# 2015 MEPAG Goals Document


**MEPAG Goals Committee**
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# Goals Presentation Structure

A. Overview (Vicky Hamilton, 15 min)

Goal presentations will include 10-15 min of discussion

B. Goal I (Jen Eigenbrode, 30 min)
C. Goal II (Scot Rafkin, 30 min)
D. Goal III (Aileen Yingst, 30 min)
E. Goal IV (Ryan Whitley, 30 min)

F. Summary and Discussion (Vicky Hamilton, 15 min)

# 2015 MEPAG Goals Document
# Module A: Overview

**Vicky Hamilton**
**MEPAG Goals Committee Chair**

# Schedule

- October 2014: Began process of revising the Goals Document
- 27-30 January: review by MEPAG ExCom

- 4 February: Released draft document to MEPAG community for comment
- **24 - 25 February: MEPAG face-to-face meeting and discussion**
- 19 March: Poster at LPSC (Hamilton et al., abstract #2543)
- **20 March: Comments due**

- ~1 May: Release of Final 2015 Goals Document

# Purpose of the Goals Document

The Goals Document aims to provide sufficient information to:

- Reflect the scientific priorities of the MEPAG community with respect to investigations for future flight missions,
- Guide NASA's Mars Exploration Program (MEP) in its advance planning of Mars flight missions,
- Help NASA develop Announcements of Opportunity and Proposal Information Packages for missions with science objectives, and
- Support the mission and instrument selection process by helping NASA distinguish those science investigations likely to make substantial (vs. incremental) advances.

This document does NOT specify implementation or imply a timeline for conducting the investigations.

# Goals Document Overview

- 2012 Goals Document is organized into a three-tiered hierarchy: Goals, Objectives, and Investigations
- Goals are organized around major areas of scientific knowledge and overarching objectives of the MEP
  - Goal I: Life
  - Goal II: Climate
  - Goal III: Geology and Geophysics
  - Goal IV: Preparation for Human Exploration
- Goals are not prioritized
- Objectives are strategies and milestones
- Investigations inform and lead to the completion of Objectives

# Objectives of this Revision

- Bring the document up to date with respect to science advancements in all Goal areas
  - e.g., science results presented at 8th Mars Conference (2014)
  - e.g., aims of the Evolvable Mars Campaign
- Increase cohesion and usability of the document, reflecting connections in current research
- Clarify language and intent

- Many changes involve reorganization and amplification of previous content

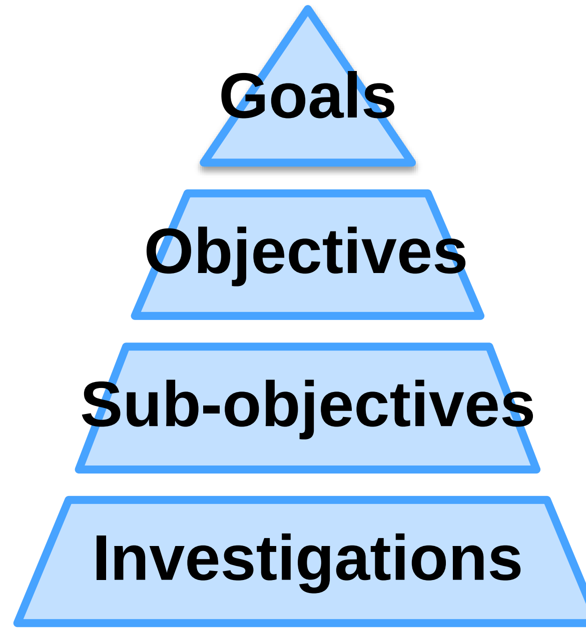
# Structure of the Document

| 2012 structure | 2015 structure |
| --- | --- |
| Preamble (4p): intro, current updates | Preamble (4p): w/prioritization + cross-cutting investigations |
| Goal I (7p) | Goal I (7p) |
| Goal I Appendix (7p) | |
| Goal II (5p) | Goal II (17p) |
| Goal III (5p) | Goal III (9p) |
| Goal IV (19p) | Goal IV (19p) |
| Cross-cutting Strategies (2p) | Exploration Strategies (4p) |
| | Appendices (13p): references, acronyms, Goal I Appendix, material from Goal IV |

