MARS 2020 MISSION: Science Rover

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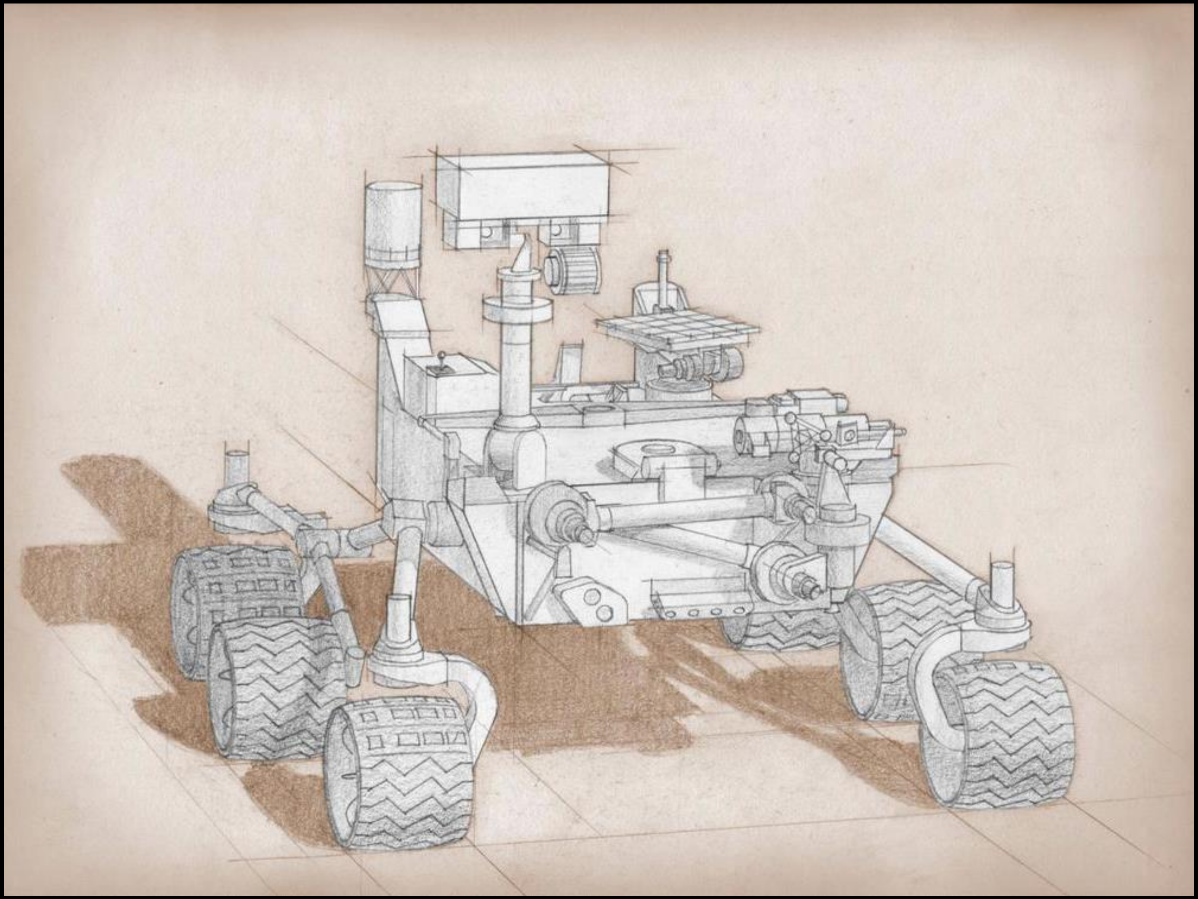
MARS 2020 Project



