Mars 2020 Project
Mars Exploration Program Advisory Group

McNamee/Farley
Mars 2020 Project Team

March 3, 2016
A new type of planetary mission in which *exploration supports sampling*
Sojourner: bulk geochemistry, no sampling

MER: abrasion + bulk geochemistry

MSL: powder drilling + bulk geochemistry

Sampling supporting exploration…
MARS 2020: coring/caching + spatially resolved geochemistry
Mars 2020 Project

What Mars 2020 science is not...

MSL exploration + *Mars Sample Return with the same rover and a lower budget

*possible
We will use our payload to explore a new region of Mars, and to support the selection of samples that, if successfully returned to Earth, would provide material for generations of planetary scientists.
For previous (and existing) Mars rover missions, *sampling supported exploration*.  

For Mars 2020, the first step towards *Mars sample return, *exploration supports sampling*.  

*This transition is analogous to the evolution of terrestrial geological/geochemical investigations as knowledge of the study area grows*
We must strive to maximize operational efficiencies using innovative and strategic approaches wherever possible.

But… *some of the scientific process is incompressible.*

As we approach a target (e.g. orbital data > remote science > proximity science), *information increases, and interpretations evolve*

The science team must arrive at Mars highly trained, nimble, and disciplined - ready to support extremely rapid data generation and dissemination, and *ready to make hard decisions quickly.*
Mars 2020 Payload Family Picture

**Instrument Key**

- **Mastcam-Z**
  - Stereo Imager
- **MEDA**
  - Mars Environmental Measurement
- **MOXIE**
  - In-Situ Oxygen Production
- **PIXL**
  - Microfocus X-ray fluorescence spectrometer
- **RIMFAX**
  - Ground Penetrating Radar
- **SHERLOC**
  - Fluorescence and Raman spectrometer and Visible context imaging
- **SuperCam**
  - LIBS and Raman
Sample Integrity Requirements

What is required to obtain a sample collection scientifically worthy of return to Earth?

Requirements derived through consultation with science community including:

- previously published documents focused on Mars Sample Return
  - especially the MEPAG publication e2e-iSAG (2011)

- ad hoc MPO Returned Sample Science working group (2013-2015)
  - predecessor of Returned Sample Science (RSS) Board

- HQ-chartered **Organic Contamination Panel** (OCP, 2014)
  - published report 2014

- HQ-chartered **Returned Sample Science Board** (2015-)
  - *board chair is a member of the Mars 2020 Project Science Group*

- consultation with JSC Curation (2015-)
  - Dr. Francis McCubbin, Mars Curator at JSC; also member of RSSB
Sample Integrity Requirements

1. Physical characteristics of samples and environments
   - Sample mass, number of samples, fracture limits, environmental requirements

2. Inorganic contaminants
   - Limitations on levels of ~20 elements critical for scientific study of samples

3. Organic contaminants
   - Total organic carbon + critical “Tier 1” list + limit on any single compound

4. Biologic contamination
   a) tightly limit the number of cells per sample
   b) collect thorough genetic inventory and contaminant archive
      to facilitate recognition of any terrestrial hitchhikers

5. Thorough characterization and archiving of materials which may add
   inorganic, organic, or biologic contamination to samples

6. Procedural blank program to characterize inorganic, organic, and biologic
   contamination occurring at and after ATLO (round-trip contamination)
Sample Integrity Requirements

7. Thorough documentation of geology of landing site and drilled sample context
   - critical linkage to the in-situ investigation
   - context-rich samples are of far greater value than “grab” samples
Planetary Protection

1. **Forward Contamination**
   (prevent contamination of Mars by terrestrial viable organisms)
   - Mars 2020 has a high heritage strategy based on successful MSL cleaning approach and will not target known Special Region

   *This is not controversial nor problematic*

2. **Backward Contamination**
   (prevent contamination of Earth by possible Martian organisms)

   - Mars 2020 has a limited role in this aspect of planetary protection
   - Backward contamination control (“break the chain”) will primarily be the responsibility of future possible missions

   *This is not controversial nor problematic*
3. Science Integrity

(Ensure that life-related* investigations in-situ on Mars and on possible returned samples on Earth can be successfully conducted)

- maintaining scientific integrity of in-situ investigations and of possible returned samples is of paramount importance to the Mars 2020 project. It is the rationale for doing the mission.

- broadly speaking, responsibility for the the scientific success of a mission rests with the science community, the mission science team, the project science group, and the project science office.

*how shall this word be interpreted?
Science Updates

1. Mars 2020 Team Guidelines adopted
   - similar to MSL's "Rules of the Road" but with a greater emphasis on open communication with external science community and the public

2. Brush capability descoped
   - Mars 2020 instruments PIXL, SHERLOC are safer and perform better on a flat, dust-free, abraded surface
   - bushing no simpler/faster than abrading
   - no unrecoverable science loss
   - sampling and caching system complexity reduced

3. Engineering team is investigating an enhanced dust/cuttings removal technique for abraded patch
   - use of compressed gas “puff”?