*Color scheme used throughout presentation*

# Changes: Addition of Sub-objectives

- Previous versions had too much lumping within an Objective
- The additional level reflects the large amount of data returned and maturity of Mars science
- This lets us better represent the increased diversity of questions and investigations
- This gives us a better way to distinguish priority within an Objective
- Some of this was present in the 2012 document in narrative (e.g., Goal I); it is simpler and more consistent to represent in hierarchy



# Changes: Cross-cutting Aspects, Prioritization Statement, Appendices

- Cross-cutting aspects of the document were not captured well in the hierarchical format – these are now defined and recorded in two ways:

  1) A Cross-cutting Investigation is an Investigation that:
     -- sheds light on other Sub-objectives within the Goal, and/or
     -- sheds light on Sub-objectives in another Goal.

  ***These are recorded in a new, supplementary spreadsheet.***

  2) An Exploration Strategy defines an important over-arching science goal that provides a holistic connection between multiple Goals:
     -- Understand the Long-Term Evolution of Habitability
     -- Understand Mars as a System
     -- Utilize Mars Science to Enhance Comparative Planetology

  ***These are captured in Section V.***

- Explicit description of prioritization (next slide)
- Appendices to hold supplemental information

# Prioritization Statement

"Within each Goal, prioritization is based on subjective consideration of four primary factors (given here in no particular order):

- Status of existing measurements compared to needed measurements
- Relative value of an investigation to achieving a stated objective
- Identification of logical sequential relationships
- Cost/risk/feasibility of implementation

Additional criteria may have been applied within an individual Goal. The specific prioritization scheme used within each Goal is described in the relevant chapter.

Although priorities should influence which Investigations are conducted first, they should not necessarily be undertaken serially, except where it is noted that one Investigation should be completed first. In such cases, the Investigation that should be done first was given a higher priority, even where it is believed that a subsequent Investigation would be more important."

*An example of an "additional criterion": Goal III has taken into consideration the cross-cutting nature of some investigations.*

# Changes Made in Goals

| | Re-organization | Re-wording |
|---|---|---|
| **Goal I, Life** | Moderate: *Removed "Habitability" Obj. (now in Section V)* | Minor |
| **Goal II, Climate** | Moderate: *Goals through Investigations* | Extensive: *Investigations* |
| **Goal III, Geology** | Extensive: *Goals through Investigations* | Extensive: *Goals through Investigations* |
| **Goal IV, Prep. Human Explor.** | Extensive: *Objectives through Sub-objectives* | Minor |

# Send Us Your Feedback

In particular:

- Comments on overall structure and flow – is this useful?
- Comments on prioritization scheme?
- Are there gaps or confusing overlaps?