Ken Farley, Project Scientist
California Institute of Technology

Outline

1) Mission Context and Scientific Objectives

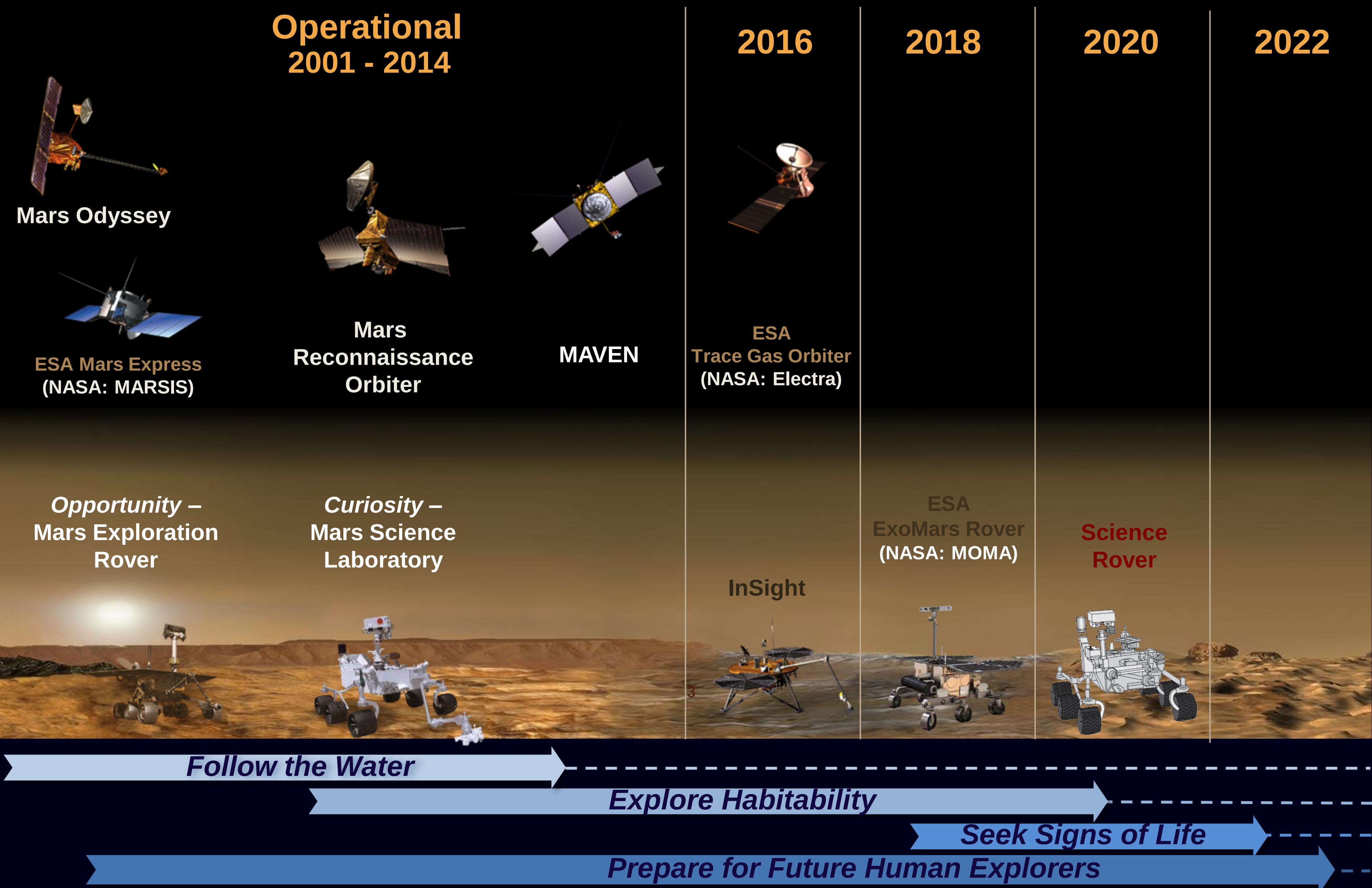
2) Implementation Strategy and Timeline

3) Sampling/Caching System and Associated Requirements

4) Important Challenges and Trade Studies

5) Status and Summary

Current & Future Mars Missions



EVOLVING MARS SCIENCE THEMES

Pre-decisional: for Planning and Discussion Purposes Only

Mars 2020 Mission Objectives

In-situ Exploration ***and*** *Sample Cache Preparation*

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1. Geologic History

Carry out an integrated set of context, contact, and spatially-coordinated measurements to characterize the geology of the landing site

