CRISM data show indications of hydrated sulfates on the SE edge of the Santa Maria crater. Opportunity will investigate that area through solar conjunction in late January and early February.
Where is the Rover Now?

October 21, 2010

**Curiosity Cam Goes Live**

The Curiosity Cam live video feed allows the public to watch technicians assemble and test NASA's next Mars rover in a clean room at the Jet Propulsion Laboratory, Pasadena, Calif.

› Read more
Sampling of MEP 2010 Science Highlights

- Sand dune modification at high-latitudes occurs during winter, triggered by CO$_2$ seasonal defrosting (E.g., E. Gardin et al., JGR, S. Diniega et al., Geology, 2010; C. J. Hansen et al., 2011, in press)

- *Spirit* data reveal carbonate-rich outcrops on Mars [next slide]


- ODY THEMIS expands areal coverage with good SNR for composition studies, including search for chlorides [coming slide]

- Possible Hesperian age hydrothermal activity in the Syrtis Major region of Mars (J. R. Skok et al., Nature Geoscience, 2010)

- Closed highland basins with “bathtub rings” of acid sulfates and kaolinite clay [coming slide]
These images show improvement in THEMIS IR spectral contrast now that ODY is in an earlier local time orbit (~3:45)

In general, pink and magenta colored areas are more mafic in composition while yellow and green are less mafic.

Note: ODY now holds the record for longest operating spacecraft at Mars
Acid-Saline Closed-Basin Lake Deposits

- **Blue-magenta** = acid sulfate
- **Green** = kaolinite
- **Red** = basaltic sand

- **Mission/instrument**: MRO/CRISM+HiRISE
- **Finding**: Bathtubs rings of acid sulfates + kaolinite clay in highland craters.
- **Importance**: As with sulfate deposits in Valles Marineris and Meridiani, these correspond to predicted locations of Hesperian-age groundwater discharge. Result supports hypothesized role of groundwater in forming sulfate-rich deposits. Comparable terrestrial environments are habitable.

Status of Items Identified at April 2010 PSS Meeting

• Hold a MEPAG meeting in Europe in June 2011, as a way to further advance cooperation on joint ESA-NASA missions
  
  Plans in progress for Lisbon June 2011 meeting*

• Consider a framework for mapping end-user sample return requirements (i.e., from a sample return campaign perspective) onto the individual flight elements, including definition of objectives, derived requirements, and site criteria for 2018 dual rover mission
  
  Formed E2E-iSAG which will complete work this spring*

• Follow-up (although perhaps not immediately) in collaboration with ESMD on the development of a humans-to-Mars roadmap that will be the successor to our current Goal IVB
  
  Heard report from ESMD on future plans at Sept. 2010 meeting*

*All these items were discussed at the 23rd MEPAG Meeting [next slides]
23rd MEPAG Meeting

  - Following MSL PSG & 4th MSL Landing Site Workshop

- Meeting Activity Highlights:
  - Updated the community on progress in the exploration of Mars with reports from NASA MEP and European Space Agency
  - Decadal Survey update (now awaiting March 7 briefing at LPSC)
  - Formed a Supporting Research and Technology SAG to provide input to the PSS study [more on next slide]
  - Discussed outreach activities and how one might get involved
  - Discussed Mars Sample Return End-to-End International SAG
  - ESMD planning, particularly with respect to Mars-related missions
  - Reports on MSL and future mission landing site activities
Supporting Research & Technology SAG (SRT-SAG)

V. E. Hamilton (Chair), A. D. Anbar, M. T. Mellon, M. A. Mischna, K. Righter

- MEPAG SRT-SAG solicited input by various means from the Mars community
- Report vetted at Fall AGU meeting with community input closed later in December
- Final Report reviewed by MEPAG Executive Com., updated & submitted to PSS
- Key conclusions and suggested actions are summarized in Back-Up
- Some Highlights:
  1. Present technology development programs are insufficiently funded and leave TRL gaps, impeding progress towards new, cutting-edge instruments and technologies for planetary exploration and increasing mission development costs and schedule risks
  2. Research and analysis programs are the primary means of getting full value of flight data and of enabling new discoveries that guide the goals and objectives of the MEP; these programs need bolstering in some areas
  3. Proposal review process takes too long; past improvements may be eroding
  4. A strong need for MSR is development of sample handling capabilities and analysis infrastructure
23rd MEPAG: Issues and Concerns

NASA-ESA Joint Program:
• Completing the MOU & Joint Program Exploration Plan (JPEP) - critical for stability
• Disconnect between NASA funding for 2016 and ESA schedule
• Finding a technical solution to the 2018 dual rover mission which satisfies the core objectives of both agencies at a single site
• Sustaining partnership after the first two missions through Mars Sample Return.