| Objectives | Sub-objectives | Investigations | Cross-cutting within goal | Cross-cutting between goals | Comments |
|---|---|---|---|---|---|
| **GOAL I: Determine whether life ever arose on Mars.** | | | | | |
| **I: A. Determine if paleoenvironments having high combined potential for prior habitability & preservation of biosignatures record evidence of past life.** | **A1.** Characterize the prior habitability of paleoenvironments, with a focus on resolving former conditions & processes that influence the degree or nature of habitability in each paleoenvironment. | 1. Establish overall geological context. | | GIII: A1.1-6, A2.1-3, B2.3 | |
| | | 2. Constrain prior water availability with respect to duration, extent, & chemical activity. | | GII: B1.1, C2.1-3; GIII: A1.1-2 | |
| | | 3. Constrain prior energy availability with respect to type (e.g., light, specific redox couples), chemical potential (e.g., Gibbs energy yield), & flux. | | GIII: A1.2 | |
| | | 4. Constrain prior physicochemical environment, emphasizing temperature, pH, water activity, & chemical composition. | | GIII: A1.2 | |
| | | 5. Constrain the abundance & characterize potential sources of bioessential elements. | | GIII: A1.2 | |
| | **A2.** Assess the potential of conditions & processes to have influenced preservation or degradation of biosignatures & evidence of habitability, from deposition to time of observation. Identify specific paleoenvironmental deposits & subsequent geological conditions that have high potential to have preserved evidence of individual or multiple types of biosignatures. | 1. Identify conditions & processes that aided preservation and/or degradation of complex organic compounds, focusing particularly on characterizing: redox changes & rates in surface & near-surface environments (including determination of the "burial depth" in regolith or rocks that may shield from ionizing radiation effects); the prevalence, extent, & type of metamorphism; & potential processes that influence isotopic or stereochemical information. | | GIII: A1.1-3, B2.3 | |
| | | 2. Identify the conditions & processes that aided preservation and/or degradation of physical structures on micron to meter scales. | | GIII: A1.1-3 | |
| | | 3. Characterize the conditions & processes that aided preservation and/or degradation of environmental imprints of metabolism, including blurring of chemical or mineralogical gradients & changes to stable isotopic composition and/or stereochemical configuration. | | GIII: A1.2 | |
| | **A3.** Determine if ancient biosignatures are present. | 1. Characterize organic chemistry, including (where possible) stable isotopic composition & stereochemical configuration. Characterize co-occurring concentrations of possible bioessential elements. | | GIII: A1.2 | |
| | | 2. Test for the presence of possibly biogenic physical structures, from microscopic (micron-scale) to macroscopic (meter-scale), combining morphological, mineralogical, & chemical information where possible. | | GIII: A1.2-3 | |
| | | 3. Test for the presence of the prior metabolic activity, including: stable isotopic composition of possible metabolic reactants & products (i.e. metabolites); mineral or other indicators of prior chemical gradients; localized concentrations or depletions of potential metabolites (e.g. biominerals); & evidence of catalysis in chemically sluggish systems. | | GIII: A1.2 | |
| **I: B. Determine if localities** | **B1.** Characterize present habitability in | 1. Identify areas where liquid water (including brines) presently exists, with emphasis | | GII: A1.1, A3.3 | |

- Please provide written justification for any proposed changes
- E-mail Vicky (hamilton@boulder.swri.edu) or mepagmeetingqs@jpl.nasa.gov, or annotate a printed copy (distributed during this meeting)

# 2015 MEPAG Goals Document
# Module B: Goal I, Life

Jen Eigenbrode
Tori Hoehler
MEPAG Goal I Reps

# Goal I: Determine if Mars ever supported life

| Objectives | Sub-objectives |
|---|---|
| **A.** Determine if paleoenvironments having high combined potential for prior habitability and preservation of biosignatures record evidence of past life. | **A1.** Characterize the prior habitability of paleoenvironments, with a focus on resolving former conditions and processes that influence the degree or nature of habitability in each paleoenvironment. |
| | **A2.** Assess the potential of conditions and processes to have influenced preservation or degradation of biosignatures and evidence of habitability, from deposition to time of observation. Identify specific paleoenvironmental deposits and subsequent geological conditions that have high potential to have preserved evidence of individual or multiple types of biosignatures. |
| | **A3.** Determine if ancient biosignatures are present. |
| **B.** Determine if localities having high combined potential for modern habitability and biosignature presence host evidence of extant life. | **B1.** Characterize present habitability in modern environments, with a focus on resolving conditions and processes that enhance or diminish habitability. |
| | **B2.** Assess the potential of specific diagenetic conditions and processes to affect the preservation and/or degradation of signatures of extant life. |
| | **B3.** Determine if biosignatures of an extant ecosystem are present. |

# Goal I, Life: Prioritization

- Priority of objectives is based on the availability of observations that support the identification of clear targets and formulation of investigative strategies in a search for past vs. extant life.

- Under both Objectives:
  - the habitability sub-objectives and preservation potential sub-objectives are considered prerequisite “screening” to support the life detection sub-objectives.
  - The life detection sub-objective yields the overall highest science value within each objective.

- Priority of investigations is based on both logical sequence and on investigations that would provide the greatest value towards discriminating among targets for life detection.