2. In Situ Astrobiology

Find and characterize ancient habitable environments, identify rocks with the highest chance of preserving signs of ancient Martian life if it were present, and within those environments, seek the signs of life

3. Preparation for Returned Sample Science

Place rigorously documented and selected samples in a returnable sample cache for possible future return to Earth

Mars 2020 Mission Objectives (2)

Additional objectives:

A) facilitate future human exploration by making significant progress towards filling at least one major Strategic Knowledge Gap (e.g., assess natural resources and/or hazards for future human explorers)

B) demonstrate additional technologies required for future Mars exploration

The Mars 2020 mission would take an important step towards the high priority Decadal Survey objective of sample return by preparing a cache of context-rich Martian samples for possible future return to Earth

Mars 2020 Mission Implementation

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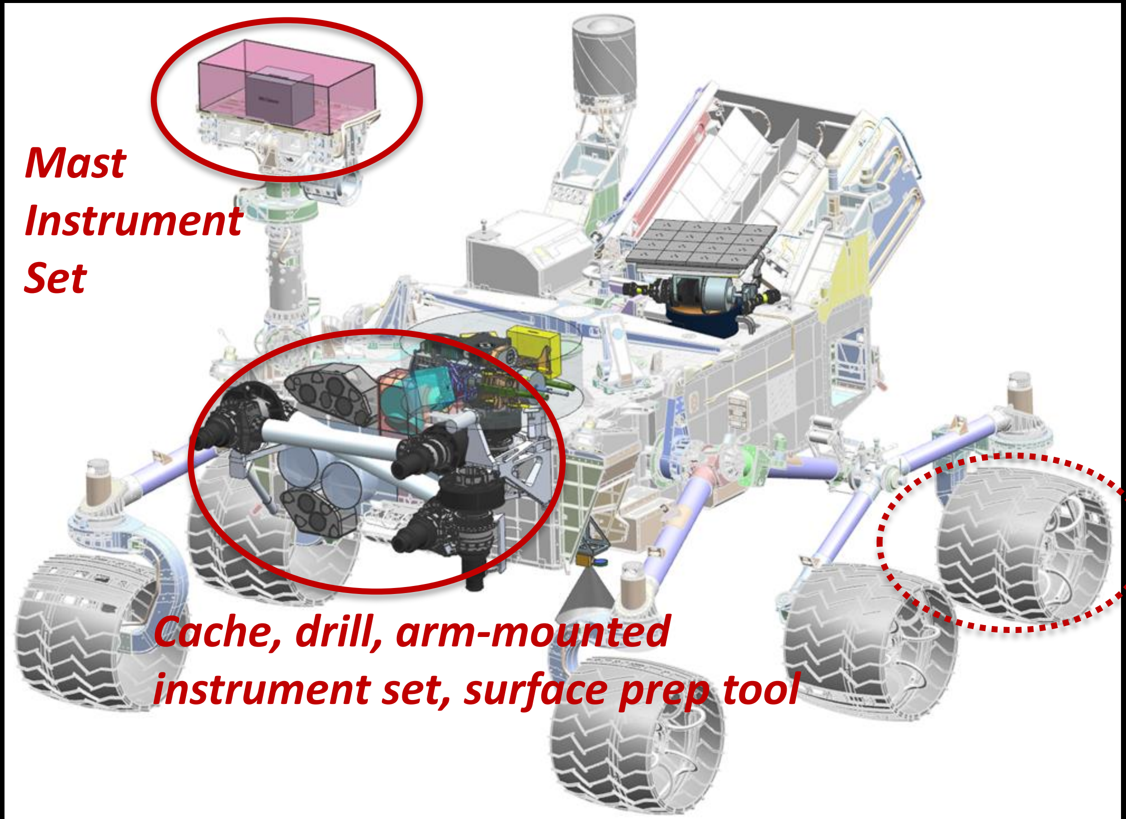
Most cost-effective and lowest risk implementation would be to reuse the proven Mars Science Laboratory architecture and design to the maximum extent possible ("very high heritage mission")

