Preparation for the Planetary Decadal Survey: The 2018 MEPAG Goals Document and Plans for 2019 Updates

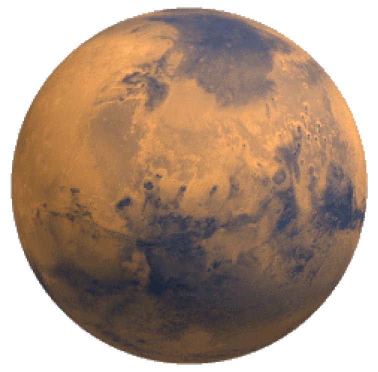
Serina Diniega[1], Donald Banfield[2], Jeffrey Johnson[3], Richard Zurek[1], and David Beaty[1]

[1]Jet Propulsion Laboratory
[2]Cornell University
[3]Applied Physics Laboratory

November 24, 2022

Abstract

Since 2001, the Mars Exploration Program Analysis Group (MEPAG) has maintained a document outlining community consensus priorities for scientific goals, objectives, and investigations for the robotic and human exploration of Mars [1]. This "Goals Document" is a living document that is revised regularly (˜every few years) in light of new Mars science results. It is organized into a hierarchy of goals, objectives, and investigations. The four Goals are not prioritized and are organized around major areas of scientific knowledge: "Life", "Climate", "Geology", and "Preparation for Human Exploration". Don Banfield is the current MEPAG Goals Committee Chair, and he oversees 2-3 representatives per Goal [2]. The most recent round of revisions (2018) was prompted by discussion at the 6th International Mars Polar Science and Exploration Conference (held in 2016 in Reykjavik, Iceland [3]), which pointed out that current high-priority Polar Science and Present-Day Activity questions were not well represented in content or priorities within the 2015 Goals Document. Upon request from the MEPAG Executive and Goals Committees [2], specific areas of disconnect were highlighted by representatives of the Mars Polar Science community; these were evaluated by the Goals Committee who proposed changes at sub-objective and investigation levels within the Climate and Geology Goals. These proposed changes were open for comment by the larger Mars community for 6 weeks, and then finalized. The official MEPAG 2018 Goals Document will be presented at the meeting. Additionally, the presentation will describe plans for the next round of revisions, which are expected to primarily come out of the presentations and discussion at the 9th International Conference on Mars (to be held at Caltech, Pasadena, CA in July 2019 [4]), and which are expected to include reference to returned sample science. The 2019 MEPAG Goals Document will form an important input to the next Planetary Science Decadal Survey [5]. [1] https://mepag.jpl.nasa.gov/reports.cfm?expand=science [2] https://mepag.jpl.nasa.gov/about.cfm [3] https://www.hou.usra.edu/meetings/marspolar2016/ [4] https://www.hou.usra.edu/meetings/ninthmars2019/ [5] NASEM, 2017. CAPS: Getting Ready for the Next Planetary Science Decadal Survey. https://doi.org/10.17226/24843.



Preparation for the Planetary Decadal Survey: The 2018 MEPAG Goals Document and plans for 2019 updates

Serina Diniega[1], Don Banfield[2], Jeffrey R. Johnson[3], Rich Zurek[1], David W. Beaty[1], MEPAG Goals Committee.
[1]Mars Program Office, Jet Propulsion Laboratory, California Institute of Technology (serina.diniega@jpl.nasa.gov); [2]Cornell University; [3]Johns Hopkins University, Applied Physics Laboratory.

The MEPAG Goals Document

Mars Exploration Program Analysis Group (MEPAG)

Since 2001, the *Mars Exploration Program Analysis Group (MEPAG)* has maintained a document outlining community consensus priorities for scientific goals, objectives, and investigations for the robotic and human exploration of Mars [1]. This "Goals Document" is a living document that is revised regularly (~every few years) in light of new Mars science results, and it serves as a reference for science priority for Mars-related flight and research projects.

It is organized into a hierarchy of goals, objectives, and investigations (Figure 1, Table 1). The four Goals are not prioritized and are organized around major areas of scientific knowledge: "Life", "Climate", "Geology", and "Preparation for Human Exploration". Don Banfield (Cornell University) is the current *MEPAG Goals Committee* Chair, and he oversees 2-3 representatives per Goal (Table 1) [2].