# Goal I, Life: Significant updates from 2012

- Change in the wording of Goal 1 (“supported” vs. “arose”).
- Former Objective C (“Long-term evolution of habitability”) has been removed and is recaptured as a stand-alone science goal in Section V (Exploration Strategies).
- Goal I Appendix has been moved to the end of the full document (with other, newly formed appendices).
- Revisited rationale for prioritization among Objectives. (Discussion topic)

# Discussion: Prioritization of Objectives A & B

## Overarching Premise:

"A clear scientific strategy (i.e., an investigative plan built on target-specific hypotheses and measurements) can only be formulated once an environmental record or environment is understood in sufficient detail."

# Discussion: Prioritization of Objectives A & B

## Prioritization:

“Ancient systems are given higher priority here because observations made by previous missions have identified a range of surface to near surface (top few meters) environments that have preliminary indicators of

- prior habitability
- conditions that could preserve ancient biosignatures
- geologic context

which collectively support clear strategies for searching for evidence of life within those targets.

In contrast, such observations have not yet yielded the level of environmental detail necessary to identify clear targets and associated strategies in a search for extant life. ”

# Discussion: Prioritization of Objectives A & B

## **Recognition of potential changes in priorities over the years:**

"However, the order of priority should remain open to reversal based on new observations that provide evidence of targets that could host extant life, and the delineation of clear strategies for seeking evidence of that life."

# Goal I, Life: Questions to the Community

- Does the document provide sufficient priority information to guide NASA in advanced planning of life investigations?
- Is information adequate to guide future development of NASA AO's (including Proposal Information Packages, SDTs) for missions with life objectives?
- Does the document provide sufficient information to support the selection process, enabling NASA to distinguish those investigations likely to make substantial vs. incremental advance?
- Are the linkages to other Goals appropriate and sufficient?

# 2015 MEPAG Goals Document
# Module C: Goal II, Climate

**Scot Rafkin**
**Paul Withers**
**MEPAG Goal II Reps**

# Goal II: Understand the processes and history of climate on Mars

| Objectives | Sub-objectives |
|---|---|
| **A.** Characterize the state of the present climate of Mars' atmosphere and surrounding plasma environment, and the underlying processes, under the current orbital configuration. | **A1.** Constrain the processes that control the present distributions of dust, water, and carbon dioxide in the lower atmosphere, at daily, seasonal and multi-annual timescales. |
| | **A2.** Constrain the processes that control the dynamics and thermal structure of the upper atmosphere and surrounding plasma environment. |
| | **A3.** Constrain the processes that control the chemical composition of the atmosphere and surrounding plasma environment. |
| | **A4.** Constrain the processes by which volatiles and dust exchange between surface and atmospheric reservoirs. |
| **B.** Characterize the history of Mars' climate in the recent past, and the underlying processes, under different orbital configurations. | **B1.** Determine how the chemical composition and mass of the atmosphere has changed in the recent past. |
| | **B2.** Determine the record of the recent past that is expressed in geological features of the polar regions. |
| | **B3.** Determine the record of the climate of the recent past that is expressed in geological features of low- and mid-latitudes. |

# Goal II: Understand the processes and history of climate on Mars

| Objectives | Sub-objectives |
|---|---|
| **C.** Characterize Mars' ancient climate and underlying processes. | **C1.** Determine present escape rates of key species and constrain the processes that control them. |
| | **C2.** Find physical and chemical records of past climates and factors that affect climate. |
| | **C3.** Determine how the chemical composition and mass of the atmosphere have evolved from the ancient past to the present. |

# Goal II, Climate: Prioritization

- Objectives are given in priority order, consistent with the philosophy that the present is the key to the past.
- Investigations are assigned a prioritization (high, medium, or low) based on subjective weighting:
  - needed measurements with respect to existing measurements.
  - relative impact of an investigation towards achieving an objective
  - identification of investigations with logical prerequisites.
- Investigation prioritization is only with respect to the Investigations within the parent Sub-objective.
  - E.g., a high priority investigation in Objective C could be on par with or more important than a lower priority investigation in Objective B.