- new/modified elements: scientific instruments, sampling/caching system, and possibly rover wheels



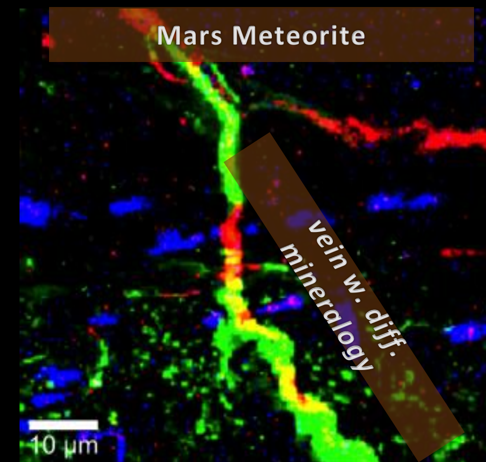
Mars 2020 Mission Implementation (2) - Science

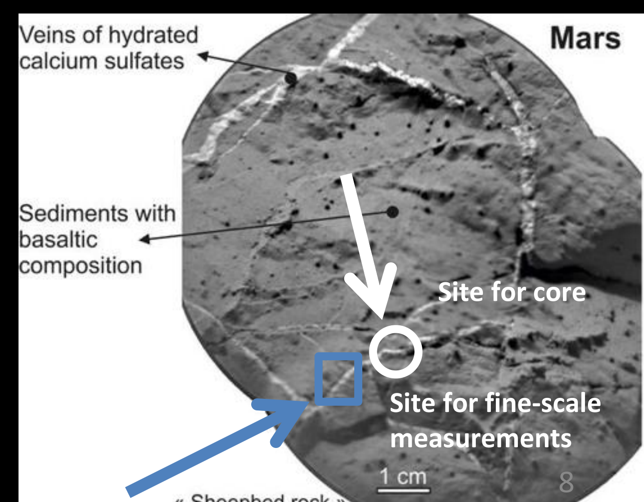
(after SDT and Instrument AO)

1) Scientific observations required to assess geologic history and astrobiology are the same as the instruments required for selecting/documenting samples for a returnable cache

2) Overarching theme for Mars 2020 instruments: make both visual/textural and mineralogical observations at a range of spatial scales from outcrop to sub-mm. Also need elemental chemistry and detection of reduced carbon.

Example: Correlation of variations in rock composition with fine-scale structures and textures is critical for geological and astrobiological interpretations. Also critical for understanding samples which would be put in cache.





Mars 2020 Mission Baseline Timeline

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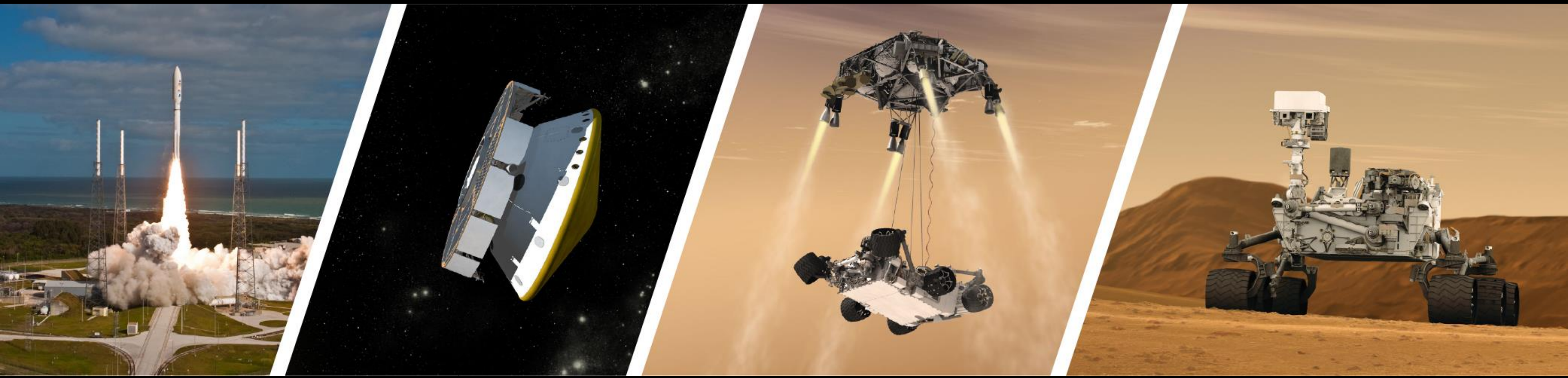