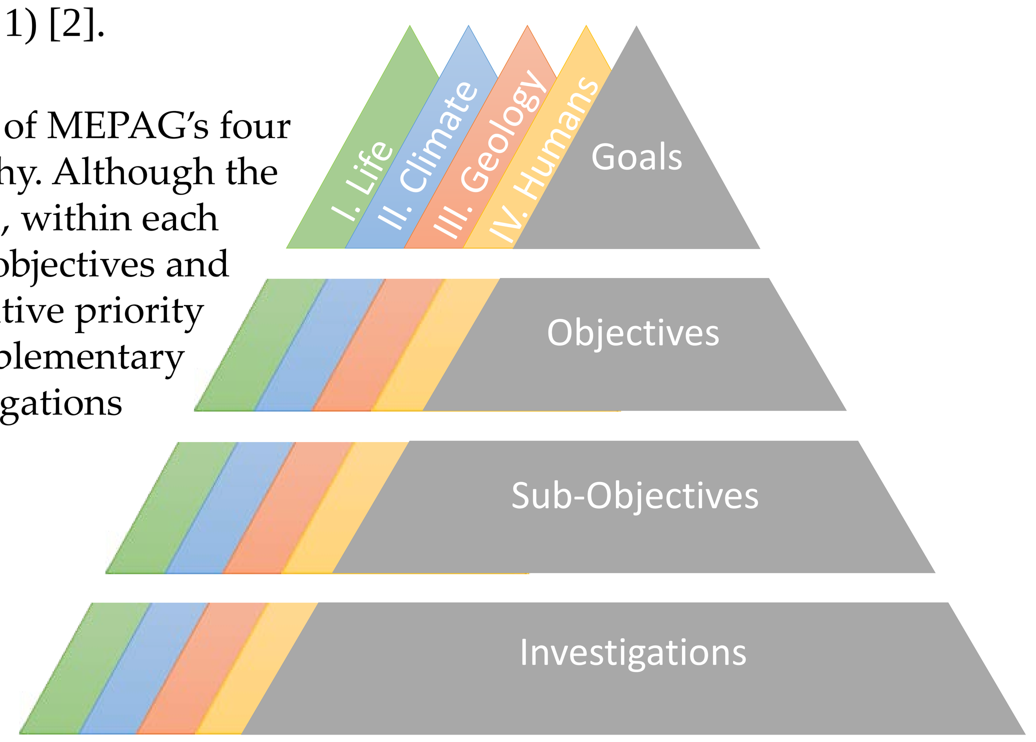


Figure 1. An illustration of MEPAG's four Goals and tiered hierarchy. Although the Goals are not prioritized, within each goal the objectives, sub-objectives and investigations are in relative priority order. Additionally, supplementary materials discuss investigations and high-level science questions that cross-cut the Goals.

The current MEPAG Goals Document, along with supplementary materials and past versions, can be downloaded from [1]. *For questions about the Goals, please contact one of the MEPAG Goals Committee members or Mars Program Office staff.*