# Goal II, Climate: Significant Updates from 2012

- Re-org of A1 with explicit mention of atmospheric scales, which can lead to different measurement demands for same parameter (e.g., pressure).
- Greater disambiguation between mapping (2-D) and profiling (3-D).
- Recognition of MAVEN science expectations in A2.
- Removal of “search for microclimates” (formerly A3).
  - More relevant to life objectives and less so to climate.
- Greater focus on forcing mechanisms and response to those forcings in investigations in A1-A4.
- Additional wording on importance of platform accommodation for *in situ* investigations → Requirements on NASA and Instrument teams.
- More emphasis in C3 on the importance of trapped gas analysis with absolute ages (both *in situ* and MSR).
- Generally higher priority assigned to new measurements or measurements that will provide usefully better resolution/precision/ accuracy or temporal coverage.

# Goal II, Climate: Questions to the Community

- Does the additional narrative reflect the zeitgeist of the climate community?
- Too much or too little specificity? Should a minimum level of expectations be established in cases where we have sufficient information? (e.g., pressure accuracy?)
- What was missed or has fallen between cracks? (e.g., Robotic Exploration Knowledge Gaps?)
- Does the document provide sufficient priority information to guide NASA in advanced planning of climate investigations?
- Is information adequate to guide future development of NASA AO's (including Proposal Information Packages, SDTs) for missions with climate objectives?
- Does the document provide sufficient information to support the selection process, enabling NASA to distinguish those investigations likely to make substantial vs. incremental advance?
- Are the linkages to other Goals appropriate and sufficient?

# 2015 MEPAG Goals Document
# Module D: Goal III, Geology


**Aileen Yingst**
**Steve Ruff**
**MEPAG Goal III Reps**

# Goal III: Understand the origin and evolution of Mars as a geological system

| Objectives | Sub-objectives |
|---|---|
| **A.** Document the geologic record preserved in the crust and interpret the processes that have created it. | **A1:** Identify and characterize past and present geologic environments and processes relevant to the crust. |
| | **A2:** Determine the relative and absolute ages of geologic units and events through Martian history. |
| | **A3:** Constrain the magnitude, nature, timing and origin of past planet-wide climate change. |
| **B.** Determine the structure, composition, and dynamics of the Martian interior and how it has evolved. | **B1:** Identify and evaluate manifestations of crust-mantle interactions. |
| | **B2**: Quantitatively constrain the age and processes of accretion, differentiation and thermal evolution of Mars. |
| **C**. Determine the manifestations of Mars' evolution as recorded by its moons. | **C1**: Constrain the planetesimal density and type within the Mars neighborhood during Mars formation, as implied by the origin of the Mars moons. |
| | **C2:** Determine the material and impactor flux within the Mars neighborhood, throughout Mars' history, as recorded on the Mars moons. |

# Goal III, Geology: Prioritization

Within Objs A and B, all levels were examined through the lens of understanding Earthlike environments. Prioritization was based on:

- how and at what level each would increase accuracy, be unique or game-changing, or be most likely to yield results in the context of geoscience.
- The likely timescale for achievement of a major advancement (sooner is preferred).
- Those supporting other goals were given a higher priority within their sub-objective.

Obj C aims to identify science investigations of Phobos/Deimos that would yield important insights about the formation and evolution of Mars.

- Determining the moons' origins is highest priority as this yields information about Mars' formation environment.

# Goal III, Geology: Significant updates from 2012

- Careful word choice in all levels (goal to investigation), to improve comprehensibility and the logic flow for content and sub-obj/investigation division.

- Within A, addition of investigations focused on sources of data that have proven fruitful (petrology/A1.3 and geologic mapping/A2.3).
- Reorganization, especially within A, of sub-obj and investigations to improve logic flow, and connect back to pressing science questions.

- The B1 Sub-objective and its Investigations are new:

  B1**:** Identify and evaluate manifestations of crust-mantle interactions.

  - B1.1: Determine the types, nature, abundance and interaction of volatiles in the mantle and crust.
  - B1.2: Seek evidence of plate tectonics and metamorphic activity, and measure modern tectonic activity.