LAUNCH

- Launch vehicle to be similar class/capability as MSL
- Period: Jul/Aug 2020

CRUISE/APPROACH

- 7.5 month cruise
- Arrive Feb 2021

ENTRY, DESCENT & LANDING

- MSL EDL system: guided entry and powered descent/Sky Crane
- 25x20km landing ellipse
- Access to landing sites ±30° latitude, ≤0.5 km elevation
- ~950 kg rover

SURFACE MISSION

- Prime mission of one Mars year
- 20 km traverse distance capability
- Seeking signs of past life
- Returnable cache of samples
- Prepare for human exploration of Mars

Mars 2020 Mission Timeline (2)

Instrument Selection

- NASA Headquarters announced that 58 complete proposals were received, including proposals for the science instruments and for exploration technology payloads

- instrument proposal reviews are in progress

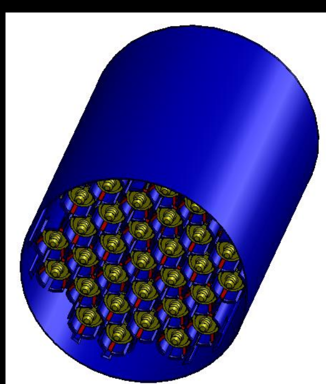
- announcement of instrument selection likely in late spring/early summer.

Sampling/Caching

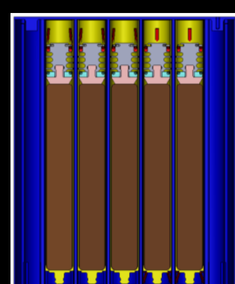
Concept for a Returnable Cache

- A returnable cache is a cache of samples that meets the interface requirements (including planetary protection) and has sufficient science value to be considered for Earth return

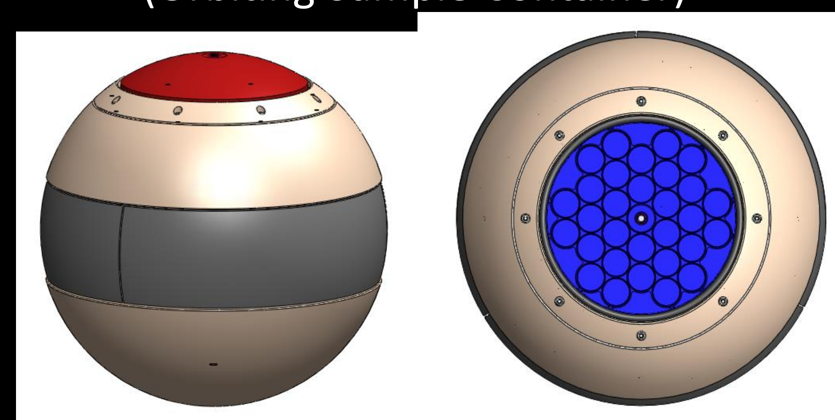
a cache



sealed sample tubes
in cache



cache inside the OS
(Orbiting Sample Container)



Sampling/Caching (2)

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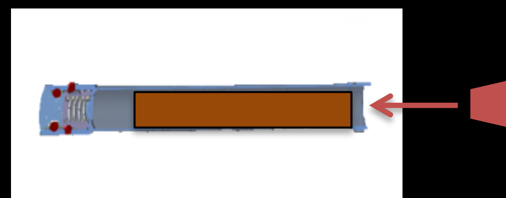
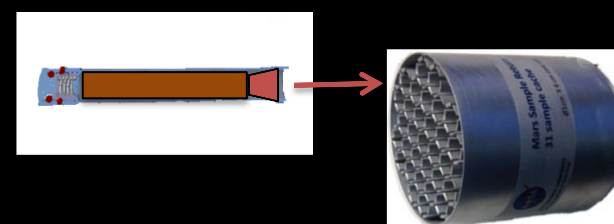
Concept for Acquiring, Storing, and Sealing a Sample