ESMD xPRM Program:
• The budget for this program, and therefore its content and scope, is currently very uncertain. Furthermore, it will be difficult to develop xScout missions for deep space (e.g., Mars) within the stated mission cost caps.
• Given the ESMD uncertainties and the SMD funding limitations, it will be challenging to identify near-term Mars missions that provide collateral benefits for ESMD & SMD.

Landing Site Selection:
• Need MEP to move aggressively on a near term program of site selection for post-MSL missions, beyond the new Critical Data Products (CDP) program call, if we are to take full advantage of current, but aging, orbital assets.
MEPAG Activities: Increasingly International

• MEPAG continues to welcome international scientists at its meetings and to invite international programs to present their current plans
  o Given the discussion of joint missions and programs in order to achieve the highest priority science goals, this is more important than ever
  o MEPAG Executive Committee has an international member (Gian Gabriele Ori) and the MEPAG Goals Committee has an international representative (Frances Westall)

• The international community is strongly represented on MEPAG SAGs:
  o Net-SAG fully international (USA-German co-chairs, 10 US, 7 EU members)
  o First formal international SAG (iSAG), November 2009: 2 Rover iSAG
    ▪ Explored the science to be gained by dual operations of the ExoMars and MAX-C rovers in the same location
  o Second iSAG 2010: End-to-end (E2E) iSAG [more on next slides]
End-to-End international SAG (E2E-iSAG)
Co-Chairs: Scott McLennan (US), Mark Sephton (UK)

Need: Synthesize prior MEPAG SAG findings, augmenting as needed, to define reference science objectives and associated criteria to support advance studies of proposed MSR campaign
• Take the perspective of what the overall campaign must achieve to ensure that study of the returned samples has the expected high value

SAG charter tasks
• Propose reference campaign-level MSR science objectives and priorities
• Understand derived implications of these objectives and priorities:
  o Kinds of samples required/desired
  o Requirements for sample acquisition and handling
  o Draft Mars site selection criteria & identify reference sites for system studies
  o Required In situ capabilities
## Draft Science Objectives, MSR Campaign

<table>
<thead>
<tr>
<th>AIM / MEPAG GOAL</th>
<th>#</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Life</strong></td>
<td></td>
<td>In rocks interpreted (from orbital and in situ data) to represent one or more paleoenvironments with high potential for past habitability and biosignature preservation:</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Critically assess any evidence for past life or its precursors.</td>
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<tr>
<td></td>
<td>2</td>
<td>Evaluate the capacity of the selected palaeoenvironments to record and retain biosignatures.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Place detailed constraints on those aspects of the past environments that affected their capacity to host life.</td>
</tr>
<tr>
<td><strong>B. Surface</strong></td>
<td>1</td>
<td>Reconstruct the history of surface and near-surface processes involving water.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Assess the history and significance of surface modifying processes, including, but not limited to: impact, photochemical, volcanic, and aeolian.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Constrain the magnitude, nature, timing, and origin of past planet-wide climate change.</td>
</tr>
<tr>
<td><strong>C. Planetary evolution</strong></td>
<td>1</td>
<td>Quantitatively constrain the age, context and processes of accretion, early differentiation and magmatic and magnetic history of Mars.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Constrain the origin and evolution of the martian atmosphere, accounting for its elemental and isotopic composition with all inert species.</td>
</tr>
<tr>
<td><strong>D. Human exploration</strong></td>
<td>1</td>
<td>Assess potential environmental hazards to future human exploration.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Evaluate potential critical resources for future human explorers.</td>
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</tbody>
</table>
PRELIMINARY PARTIAL LIST OF SAMPLE TYPE PRIORITIES

DRAFT PRIORITY ORDER (discussion invited)

• Lacustrine sedimentary rocks*
• Hydrothermal rocks*
• Igneous rocks
• Atmospheric gas
• Airfall dust
• Regolith
• Breccia

NOTES:

It is not assumed that it would be possible to sample all of the above at any single landing site.

SAMPLE SUITES

a. Span the range of depositional paleoenvironments, facies and mineralogical diversity
b. As wide a range of age as possible, spanning Noachian/Hesperian boundary

a. Span range of thermochemical environments
b. Range of rock-forming environments

a. Diversity in bulk chemical composition / mineralogy (incl. xenoliths)
b. Widest range of ages (with a focus on Noachian samples)

NO SUITE REQUIRED
CAPABILITIES IMPLIED (priority order)

1. Outcrop or boulder sampling—rock cores (~10 g samples)
   • Ability to collect samples of opportunity (the constraints of the landing site selection process would force us into compromises).

