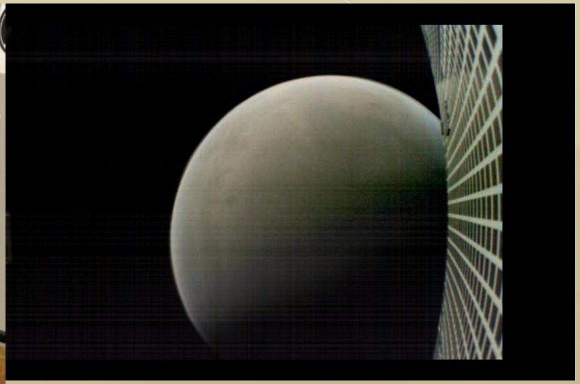

Image credit: NASA

Workshop Goals

Overarching Goal: Determine how to substantially reduce the cost associated with landed scientific missions to Mars.

How? Three primary goals:

1. Identify most important measurements related to Decadal survey science questions that require access to Martian surface and instruments/platforms/mobility required to achieve them.
2. Conceive mission architecture(s) and technologies to access the Martian surface (e.g. EDL) and conduct efficient operations of multiple Mars assets.
3. Identify how/if emerging small satellite approaches, commercial lunar capabilities, or other innovative approaches can break the mass-cost dependency for Mars surface missions and enable access at lower price point.

In Situ Science Measurement Needs

- **Atmosphere**: measurements in lowest scale height not available from orbit; concurrent measurements provide additional science value
- **Geology**: local and regional-scale measurements needed; long traverses provide geological comparison
- **Geophysics**: multiple landing sites (network) and/or mobility needed

Multiple landers and/or mobility systems needed to address high-priority science goals across multiple science disciplines.

Improving Surface Access: [some] Tall Tent Poles

Cultural and Programmatic

- Current community risk posture
- Make "smaller science" okay
- The "cost=mass" mentality
- Limited mission opportunities

Technology

- EDL system
- Surface mobility
- Payload SWaP
- Manufacturing, ATLO

EDL Systems and Cost

- Current paradigm: each EDL system is bespoke…and expensive.
- Options for reducing EDL cost:
  - Eliminate subsystems (e.g. remove landing system → hard lander)
  - Miniaturization
  - Additive manufacturing
  - Block buys and builds
- Potential EDL contributions to mission cost reduction
  - Deployables for rideshare packaging and/or improved performance
  - High-g landing systems
  - Use more mass to reduce cost (e.g. larger aeroshells)

Continuing Workshop Efforts

- 4 study groups investigating high-priority areas:
  1. Programmatic changes to Mars exploration program
  2. The “Culture Club”
  3. $200M Medium Mobile Mission (or MMM…)
  4. Architecture trade study for small networks

- Second workshop meeting in September

- Final report to follow

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