# Goal III, Geology: Significant updates from 2012

- Objective C has changed to be oriented toward what we can learn about Mars by studying its moons:

  C. Determine the manifestations of Mars' evolution as recorded by its moons.

  - We expect SBAG goals will complement those of MEPAG.

# Discussion: Inclusion of RSL

For landforms where a process/change is observed but not yet identified (e.g., RSLs), are the present investigations sufficient in scope to include relevant studies?

| Sub-objective | Investigation |
|---|---|
| **A1:** Identify and characterize past and present geologic environments and processes relevant to the crust. | 1: Determine the role of water and other processes in the sediment cycle. |
| | 2: Identify the geochemical and mineralogic constituents of crustal materials and the processes that have altered them. |
| **A3:** Constrain the magnitude, nature, timing and origin of past planet-wide climate change. | 2: Characterize surface-atmosphere interactions as recorded by aeolian, glacial/periglacial, fluvial, chemical and mechanical erosion, cratering and other processes. |
| | 3: Determine the present state, 3-dimensional distribution, and cycling of water on Mars including the cryosphere and possible deep aquifers. |

# Goal III, Geology: Questions to the Community

- Does the document provide sufficient priority information to guide NASA in advanced planning of geology investigations?

- Is information adequate to guide future development of NASA AO's (including Proposal Information Packages, SDTs) for missions with geology objectives?

- Does the document provide sufficient information to support the selection process, enabling NASA to distinguish those investigations likely to make substantial vs. incremental advance?

- Are the linkages to other Goals appropriate and sufficient?

# 2015 MEPAG Goals Document Module E: Goal IV, Preparation For Human Exploration

**Ryan Whitley**
**Darlene Lim**
**MEPAG Goal IV Reps**

# Goal IV: Prepare for Human Exploration

| Objectives | Sub-objectives |
|---|---|
| A. Obtain knowledge of Mars sufficient to design and implement a human mission to Mars orbit with acceptable cost, risk and performance. | **A1.** Determine the aspects of the atmospheric state that affect aerocapture and aerobreaking for human-scale missions at Mars. |
| | **A2.** Determine the orbital particulate environment in high Mars orbit that may impact the delivery of cargo and crew to the Martian system. |
| **B.** Obtain knowledge of Mars sufficient to design and implement a human mission to the Martian surface with acceptable cost, risk and performance. | **B1.** Determine the aspects of the atmospheric state that affect Entry Design and Landing (EDL) design, or atmospheric electricity that may pose a risk to ascent vehicles, ground systems and human explorers. |
| | **B2.** Determine if the Martian environments to be contacted by humans are free of biohazards that might have adverse effects on the crew that might be directly exposed while on Mars, and on other terrestrial species if uncontained Martian material would be returned to Earth. |
| | **B3.** Determine the Martian environmental niches that meet the definition of “Special Region.” |
| | **B4+**. Next slide … |

# Goal IV: Prepare for Human Exploration

| Objectives | Sub-objectives |
|---|---|
| **B.** Obtain knowledge of Mars sufficient to design and implement a human mission to the Martian surface with acceptable cost, risk and performance. | **B4.** Characterize the particulates that could be transported to hardware and infrastructure through the air (including natural aeolian dust and other materials that could be raised from the Martian regolith by ground operations), and that could affect engineering performance and in situ lifetime. |
| | **B5.** Understand the resilience of atmospheric ISRU processing systems to variations in martian near-surface environmental conditions. |
| | **B6.** Assess landing site-related hazards, including those related both to safe landing and safe operations (includng trafficability) within the possible area to be accessed by elements of a human mission. |
| | **B7.** Assess risks to crew health and performance by (1) characterizing in detail the ionizing radiation environment at the Martian surface and (2) determining the possible toxic effects of Martian dust on humans. |
| **C**+. Next slide … | |