1) Rover would drill a core of pencil-like thickness, 5 cm long, directly into a clean tube



2) Tube would be hermetically sealed



3) Sealed tube would be placed in cache

Sampling/Caching (3)

Key Scientific Questions

1) How many samples can be documented adequately, drilled, and cached in one Mars year?

2) What contamination levels are acceptable in the samples (especially organic compounds)?

3) What are the physical integrity requirements for samples?

4) What are the post-drilling environmental requirements for cached samples (temperature, sealing, magnetic fields, radiation, etc)?

Sampling/Caching (4)

Approach to Answering These Questions:

Program Level: Dave Beaty and panel of experts are evaluating sample integrity requirements for potential sample return.

Open community workshop at LPSC March 16; in April, proposed requirements will be communicated to Mars 2020 Project for its consideration.

Project Level: “Mars 2020 Returned Sample Science Board” Dave Beaty is Chair

- Additional board members to be appointed soon

Mars 2020 Contamination Study Panel

- NASA HQ sponsored study to inform development of requirements for organic contamination levels for science and for planetary protection considerations.

- Charter:

  Evaluate draft Mars 2020 mission sample contamination requirements. Assess implementation approaches with respect to returned sample science objectives to support the investigation of martian organic geochemistry in returned samples and differentiation of indigenous molecules from terrestrial contamination.

- Broad community engagement solicited by "Dear Colleague" letter last month.

- Study kickoff scheduled for second week of March (TBR).

See: http://www.lpi.usra.edu/planetary_news/tag/mars-2020-contamination-study-panel/

Mars 2020 Landing Site Selection Process

Similar to MSL Process:

1) The broad expertise of the science community is crucial to the identification of optimal sites.

2) Process is open to all and has no predetermined outcome

3) Final site recommendation, selection, and approval is the job of the Project, 2020 Science Team, and NASA HQ, respectively.

Participants:

- NASA-Appointed Landing Site Steering Committee (Grant, Golombek ; Co-chairs)
- Science Community Input: Broad e-mail distribution of workshop invitations, workshop attendance
- Mars Characterization Investigators (MDAP, MFRP, CDP): Insight to landing site science and safety
- Mars 2020 Science Office, Project Management and EDL Team
- Headquarters and Other Ex-Officios: Ensures broad, relevant MEP participation, access to ongoing mission data

See: http://marsnext.jpl.nasa.gov/announcements/index.cfm

Mars 2020 Landing Site Selection Process (2)

Goal of the first workshop in April 2014:

1) a list of all known landing sites that meet the Mars 2020 threshold science criteria

2) for those sites, an assessment of what landing capability is required, choosing from three categories: MSL-only, MSL + Range Trigger (smaller ellipse), and MSL + Range Trigger + Terrain Relative Navigation

3) for each category of landing capability, a ranking of the sites using the qualifying geological criteria.

Key Issues:

1) How critical are possible EDL enhancements to science objectives?

2) Timely acquisition of critical MRO data: CRISM (mineralogy), HiRISE (high spatial resolution)

TRADE STUDY: Terrain Relative Navigation (TRN) Value to Mars 2020 Science?

