MEPAG Report to PSS Telecon - 21 Dec. 2011

MSL Launches!
MER Exploration Highlights
MEPAG June 2011 Meeting in Lisbon, Portugal
Senior Review of Continuing Missions
Orbiter Exploration Highlights
Future Planning, Meetings and Milestones
Summary
MSL launches successfully!!!
Gale Crater
154 km diameter

olivine (dunes); (Mg,Fe)$_2$SiO$_4$
pyroxene (LCP & HCP) in/near mound
(Fe, Mg) smectite clays; e.g.,
nontronite Fe$_2$(Si,Al)$_4$O$_{10}$(OH)$_2$$\cdot$$n$(H$_2$O)
sulfates (monohydrated)
e.g., kieserite MgSO$_4$$\cdot$H$_2$O
sulfates (polyhydrated)
sulfates & clays
& crystalline red hematite
• Three-year, 20-km journey to Endeavour crater completed.
• New vistas, new rocks, new science!
• Conducted full sets of analyses on rocks and bedrock, including elemental analyses and microscopic imaging on unbrushed, brushed, and RATed (abraded) surfaces, as well as an exploratory Moessbauer integration.
• “Chester Lake” bedrock target appears to be a suevite, a basaltic impact breccia that has been chemically altered (presumably by impact-related hydrothermal activity).
• Opportunity is projected to require a north-facing slope in order to assure winter survival. It is approaching the north end of Cape York, which appears to offer adequate north slopes and key science targets.
Homestake Vein Deposit

- Several linear, brighter features in the Cape York area might be veins formed by fluid flow and mineral deposition along fractures.
- APXS elemental analysis of “Homestake” vein indicated that it is dominated by calcium and sulfur (gypsum? anhydrite? altered carbonate?).
- These features are consistent with fluid flow and mineral deposition initiated by the impact that formed Endeavour crater.
Plans for Opportunity's 5th Winter

Like Spirit in previous winters, Opportunity is projected to require a north-facing slope in order to assure winter survival.

Only moderate slopes (10-15°) are required by the January-February timeframe.

The best candidate sites appear to be on the north end of Cape York, about 350 m from Opportunity's current location.
NASA implementation of Decadal Survey recommendations

Lisbon meeting participants endorsed the program with the Trace Gas Orbiter (with EDL Demo Module) launched in 2016 and a single Joint Rover in 2018.

MEPAG's view is that the agreement on these missions that ESA and NASA presented at the meeting should go forward; it was consistent with the Decadal Survey priorities.

Landing site selection - MSL and subsequent missions

Discussed choice of Gale Crater as MSL landing site

Endorsed proposal to emulate MSL site selection process for 2018 Joint Rover

Noted urgency of using existing orbital assets for future landing site selection
End-2-End International SAG (E2E-iSAG) report

Report provides a solid foundation for the Joint Science Working Group (JSWG) which is serving as the Science Definition Team for 2018 (Final report was released in November 2011; see mepag.jpl.nasa.gov/reports/index)

Addresses MSR science objectives, landing sites, sample types, sampling priorities, Earth-based labs, etc.

MEPAG endorsed findings of the E2E-iSAG regarding the sample selection and caching objectives of the 2018 Joint Rover mission

This E2E-iSAG was an excellent example of how international cooperation and participation could work in a joint program
## Planning for Returned Sample Science: Final Report of the E2E-iSAG*

### Co-Chair
- Mark Sephton  
  Imperial College, London, UK  
  Organics, ExoMars
- Scott McLennan  
  SUNY Stony Brook, NY  
  Sedimentology, geochemistry Co-I MER

### Science Members
- Carl Allen  
  JSC, Houston, TX  
  Petrology, sample curation, Mars surface
- Abby Allwood  
  JPL, Pasadena, CA  
  Field Astrobio., early life, liason MAX-C
- Roberto Barbieri  
  Univ. Bologna, IT  
  Astrobiology, paleontology, evaporites
- Penny Boston  
  NM Inst. Mining & Tech, NM  
  Cave geology/biology, member PSS
- Mike Carr  
  USGS (ret.), CA  
  Mars geology, water on Mars
- Monica Grady  
  Open Univ. UK  
  Mars meteorites, isotop., sample curation
- John Grant  
  Smithsonian, DC  
  Geophys., landing sites, MER, MRO
- Veronika Heber  
  UCLA  
  Gas geochemistry
- Chris Herd  
  Univ. Alberta, CAN  
  Petrology, sample curation
- Beda Hofmann  
  Nat. Hist. Museum, Bern, CH  
  Geomicrobiology, ExoMars (Deputy CLUPI)
- Penny King  
  Univ. New Mexico  
  Petrology, geochemistry, MSL
- Nicolas Mangold  
  Univ. Nantes, FR  
  Geology, spectroscopy MEX, MSL
- Gian Gabriele Ori  
  IRSPS, Pescara, IT  
  Mars geology, sedimentology, MEX, MRO
- Angelo Pio Rossi  
  Jacobs Univ. Bremen, DH  
  Planetary geology, HRSC, SHARAD
- François Raulin  
  Univ. Paris 12, FR  
  Astrobio., extraterrestrial material, Deputy MOMA
- Steve Ruff  
  Arizona State Univ.  
  MER operations, spectral geology, MGS, MER
- Barb Sherwood Lollar  
  Univ. Toronto, CAN  
  Astrobiology, stable isotopes
- Steve Symes  
  Univ. Tennessee  
  REE, geochronology, member CAPTEM