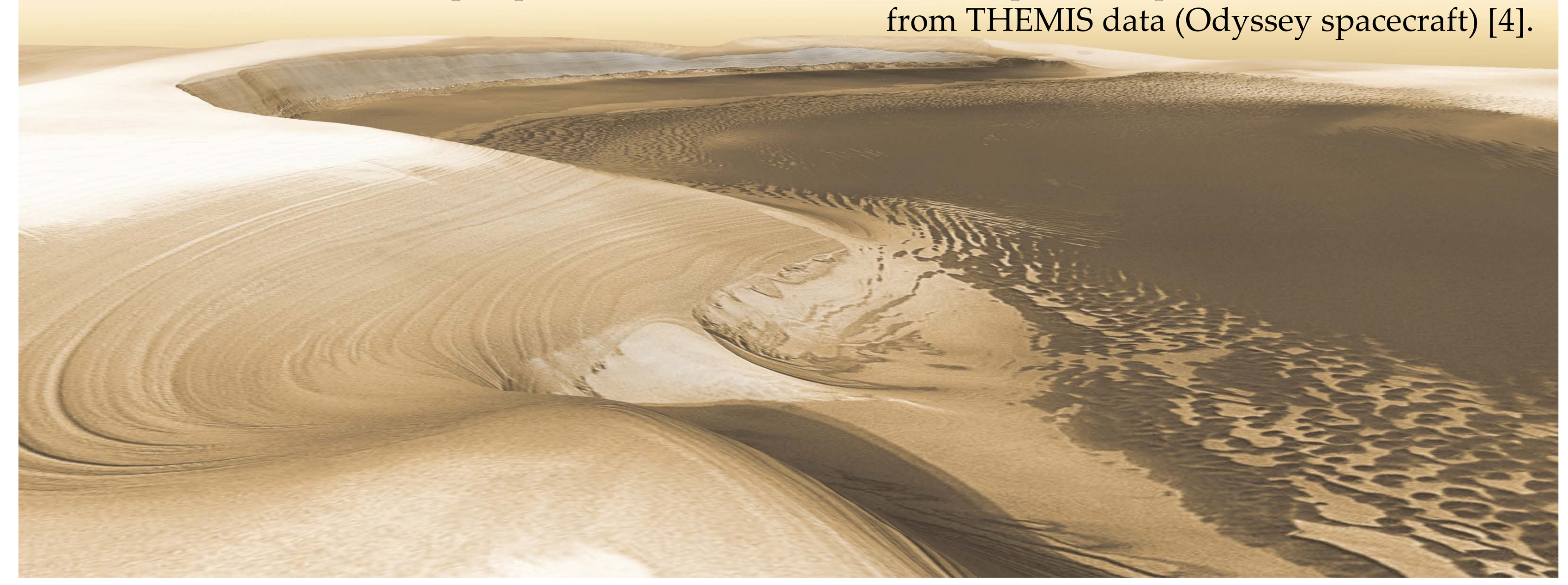
The 2018 Revisions

The most recent round of revisions (2018) was prompted by discussion at the 6th International Mars Polar Science and Exploration Conference (held in 2016 in Reykjavik, Iceland [3]), which pointed out that current high-priority Polar Science and Present-Day Activity questions were not well represented in content or priorities within the 2015 Goals Document. Upon request from the MEPAG Executive and Goals Committees [2], specific areas of disconnect were highlighted by representatives of the Mars Polar Science community; these were evaluated by the Goals Committee who proposed changes at sub-objective and investigation levels within the Climate and Geology Goals. These proposed changes were open for comment by the larger Mars community for 6 weeks, and then finalized. The official MEPAG 2018 Goals Document was posted on October 1, 2018 [1].

Goals I and IV were unchanged. The resultant changes to Goals II and III:

- Included more explicit mention of ice (including frozen CO_2 and icy landforms) and dust.
- Shifted/refineed some polar-focused investigations to better reflect present state of understanding and open questions.
- More explicitly and comprehensively included focus on present-day changes and related science questions (i.e., new Sub-objective A3 in Goal III).

Figure 2. A simulated 3-D perspective view of the martian north polar scarp and dune fields, created from THEMIS data (Odyssey spacecraft) [4].



The Plan for 2019 Revisions

The next round of revisions are expected to primarily come out of the presentations and discussion at the 9th International Conference on Mars (currently planned for July 2019 in Pasadena, CA [5]), and which are expected to include reference to returned sample science. Similar to the 2015 revision -- in the 2019 revision, all four Goals are going to be re-evaluated, as well as the overall structure and content of the Goals Document. Relative prioritization within each Goal will also be considered. Special attention will be paid to driving cross-cutting Mars science questions and how addressing those questions advances Planetary Science.

Revisions are planned to be completed in Fall-Winter 2019, with community review before finalizing in Spring 2020 – so that the update will be completed before the next Planetary Science Decadal Survey committee is underway (this Decadal Survey will span 2023-2032). The 2019 MEPAG Goals Document, along with updated Goals Documents from other portions of the Planetary Science Community, will form important community-generated inputs to the Planetary Science Decadal Survey process [6].

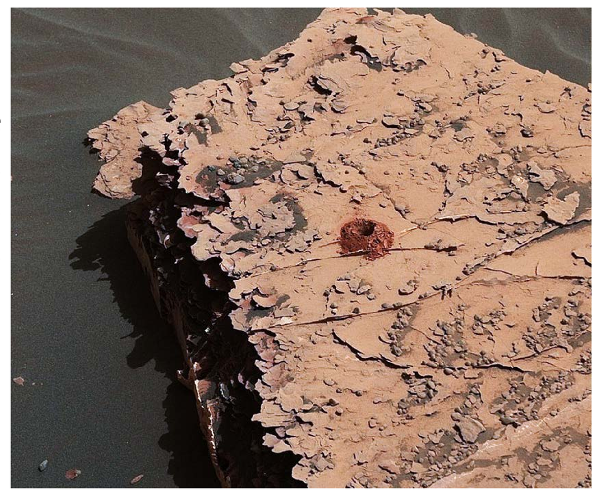


Figure 3. A 1.6cm wide/5.1cm deep drill hole by the Curiosity rover, into a target called "Duluth" [7]. The Mars 2020 rover will also drill into rocks, caching cores for later return to Earth [8].

References:
[1] https://mepag.jpl.nasa.gov/reports.cfm?expand=science.
[2] https://mepag.jpl.nasa.gov/about.cfm
[3] https://www.hou.usra.edu/meetings/marspolar2016/
[4] https://www.nasa.gov/feature/jpl/nasa-radar-finds-ice-age-record-in-mars-polar-cap.
[5] https://www.hou.usra.edu/meetings/ninthmars2019/
[6] NASEM, 2017. Report Series: CAPS: Getting Ready for the Next Planetary Science Decadal Survey. https://doi.org/10.17226/24843.
[7] https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA22325.
[8] https://mars.nasa.gov/mars2020/mission/rover/.

Table 1. Goal Representatives during the 2018 Revision and planned 2019 work, and listing of 2018 Goal/Objectives/Sub-objectives.