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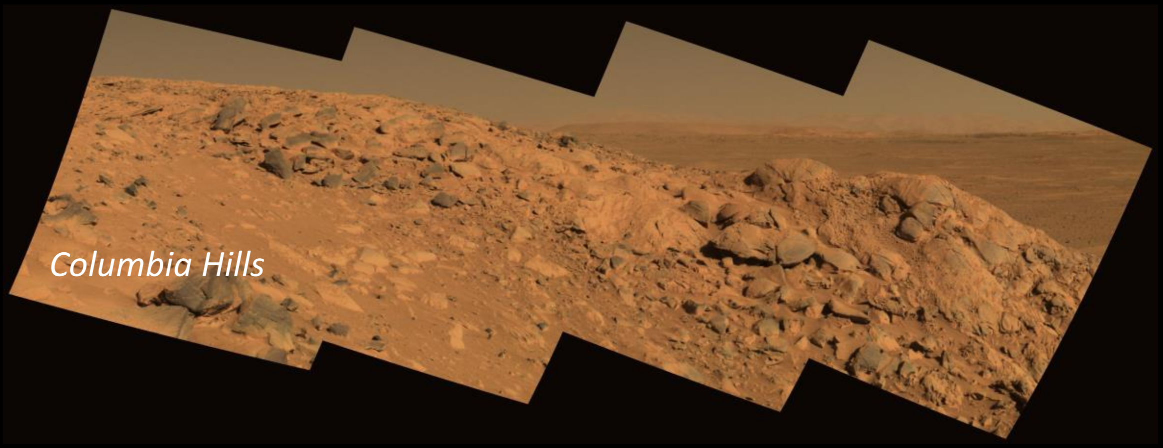
-enhancement to MSL landing capabilities

Science Driver: Mars 2020 may need to land at a site inaccessible to MSL because it has different science objectives.



MSL Criteria	vs	2020 Criteria
Search for Habitability		Habitability Biosignature Preservation Assessment of multiple rock types In-place igneous rocks [*maybe*]

High value rocks are usually found in topographically uneven locations with scarps, buttes, boulders – obvious landing challenges.

- Hazards are generally small and distributed throughout the ellipse
  - In many cases, the *hazards are actually the interesting targets (igneous rocks, sedimentary scarps)*
  - TRN allows some hazards to be present by enabling divert around small, distributed hazards
- Many of the places we want to go would be inherently hazardous to the as flown MSL EDL system
- TRN can reduce terrain failure rates at certain sites to MSL-like levels (~1-2% failure)

Terrain Relative Navigation (2)

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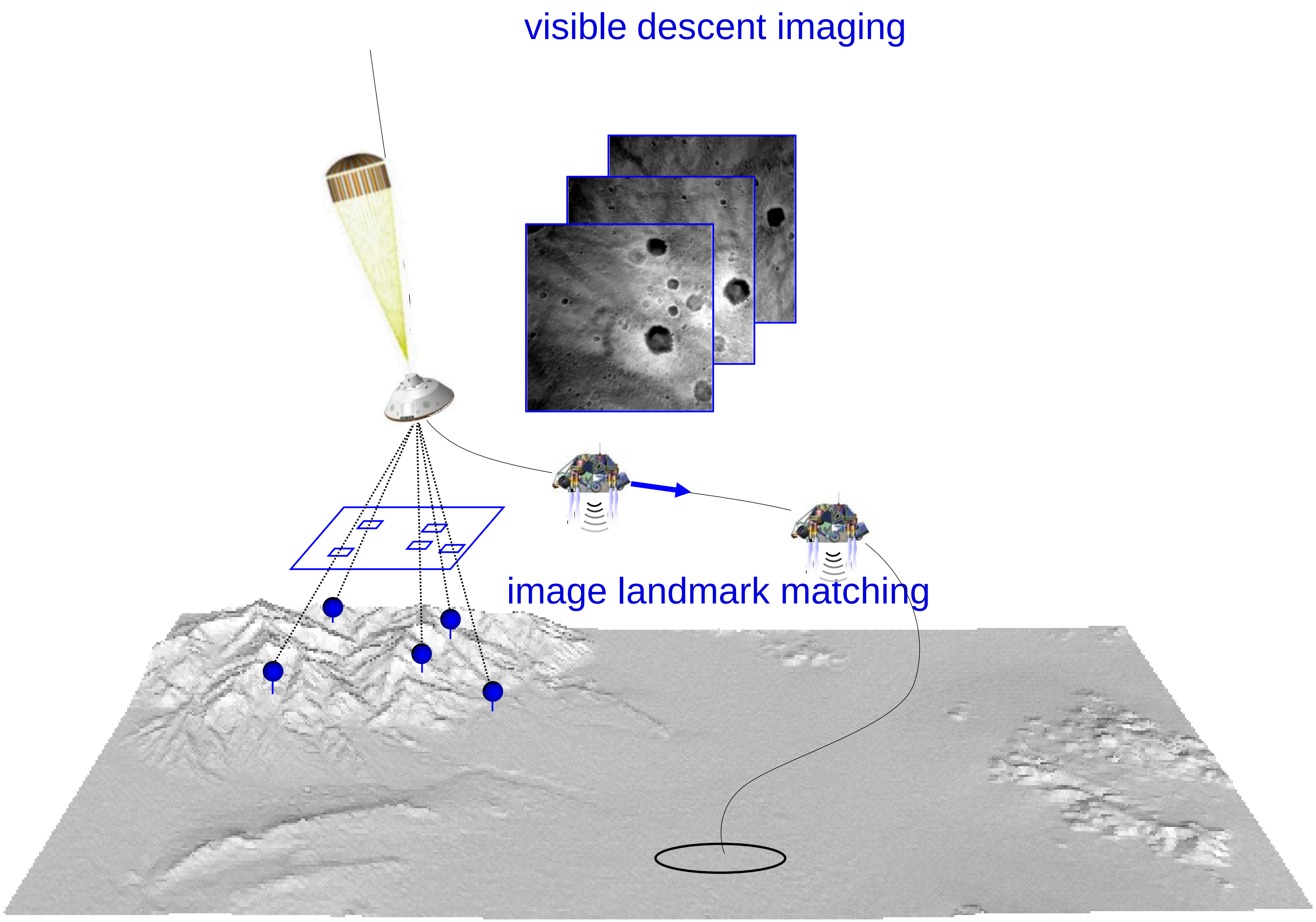