### Eng. Reps.
- Peter Falkner  
  ESA  
  Advanced mission planning, MSR
- Michael Wilson  
  JPL  
  Advanced mission planning, MSR

### Ex-officio
- Dave Beaty  
  Mars Program Off., JPL  
  Liaison to MEPAG, cat herder

* [http://mepag.jpl.nasa.gov/reports/]
Overview

Prioritized MSR science objectives

Derived implications

Samples required/desired to meet objectives
Measurements on Earth

Critical Science Planning Questions for 2018

Variations of interest?
# of samples?
Types of landing sites that best support the objectives?
Sample size?
Measurements needed to interpret & document geology and select samples?
On-Mars strategies?

Engineering implications

Sampling hardware
Instruments on sampling rover
EDL & mobility parameters, lifetime, ops scenario
Sample preservation

12/23/2011

Pre-decisional: for discussion purposes only
E2E-iSAG: Key Messages

http://mepag.jpl.nasa.gov/reports/

1. MSR should address 8 major, community-developed science objectives. The most important objective by far relates to determining whether evidence of past life or prebiotic chemistry exists in the examined materials.

2. To answer the complex questions associated with the highest priority objectives (1-4) would require sample suites that are carefully selected through a process of comprehensive *in situ* science that also provides critical context for sample analyses back on Earth.

3. The total number of samples that would be needed to address the objectives is 30-40. Approximate mass per rock sample needed for analyses on Earth is 14-16 g.

4. There are multiple potential landing sites on Mars where it appears possible to meet the proposed MSR science objectives. To access these sites and sample the desired rocks, the mission may need to be able to tolerate some hazards in the landing ellipse (OR have an ellipse small enough to avoid the hazards) AND be able to traverse beyond the ellipse.

5. In order to achieve the *in situ* science and assemble the necessary sample suites, the 2018 rover should have the field exploration capabilities defined by the E2E-iSAG
## MSR Science Objectives and Samples Required/Desired

### Scientific Objectives in Priority Order

<table>
<thead>
<tr>
<th>#</th>
<th>Objective</th>
<th>Sample Types</th>
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<tbody>
<tr>
<td>1</td>
<td>Critically assess any evidence for past life or its chemical precursors, and place detailed constraints on the past habitability and the potential for preservation of the signs of life</td>
<td>1A. Subaqueous or hydrothermal sediments (EQUAL PRIORITY)</td>
</tr>
<tr>
<td>2</td>
<td>Quantitatively constrain the age, context and processes of accretion, early differentiation and magmatic and magnetic history of Mars.</td>
<td>1B. Hydrothermally altered rocks or Low-T fluid-altered rocks</td>
</tr>
<tr>
<td>3</td>
<td>Reconstruct the history of surface and near-surface processes involving water.</td>
<td>2. Unaltered Igneous rocks</td>
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<tr>
<td>4</td>
<td>Constrain the magnitude, nature, timing, and origin of past planet-wide climate change.</td>
<td>3. Regolith</td>
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<tr>
<td>5</td>
<td>Assess potential environmental hazards to future human exploration.</td>
<td>4. Atmosphere, rocks with trapped atmosphere</td>
</tr>
<tr>
<td>6</td>
<td>Assess the history and significance of surface modifying processes, including, but not limited to: impact, photochemical, volcanic, and aeolian.</td>
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<tr>
<td>7</td>
<td>Constrain the origin and evolution of the martian atmosphere, accounting for its elemental and isotopic composition with all inert species.</td>
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<tr>
<td>8</td>
<td>Evaluate potential critical resources for future human explorers.</td>
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**Mandatory:** Determine if the surface and near-surface materials contain evidence of extant life.
FINDING #30. In order to recognize the geological characteristics of interest and to provide a proper basis for sample selections, two measurement types are required from the mast, and 3-4 more from the arm, as identified in the figure below. On-board laboratory measurements such as provided by the ExoMars ALD are highly desirable for sample selection and establishing geologic context.