Goal	Representative	Objectives and Sub-objectives			
I: Determine if Mars ever supported life.	• Jennifer Stern (NASA Goddard Space Flight Center) • Sarah Stewart Johnson (Georgetown University)	**A. Determine if environments having high potential for prior habitability & preservation of biosignatures contain evidence of past life.** A1. Identify environments that were habitable in the past, & characterize conditions & processes that may have influenced the degree or nature of habitability therein. A2. Assess the potential of conditions & processes to have influenced preservation or degradation of biosignatures & evidence of habitability, from the time of formation to the time of observation. Identify specific deposits & subsequent geological conditions that have high potential to have preserved individual or multiple types of biosignatures. A3. Determine if biosignatures of a prior ecosystem are present.	**B. Determine if environments with high potential for current habitability & expression of biosignatures contain evidence of extant life.** B1. Identify environments that are presently habitable, & characterize conditions & processes that may influence the nature or degree of habitability therein. B2. Assess the potential of specific conditions & processes to affect the expression and/or degradation of signatures of extant life. B3. Determine if biosignatures of an extant ecosystem are present.		
II: Understand the processes & history of climate on Mars.	• Robin Wordsworth (Harvard University) • David Brain (University of Colorado, Boulder) • Paul Withers (Boston University) *– 2018*	**A. Characterize the state of the present climate of Mars' atmosphere & surrounding plasma environment, & the underlying processes, under the current orbital configuration.** A1. Constrain the processes that control the present distributions of dust, water, & carbon dioxide in the lower atmosphere, at daily, seasonal & multi-annual timescales. A2. Constrain the processes that control the dynamics & thermal structure of the upper atmosphere & surrounding plasma environment. A3. Constrain the processes that control the chemical composition of the atmosphere & surrounding plasma environment. A4. Constrain the processes by which volatiles & dust exchange between surface & atmospheric reservoirs.	**B. Characterize the history of Mars' climate in the recent past, & the underlying processes, under different orbital configurations.** B1. Determine how the chemical composition & mass of the atmosphere has changed in the recent past. B2. Determine the climate record of the recent past that is expressed in geological, glaciological, & mineralogical features of the polar regions. B3. Determine the record of the climate of the recent past that is expressed in geological & mineralogical features of low- & mid-latitudes.	**C. Characterize Mars' ancient climate & underlying processes.** C1. Determine how the chemical composition & mass of the atmosphere have evolved from the ancient past to the present. C2. Find physical & chemical records of past climates & factors that affect climate. C3. Determine present escape rates of key species & constrain the processes that control them.	
III: Understand the origin & evolution of Mars as a geological system.	• Aileen Yingst (Planetary Science Institute) • Steve Ruff (Arizona State University) *– 2018* • Briony Horgan (Purdue University) *– 2019*	**A. Document the geologic record preserved in the crust & investigate the processes that have created that record.** A1. Identify & characterize past & present geologic environments & processes relevant to the crust. A2. Determine the absolute & relative ages of geologic units & events through Martian history. A3. Identify & characterize processes that are actively shaping the present-day surface of Mars. A4. Constrain the magnitude, nature, timing & origin of past planet-wide climate change.	**B. Determine the structure, composition, & dynamics of the Martian interior & how it has evolved.** B1. Identify & evaluate manifestations of crust-mantle interactions. B2. Quantitatively constrain the age & processes of accretion, differentiation & thermal evolution of Mars.	**C. Determine the manifestations of Mars' evolution as recorded by its moons.** C1. Constrain the planetesimal density & type within the Mars neighborhood during Mars formation, as implied by the origin of the Mars moons. C2. Determine the material & impactor flux within the Mars neighborhood, throughout Mars' history, as recorded on the Mars moons.	
IV: Prepare for human exploration.	• Jacob Bleacher (NASA Goddard Space Flight Center) • Ryan Whitley (NASA Johnson Space Center)	**A. Human mission to Mars orbit with acceptable cost, risk, & performance.** A1. Aerocapture & aerobraking investigations A2. Orbital particulate environment *These Goal IV sub-objectives were left in short-hand due to space limitations.*	**B. Human mission to the Martian surface with acceptable cost, risk, & performance.** B1. Atmospheric dynamics - EDL B2. Biohazard assessment B3. Identify special regions B4. ISRU tech demo B5. Identify landing-site hazards B6. Surface radiation & dust hazards B7. Impact of dust on hardware	**C. Human mission to the surface of Phobos or Deimos with acceptable cost, risk, & performance.** C1. Phobos & Deimos science C2. Moon science	**D. Sustained human presence with acceptable cost, risk, & performance.** D1. Extractable water resources

Scan this QR code to view the MEPAG webpage with links to the current MEPAG Goals Document.