2. Ability to collect near-surface sample regolith and dust (granular materials).

3. Encapsulation (hermeticity to be defined)

4. Atmospheric gas sampling (assume pressurized)

5. “Deep” subsurface sample from ExoMars drill (rock, soil, or both?)

6. Capability to reject previous samples, and replace with better ones.

7. Capability to record orientation

IN PLACE vs. FLOW SAMPLE

Sampling of sedimentary rocks in-place judged to be essential

For igneous rocks, in-place sampling is judged to be essential or important depending on the objective

For breccia (and other samples of opportunity), float would be OK
E2E SAG: What’s Next

• Complete work on objectives and sample handling issues

• Work on site criteria and reference landing sites
  o Criteria needed to guide data acquisition by current orbital assets at Mars
  o Reference sites needed to inform technical studies
  o Provide preliminary findings to interested parties [E.g., next slides]

• Final Report
  o Report out at June 2011 international MEPAG meeting
  o Provide input to programmatic groups (JMART?)
  o Make way for 2018 Science Definition Team in FY12
Science/PP Interface Issues
For Mars Sample Return (MSR)

Penny Boston and the E2E-iSAG team
Jan. 20, 2010

Pre-decisional for discussion purposes only
A call for action!

NASA’s 2018 sample caching mission:
- Announcement of Opportunity (AO) scheduled for ~May, 2012
- System Requirements Review (SRR) for ~Feb. 2013

Science inputs:
Science team proposes quantitative contamination limits relevant to science & total sample mass needed

PP inputs:
PP bodies (on an international basis) determine quantitative contamination limits relevant to PP, & total sample mass needed

Integration:
A coordination group consolidates and integrates, proposes draft requirements

NASA-initiated efforts
Summ/Fall, 2011?

ESA Study
Fall 2012

MCR
Prededential for discussion purposes only
 MEPAG Future Planning

• **March 7, 2011:** Planetary Decadal Survey recommendations for Mars
  o Depending on outcome, MEPAG may modify charter for E2E-iSAG or, if appropriate, start new SAG before June meeting

• **February – May 2011:**
  o Finish present E2E-iSAG work & prepare report
  o 5th MSL Landing Site Workshop May 16-18
  o MSL Participating Scientist selections

• **2011:** Monitor developments in ESA-NASA joint Mars program
  o Continue to ask for reports from agencies and projects/studies
  o Present information (e.g., E2E-iSAG report) as requested
  o Conduct additional studies (new iSAGs) as needed
    ▪ Follow-on iSAG to address MSR sample contamination issues?

• **June 13-17, 2011:** Mars Habitability Conference and MEPAG Meeting

• **November 27 – December 9, 2011:** MSL launch!
Back-up
<table>
<thead>
<tr>
<th>Start</th>
<th>Time</th>
<th>Agenda Item</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30 AM</td>
<td>00:15</td>
<td>Welcome; MEPAG Purpose, Scope, Expected Results</td>
<td>D. Des Marais</td>
</tr>
<tr>
<td>08:45 AM</td>
<td>00:30</td>
<td>Mars Program Director's Comments</td>
<td>D. McCuistion</td>
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<tr>
<td>09:15 AM</td>
<td>00:30</td>
<td>ESA's Mars Exploration Activities</td>
<td>M. Coradini/J. Vago</td>
</tr>
<tr>
<td>09:45 AM</td>
<td>00:15</td>
<td>Break</td>
<td></td>
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<tr>
<td>10:00 AM</td>
<td>00:30</td>
<td>Mars Program Status</td>
<td>F. Li</td>
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<tr>
<td>10:30 AM</td>
<td>00:45</td>
<td>Mars Program Lead Scientist's Comments</td>
<td>M. Meyer</td>
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<tr>
<td>11:15 AM</td>
<td>00:30</td>
<td>2016 Selections</td>
<td>P. Crane/J. Vago</td>
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<tr>
<td>11:45 AM</td>
<td>01:30</td>
<td>Lunch</td>
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<tr>
<td>01:15 PM</td>
<td>00:45</td>
<td>PSS-requested feedback on proposed changes to SMD R&amp;TD</td>
<td>D. Des Marais</td>
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<tr>
<td>02:00 PM</td>
<td>00:30</td>
<td>Decadal Survey Update</td>
<td>S. Squyres</td>
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<tr>
<td>02:30 PM</td>
<td>00:20</td>
<td>Spirit: Status and future science plan</td>
<td>S. Squyres</td>
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<tr>
<td>02:50 PM</td>
<td>00:15</td>
<td>Break</td>
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<tr>
<td>03:05 PM</td>
<td></td>
<td>Reports on Mission Planning Activity</td>
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<tr>
<td>03:05 PM</td>
<td>01:00</td>
<td>E2E-iSAG: Community input into initial planning</td>
<td>M. Sephton/S. McLennan</td>
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<td>04:05 PM</td>
<td>01:00</td>
<td>Mars Outreach Strategy</td>
<td>M. Viotti</td>
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<tr>
<td>05:05 PM</td>
<td>00:10</td>
<td>Day 1 discussion and wrap-up</td>
<td>D. Des Marais</td>
</tr>
<tr>
<td>05:15 PM</td>
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<td>Adjourn</td>
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## MEPAG Agenda, Day 2