# Goal IV: Prepare for Human Exploration

| Objectives | Sub-objectives |
|---|---|
| **C.** Obtain knowledge of Mars sufficient to design and implement a human mission to the surface of either Phobos or Deimos (P/D) with acceptable cost, risk and performance. | **C1.** Understand the geological, compositional and geophysical properties of P/D sufficient to establish specific scientific objectives, operations planning, and any potentially available resources. |
| | **C2.** Understand the conditions at the surface and the low orbital environment for P/D sufficiently to be able to design an operations plan (including close proximity and surface interactions). |
| **D.** Obtain knowledge of Mars sufficient to design and implement sustained human presence at the Martian surface with acceptable cost, risk and performance. | **D1.** Characterize potentially extractable water resources to support In Situ Resource Utilization (ISRU) for long-term human needs. |

# Goal IV, Prep. Human: Significant updates from 2012

- **<u>The structure of Goal IV was reorganized</u>** to be more closely aligned with the P-SAG report structure.
  - There are now four Objectives that correspond to the goals timing in the P-SAG document, including the addition of an objective specifically for Phobos or Deimos
  - The Mars mission SKGs correspond to Sub-objectives.
  - The GFAs under these SKGs correspond to MEPAG Investigations.
- **<u>Four Investigations are proposed for retirement</u>** due to ongoing research:
  - B5.1: Measure the trace gas composition of the martian atmosphere with sufficient resolution and accuracy to determine the potential effects on atmospheric ISRU
  - B6.6: Determine traction/cohesion in Martian regolith throughout planned landing sites; where possible, feed findings into surface asset design requirements.
  - B7.2: Simultaneous with surface measurements, a detector should be placed in orbit to measure energy spectra in solar energetic particle events
  - B7.3: Charged particle spectra, neutral particle spectra, and absorbed dose at the Martian surface from solar maximum to solar minimum

# Goal IV, Prep. Human: Significant updates from 2012

- **Three investigations have changed priority** due to ongoing research, primarily by MSL and MRO as well as a new emphasis to better understand potential landing sites
  - B1.2: Surface pressure to characterize seasonal and diurnal cycles and perturbations
  - B4.4: Regolith and dust to characterize electrical and thermal conductivity, physical properties and chemistry, in a second location (not Gale Crater)
  - B6.5: Imaging of potential landing sites
- **Three new investigations have been added** in the areas of atmospheric ISRU and water resources.
  - B5.2: Test ISRU atmospheric processing system
  - B7.4: Charged and neutral particle spectra, and absorbed dose at the Martian surface from solar maximum to solar minimum *(not yet in spreadsheet)*
  - D1.1: Set of candidate water resource deposits, prioritize

The total number of investigations has increased from **33 to 44** due in large part to the addition of Phobos/Deimos investigations (7). A total of **10** out of the current set of 44 investigations have been changed in some way: retired, priority changed, or added.

# Goal IV, Prep. Human: Summary of Updates (1 of 2)

| Goal IV Sub-objective | Goal IV Investigation | Rovers Progress | MRO Progress | Original Priority | New Priority |
|---|---|---|---|---|---|
| A1 Upper atmosphere | A1.1 Long-term global atmospheric temperature field at all local times | | Major | High | High |
| | A1.2 Global measurements of vertical profile of aerosols at all local times | | Major | High | High |
| | A1.3 Long-term global winds and wind direction | | | High | High |
| A2 Orbital Particulates | A2.1 Distribution of particulates from Phobos/Deimos in Mars orbit | | | Med | Med |
| B1 Lower Atmosphere | B1.1 Dust and aerosol activity to create long-term climatology | | | High | High |
| | B1.2 Surface pressure to characterize seasonal and diurnal cycles and perturbations | Major | | High | Low |
| | B1.3 Near-surface winds simultaneous with global winds | | | High | High |
| | B1.4 EDL temperature and density profiles | | | Med | Med |
| | B1.5; B1.6; B1.7 Atmospheric electricity conditions along with meteorological and dust | | | Low | Low |
| B2 Back Contam. | B2.1 Extant life in the martian near-surface regolith | | | High | High |
| B3 Forward Contam. | B3.1 Distribution of special regions | | Major | High | High |
| B4 Dust Effects on Surface Systems | B4.1; B4.2; B4.3 Electric conductivity of the ground, electric fields in the atmosphere from dust, charge on individual dust grains | | | Low | Low |
| | B4.4 Regolith and dust to characterize electrical and thermal conductivity, physical properties and chemistry, in a second location (not Gale Crater) | Major | | High | Low |
| | B4.5 Abundance and distribution of dust in atmosphere | | Minor | Low | Low |
| B5 Atmos. ISRU | ~~B5.1 Trace gas composition of martian atmosphere~~ | Major | | Low | Retired |
| | B5.2 Test ISRU atmospheric processing system | | | NEW | High |