4. Baseline use of *Procedural Witness Blanks* rather than drilled blank
5. Mitigation strategy developed for sample tube heating after depot caching
- coating of tube with alumina keeps samples below the required level of 60°C at all prioritized landing sites

- mechanical integrity now being investigated
Last August's Landing Site Workshop:

a) "Fluvial/Deltaic/Lacustrine Sites"
   - Eberswalde
   - Holden
   - Jezero
   - SW Melas

b) "Hydrothermal/Crustal/Other Sites"
   - Columbia Hills
   - NE Syrtis
   - Nili Fossae
   - Mawrth

With TRN baselined - we now have access to all of these sites!

These sites are now being extensively investigated by the project: safety, operability, traversability. Metric: can we acquire sufficient number of samples in prime mission?

Sites prioritized for further scientific investigation: McLaughlin, Hypanis
Project Update
McNamee
Mission Overview

LAUNCH
- MSL Class/Capability LV
- Period: Jul/Aug 2020

CRUISE/APPROACH
- 7.5 month cruise
- Arrive Feb 2021

ENTRY, DESCENT & LANDING
- MSL EDL system (Range Trigger and TRN baselined): guided entry and powered descent/Sky Crane
- 16 x 14 km landing ellipse (range trigger baselined)
- Access to landing sites ±30° latitude, ±0.5 km elevation
- Curiosity-class Rover

SURFACE MISSION
- 20 km traverse distance capability
- Enhanced surface productivity
- Qualified to 1.5 Martian year lifetime
- Seeking signs of past life
- Returnable cache of samples
- Prepare for human exploration of Mars

http://mars.jpl.nasa.gov/mars2020/
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<td>Payload (+) Systems Review</td>
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<td>25 Mar 2015</td>
<td>JPL KDP-B Center Management Council</td>
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<td>8 May 2015</td>
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<td>20 May 2015</td>
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<td>Phase B start</td>
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<td>2-3 June 2015</td>
<td>Flight System Baseline Workshop #2</td>
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<td>9 June 2015</td>
<td>Sampling and Caching System Final Architecture Review</td>
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<td>Phase C Start</td>
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Project Overview

Salient Features

- Category: 1
- Risk Class: B
- Directed, JPL in-house implementation
- High heritage MSL design
- Modifications only as necessary to accommodate new payload and Sampling / Caching System (SCS)
- Planetary Protection Category V per Level 1 Requirements

Science

- Assess past habitability of an astrobiologically relevant ancient environment on Mars
- Assess biosignature preservation potential with the environment and search for biosignatures
- Assemble cached samples for possible future return to Earth
- Provide an opportunity for contributed HEO/STMD participation to advance technologies with potential applications to future human exploration objectives
Spacecraft Build Approach

- **Launch Vehicle**
  - KSC/Launch Services
  - Program procurement

- **MMRTG**
  - DoE procurement to industry

- **Science & Exploration Technology Investigations**
  - Source per proposals via AO selection

- **MEDLI**
  - NASA Centers (LaRC, ARC, and JPL)

- Built in-house at JPL
  - Lowest cost and risk per make-buy study and industry RFIs

- Built by Lockheed-Martin/Denver
  - Procure as sole source—most cost effective

- Built in-house at JPL
  - Major industry subcontracts/components
  - Rebuild in-house due to criticality of EDL and rover interface

- Built in-house at JPL
  - Major industry subcontracts/components
  - Spanish contributed High Gain Antenna
  - Rebuild in-house due to complexity of vehicle, residual hardware, criticality of EDL and rover interface, operations experience

- Built by Lockheed-Martin/Denver
  - Procure as sole source—most cost effective
Mars 2020 Rover Concept

Stays the Same as MSL
- Avionics
- Power
- GN&C
- Telecom
- Thermal
- Mobility

Changed
- New Science Instrument Suite
- New Sampling Caching System
- Modified Chassis
- Modified Rover Harness
- Modified Surface FSW
- Modified Rover Motor Controller
- Modified Wheels

Expected to Change
- Some Mobility components (to support wheel and/or Rover mass)
SMD Directed Study Status

- Terrain Relative Navigation: BASELINED BY PROJECT – DIRECTION FORTHCOMING
- Turret Imaging Upgrade: BASELINED
- Helicopter: SUPPORT ACCOMMODATION STUDY
- Cubesats: ELIMINATED FROM CONSIDERATION
- Microphone: BASELINED WITH EDL CAMERAS
- Ringsail Parachute: ELIMINATED FROM CONSIDERATION
- EDL Cameras BASELINED

Program / Project Initiated Studies

- Adaptive Cache Approach: BASELINED
The Mars 2020 Project has conducted successfully the lower level instrument, subsystem, and Office level PDR’s necessary to provide confidence in a full understanding of the requirements, design response, and associated cost estimates.

SHERLOC issues have been identified and action taken. A full and successful PDR was conducted Feb. 16-17.

Cost performance on heritage HW continues to perform under plan.

Cost estimates for new developments, particularly the instrument payload and SCS, are believed to provide acceptable financial and schedule margins that support a 2020 launch within the estimated A thru D cost target.