**Day 2 – Friday October 1, 2010**

<table>
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<tr>
<th>Time</th>
<th>Duration</th>
<th>Agenda Item</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>08:00 AM</td>
<td>00:15</td>
<td>Recap of yesterday and goals for today</td>
<td>D. Des Marais</td>
</tr>
<tr>
<td>08:15 AM</td>
<td>00:45</td>
<td><strong>ESMD Status and Update</strong></td>
<td>Mike Wargo</td>
</tr>
<tr>
<td>09:00 AM</td>
<td></td>
<td>Mars Themed Workshop reports</td>
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<tr>
<td>09:00 AM</td>
<td>00:15</td>
<td>Conference on Mars Sedimentology and Stratigraphy</td>
<td>D. Beaty</td>
</tr>
<tr>
<td>09:15 AM</td>
<td>00:15</td>
<td>Second International Planetary Dunes Workshop</td>
<td>T. Titus</td>
</tr>
<tr>
<td>09:30 AM</td>
<td>00:15</td>
<td>AbSciCon MSR Landing Sites</td>
<td>C. Allen/A. Allwood</td>
</tr>
<tr>
<td>09:45 AM</td>
<td>00:15</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>00:30</td>
<td>MSL Landing site update</td>
<td>M. Golombek/J. Grant</td>
</tr>
<tr>
<td>10:30 AM</td>
<td>00:30</td>
<td>Future landing sites</td>
<td>R. Zurek/J. Grant</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>00:30</td>
<td>Goals Committee</td>
<td>J. Johnson</td>
</tr>
<tr>
<td>11:30 AM</td>
<td>00:30</td>
<td>Discussion/Future Planning for MEPAG Activities</td>
<td>D. Des Marais</td>
</tr>
<tr>
<td>12:00 PM</td>
<td></td>
<td>Adjourn</td>
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</table>
Key conclusions, in priority order, include:

1. Healthy technology development programs are required for making progress towards new, cutting-edge instruments and technologies for planetary exploration, and ensuring that there is a pool of sufficiently well developed hardware for flight missions; however, these programs currently are insufficiently funded and are not effective in supporting MEP and PSD goals and objectives;

2. Research and analysis programs are the primary means of enabling new discoveries that guide the goals and objectives of the MEP and ensuring that flight data are examined to their fullest extent, but critical programs (e.g., Planetary Geology and Geophysics, Exobiology/Evolutionary Biology, Mars Fundamental Research, Mars Data Analysis) are seeing flat or negative growth;

3. The proposal review process takes too long from the time a proposal is submitted until the Principal Investigator is informed of the outcome;

4. There is insufficient funding for the development of sample handling and analysis infrastructure that will be critical to a Mars Sample Return mission, and which requires a substantial lead time to implement.
Prioritized list of suggestions for maintaining and improving the SR&T programs:

1. The PSD should establish an adequately-funded instrument development program (or series of programs) that take instruments from concept to readiness for proposal for flight; funding levels and the pace of solicitations need to be consistent in order to enable and support a long-term strategy for technology advancement.

2. The PSD should ensure that research and analysis programs supporting fundamental research and data analysis efforts that are highly relevant to the MEP (in particular, the Planetary Geology and Geophysics, Exobiology/Evolutionary Biology, Mars Fundamental Research, & Mars Data Analysis programs) receive increased financial support from NASA;

3. The amount of time it takes for proposals to navigate the review process and notifications to be made needs to be reduced to ~6 months; this requires finding new efficiencies, such as instituting a pre-proposal or tiered proposal review approach that does not require investigators to submit, or panels to review, a full proposal at the outset of the process;

4. A program should be instituted (or a current program modified in scope) to support work related to Mars sample return handling, curation, and analysis and foster the development of new approaches and laboratory infrastructure required for this specialized sample set of the future.