“Selecting high quality samples is essential to the success of the sample return effort”—NRC (2011)

Required contact measurements* on ARM:
- Microscopic imagery
- Elemental chemistry
- Mineralogy

Highly desired measurement* on ARM:
- Organic C detection

Additional capability required on ARM:
- ability to remove rock weathering layer

*Sub-mm measurement scale highly desirable for all contact measurements; required for imaging and mineralogy

Required on MAST:
- Macroscopic imagery
- Mineralogy (spectroscopy)

Highly desirable and assumed to be present (in ALD):
- Organic carbon detection & analysis
- Mineralogy
  (more detailed /precise measurements than instruments on arm or mast)

Reinforces key findings of MRR-SAG (2009) and NRC Decadal Survey (2011)
Potential Landing Sites

- Mask shows draft latitude and elevation constraints for proposed MSR (as of Jan. 2011)
- All sites are community-proposed:
  - 59 sites from MSL landing site process, 26 sites from CDP future selection process
- Labeled sites are E2E-iSAG reference sites to guide early engineering trade studies
Continuing Missions - Senior Review

MEPAG agrees with the Decadal Survey recommendation that "early planning be done to provide adequate funding of mission extensions", as these extensions "can be significant and highly productive"

MER-Opportunity, ODY, MEX (U. S.), and MRO are the Mars missions preparing proposals for the Planetary Science Division's 2012 Senior Review

These Mars missions have many unique capabilities (e.g., radar sounding, very high resolution imaging), with respect to past and future missions

Selection criteria will include ability to carry out programmatic functions (landing site selection, critical event coverage, environmental monitoring, relay) as well as high-value science observations

Review Panel will be challenged to cover the breath of these Mars missions plus the small bodies and outer planet missions (LRO, GRAIL, Cassini, Deep Impact concepts) being considered
Recurring Slope Lineae (RSL) are narrow (0.5-5 m), dark markings on steep slopes (>25°).

Form and incrementally grow in warm seasons (late spring to summer), then fade or disappear in cold seasons.

Reform at nearly same locations in multiple Mars years.

Extend downslope from bedrock outcrops or rocky areas; often associated with small channels.

Concentrated in southern hemisphere (32° S to 48° S), favoring equator-facing slopes.

Form and grow at temperatures at which brines (salty water) would be liquid.

Exact mechanism not understood, but activity of brines is current best model.
Massive South Polar CO$_2$ Deposits

Phillips et al. (2011) in *Science*

SHARAD detected a mostly featureless (to radar) unit (RFZ$_3$) in portions of the South Polar Layered Deposits (SPLD)

Permittivity of unit extracted from the radar data, 2.0 to 2.2 ± 0.2, and its invariance with unit thickness are consistent with bulk CO$_2$ ice.

Correlation between the radar unit (RFZ$_3$) and a previously mapped geologic unit (AA$_3$) enables extrapolation of RFZ$_3$ to areas not covered by SHARAD.

Total volume of unit estimated to be 9,500–12,500 km$^3$. If released, this new inventory of CO$_2$ would increase atmospheric mass by 80%, extending water stability at the surface and making dust storms more prevalent.

Mystery: How do you build a massive CO$_2$ ice deposit surrounded by water ice?
# Future Planning, Meetings and Milestones

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<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>Report to Agencies on ESA-NASA-Russia Mars Activities</td>
<td>January 31</td>
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<td><strong>President’s Budget Release</strong></td>
<td>February 6 TBC</td>
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<tr>
<td>Conference on Life Detection in Extraterrestrial Samples</td>
<td>February 13-15</td>
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<td>MEPAG Meeting #25</td>
<td>February 27-28</td>
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<td>Mars 2018 Landing Site Workshop</td>
<td>Feb 29 – Mar 2</td>
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<tr>
<td>43rd Lunar &amp; Planetary Science Conference</td>
<td>March 19-23</td>
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<tr>
<td>Astrobiology Science Conference</td>
<td>April 16-20</td>
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<tr>
<td>European Geosciences Union General Assembly</td>
<td>April 22-27</td>
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<tr>
<td>PSD Senior Review of Operating Missions</td>
<td>April TBD</td>
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<tr>
<td>Mars Recent Climate Change Workshop</td>
<td>May 15-17</td>
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<tr>
<td>Third International Conference on Early Mars</td>
<td>May 20-25</td>
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<tr>
<td>Third International Planetary Dunes Workshop</td>
<td>June 12-15</td>
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<tr>
<td>Conf. on Comparative Climatology of Terrestrial Planets</td>
<td>June 25-28</td>
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<td>COSPAR 2012</td>
<td>July 14-22</td>
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<tr>
<td><strong>MSL Landing</strong></td>
<td>Aug 5/6 (P/EDT)</td>
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The Mars community remains committed to the 2016 and 2018 Mars missions, with the caching rover identified as the Decadal Survey’s first-priority flagship and consistent with the E2E-iSAG’s recommendations.

The implementation approach, including status of the international cooperation and the President’s budget profile for planetary, will be discussed at the next MEPAG meeting, February 27-28, 2012, Washington, DC.

MEPAG notes the high scientific and programmatic value of the currently operating Mars missions and of the research and analysis programs that exploit the full value of data already in hand or soon to be acquired.

MEPAG looks forward to a successful MSL EDL and Curiosity surface mission!