Science and Mission Concepts:

Panel Summary by
Doug Stetson
Steve Clifford
Jorge Vago

June 12-14, 2012
Science and Mission Concepts

Topic Areas

• Using Mars Moons
  – Rationale and mission concepts

• Motivating Science
  – Identification and exploration of modern aqueous/icy environments
  – Strategic investments and imperatives

• Compositional Investigations
  – New and improved sensors and instruments

• Geophysical Investigations
  – Subsurface exploration techniques
  – Martian interior

• Organic Molecule and Life Detection
  – Measurement strategies
  – Sensors and instruments
Cross-Cutting Themes

• Enhancing the value of Mars Sample Return: Site and sample selection

• Preparing for human exploration: Precursors, locations, resources

• Ensuring human safety and productivity

• Unlocking the mysteries of Mars: New opportunities for the next decade
Enhancing MSR

• Our understanding of Mars, especially evidence for an active hydrologic cycle, has advanced significantly even since the Decadal Survey
  – Possible/likely present-day water and brines (gully processes/RSLs)
  – Amount and distribution of ice, esp. mid-latitude ice
  – Geology/geomorphology indicative of past water and habitable environments

• There are significant investigations that could/should be done prior to committing to a specific MSR site and mission architecture
  – Imaging radar and and atmospheric composition to localize interesting sites
  – Detailed imaging and compositional mapping from orbit
  – In situ exploration of diverse sites (surface and subsurface)
  – GPR for geological context and detection of ice/habitable environments
  – Detailed chemical/biological analysis to fine-tune sites and sample selection

• Ensuring the scientific success and operational safety of MSR
  – In situ sample assessment: Micro-imaging, mineralogy, wet chemistry
  – Sample caching and monitoring: Smart containers
  – High-resolution mapping of specific sites
Preparing for Human Exploration

• Continued scientific study of Mars is a key to enabling targeted, cost-effective human exploration
  – Extensive characterization of environments (surface/subsurface)
  – High-resolution mapping of mineralogy, resources – site selection
  – Subsurface sounding and imaging radar
  – Bioassays
  – Polar locations are scientifically compelling and potentially resource-rich human destinations, and merit further study

• Understanding the subsurface is an important step (resources/habitability)

• Phobos/Deimos are important destinations that may provide much of the value of human surface exploration at reduced cost and risk
  – Natural space stations and a potential “base camp”
  – Teleoperation of surface payloads and habitat build-up; alleviates some planetary protection issues
  – Accessible resources
  – Compositional studies, and possibly sample return, are critical robotic precursors
Ensuring Human Safety and Productivity

• Robotic science missions will provide critical knowledge for safe and effective human exploration
  – New sensor and instrument concepts hold the promise of providing significant new data at relatively low cost
  – Characterization of atmosphere and landing sites, and correlation of orbital and in situ data
  – High-resolution imaging and detailed topographical maps
  – Understanding toxicity ("some Mars locations would be Superfund sites")

• Evolution of robotic science instruments will lead to devices that allow humans to conduct effective science on Mars, for example:
  – "Chemical laptop" for rapid assessment of biological activity or potential
  – Backpack GPR to determine drilling sites
  – "Tricorder" for sample selection – interior of rocks with minimal preparation

• Exploit terrestrial analogs to establish a culture of field work

• Enhance systems engineering approach – requirements flowdown from human needs to robotic/science missions and measurements
Unlocking the Mysteries of Mars: Fundamental Planetary Science

There is a tremendous amount of important planetary science to do at Mars, independent of MSR and human exploration

• Exploration of unique environments to understand planetary evolution and habitability
• Martian interior through seismic studies
• Climate evolution and atmospheric processes/escape
• Search for past and present life
  – Diverse suite of sensors and techniques to detect and characterize biological activity and potential
  – Broad approach recommended: Surface and atmosphere from orbit, in situ sample analysis (chemical and morphological), subsurface
• Phobos and Deimos – origin and composition

A reformulated Mars program should preserve these important aspects of the overall solar system exploration program
Key Issues and Recommendations

- Readiness for Mars Sample Return
  - New findings since Decadal should be considered during program reformulation
  - Value of MSR would be enhanced by further robotic missions
  - Need to factor in results from MSL and ExoMars, especially in regards to habitability and subsurface
  - New life detection concepts hold great potential to enhance understanding prior to MSR and could lead to optimum mission architecture

- Near-term opportunities
  - 2018/2020 opportunities should be considered for site/atmosphere characterization from orbit, and lander/small rover to specific interesting locations

- Internationalize MSR and restore some (limited) participation on ExoMars
- Re-establish a regular means to conduct small focused Mars missions
- Ensure a well-funded R&A program including studies of martian meteorites and development of sample analysis techniques