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Other Challenges:

TRADE STUDY: How Many Samples Can be Cached?

Plausible mission scenarios can be found throughout this triangle –

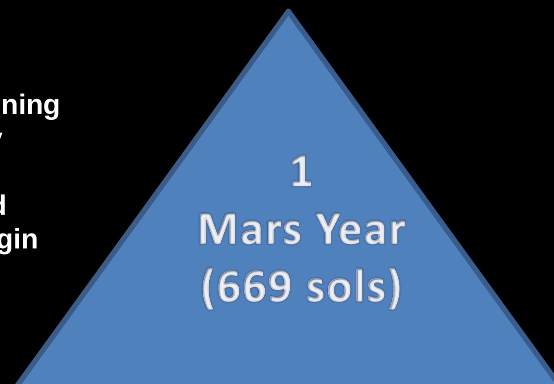
**trading drive distance,
total number of cached samples,
& number of cached samples
within a characterized suite**

– to suit a variety of possible landing sites.

Quantity of field work

e.g., 3 km total driving, 20 samples, full complement of fieldwork (1 core per characterized target)

Assumptions for all:
- **60 sols commissioning**
- **100 m/sol max trav rate**
- **Blue straw payload**
- **25% schedule margin**
- **MSL ops comm & schedule**



Quantity of coring/caching

e.g., 5 km total driving, 34 samples, 2 cores per characterized target

Quantity of driving

e.g., 15 km total driving, 20 samples, 2 cores per characterized target

"You can get anything you want, but you can't get everything you want."

Mars 2020 Status and Summary

1) The project is moving smoothly and on schedule through its key milestones, including SDT report, Mission Concept Review, instrument AO, and transition to Phase A
   - *next up is System Requirements Review, this fall*

2) There is extraordinary interest in the mission, as indicated by the very large number of proposals submitted to the AO.

2) The Mars 2020 stakeholders are unusually diverse, including the Science, Space Technology, and Human mission directorates at NASA

Mars 2020 Status and Summary (2)

4) We are building a high heritage design following on the remarkably successful and ongoing MSL mission. MSL adds both key data and operational experience for 2020 to capitalize on.

5) The Mars 2020 mission has been well-funded so far, and this has allowed the project to successfully retire a lot of the heritage rebuild risk.