# Goal IV, Prep. Human: Summary of Updates (2 of 2)

| Goal IV Sub-objective | Goal IV Investigation | Rovers Progress | MRO Progress | Original Priority | New Priority |
|---|---|---|---|---|---|
| B6 Landing Site and Operations Hazards | B6.1; B6.2; B6.3; B6.4 Regolith physical properties and structure, bearing strength, gas permeability, particle shape and size distribution, chemistry and mineralogy | Minor | Minor | Med | Med |
| | B6.5 Imaging of potential landing sites | Minor | | Med | High |
| | ~~B6.6 Traction/cohesion of martian regolith~~ | Minor | | Low | Retired |
| | B6.7 vertical variation of regolith density | | | Low | Low |
| B7 Crew Health & Performance | B7.1 Measurement of neutrons with directionality | | | Med | Med |
| | ~~B7.2 Orbital measurements simultaneous with surface measurements~~ | Major | | Low | Retired |
| | ~~B7.3 Identify of charged particles at the surface~~ | Major | | Med | Med |
| | B7.4 Charged particle spectra, neutral particle spectra, and absorbed dose at the Martian surface from solar maximum to solar minimum | | | NEW | Med |
| | B7.5; B7.6; B7.7 Assay for chemicals with known toxicity, fully characterize soluble ion distributions, shapes of martian dust grains and size distribution | Some | | Low | Low |
| C1 P/D Surface Science | C1.1; C1.2 Elemental and mineralogical composition, and identify units for science/exploration and ISRU | | | High | High |
| | C1.3 Gravitational field to understand structure and mass concentrations | | | Med | Med |
| C2 P/D Surface Operations | C2.1 Electrostatic charge and plasma fields near P/D surface | | | Low | Low |
| | C2.2 Gravitational field to carry out proximity orbital operations | | | Med | Med |
| | C2.3 Physical properties and structure of regolith | | | High | High |
| | C2.4 Surface and subsurface temperature regime | | | Low | Low |
| D1 Water Resources | D1.1 Identify a set of candidate water resource deposit for prioritization | | Minor | NEW | High |
| | D1.2; D1.3 Energy required to excavate/drill and extract water from hydrated minerals | | | Med | Med |
| | D1.4; D1.5 Energy required to excavate/drill and extract water from shallow water ice | | | High | High |
| | D1.6 High spatial resolution maps of at least one high-priority water resource deposit | | | Med | Med |

# Goal IV, Prep. Human: Questions to the Community

- Does the document provide sufficient priority information to guide NASA in advanced planning of investigations relevant to future human exploration?

- Is information adequate to guide future development of NASA AO's (including Proposal Information Packages, SDTs) for missions with objectives regarding the preparation for human exploration?

- Does the document provide sufficient information to support the selection process, enabling NASA to distinguish those investigations likely to make substantial vs. incremental advance?

- Are the linkages to other Goals appropriate and sufficient?

# 2015 MEPAG Goals Document Module F: Summary and Discussion

**Vicky Hamilton**
**MEPAG Goals Committee Chair**

# Final Thoughts

- Exploration Strategies/Section V
  - How can we make this section most useful?
  - What additional strategies are we (or should we be) pursuing?

- Specific feedback at any level of the hierarchy is requested, including phrasing, missing elements, and prioritization
  - Comments on prioritization should include brief justification
  - Talk to Goals Committee reps in person
  - Talk to your buddies tonight, revisit tomorrow
  - Send e-mail to mepagmeetingqs@jpl.nasa.gov or to Vicky (hamilton@boulder.swri.edu)