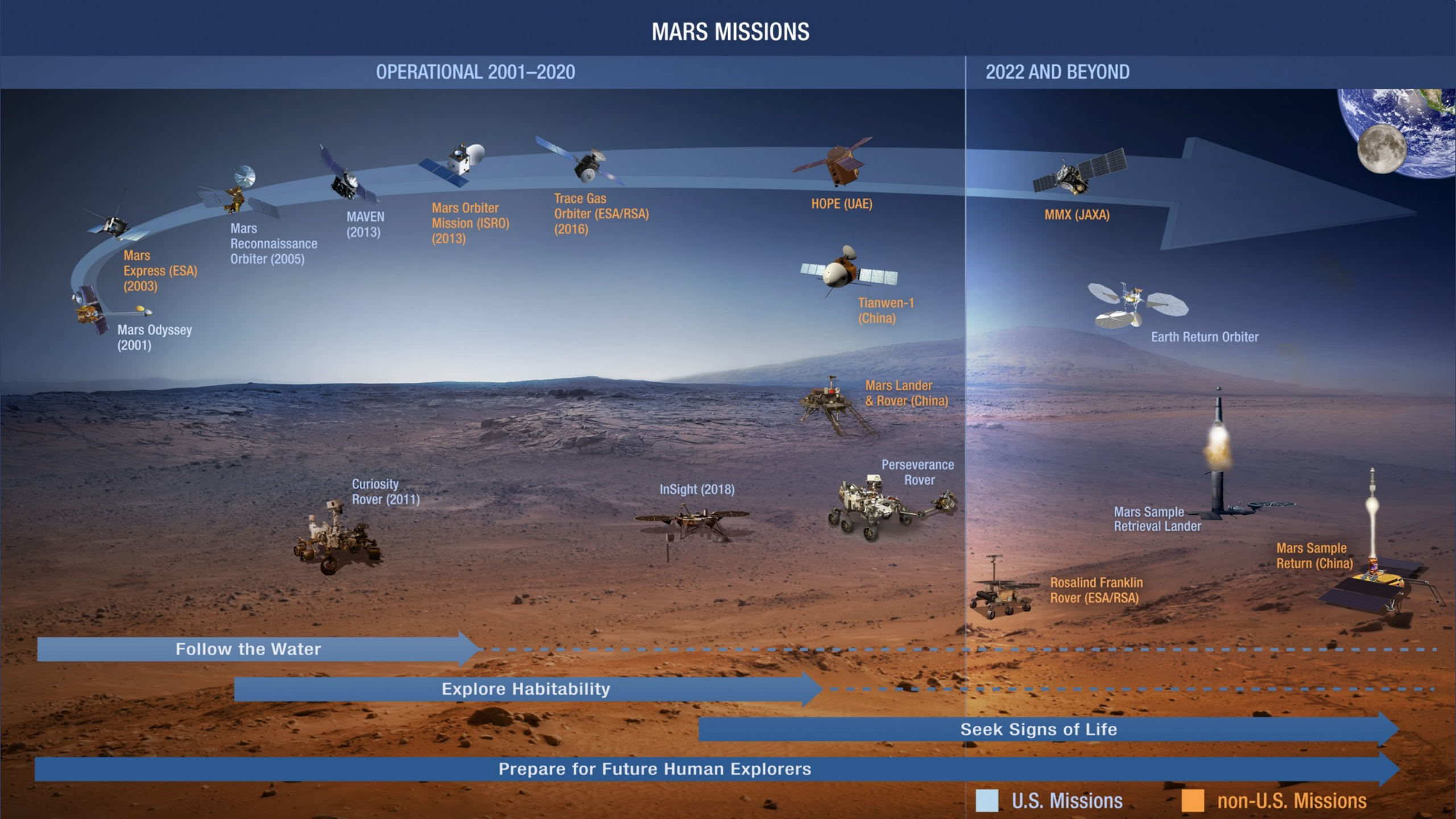
Eric Ianson
NASA Planetary Science Division Deputy Director
Mars Exploration Program Director

Decadal Survey – Mars Panel
November 2, 2020


MARS MISSIONS
OPERATIONAL 2001–2020
2022 AND BEYOND
Mars Express (ESA) (2003)
Mars Reconnaissance Orbiter (2005)
MAVEN (2013)
Mars Orbiter Mission (ISRO) (2013)
Trace Gas Orbiter (ESA/RSA) (2016)
HOPE (UAE)
MMX (JAXA)
Mars Odyssey (2001)
Tianwen-1 (China)
Earth Return Orbiter
Mars Lander & Rover (China)
Curiosity Rover (2011)
InSight (2018)
Perseverance Rover
Mars Sample Retrieval Lander
Mars Sample Return (China)
Rosalind Franklin Rover (ESA/RSA)
Follow the Water
Explore Habitability
Seek Signs of Life
Prepare for Future Human Explorers
U.S. Missions
non-U.S. Missions

Mars Exploration in SMD

- Deputy Director of Planetary Science (Eric Ianson) serves as Director of the Mars Exploration Program (MEP) in addition to existing role, supported by Deputy Director / Lead Program Executive (George Tahu - Acting) for MEP

- Lead Scientist (Michael Meyer) for MEP and Mars Sample Return (MSR)
  - Provides the science bridge between the programs
  - Ensures coordination of Mars 2020 caching with MSR
  - Preparing science recommendations for facility and management of returned samples within MEP

- Mars Sample Return has been established as a new program, organizationally independent of MEP, for implementing the retrieval and return of samples to Earth
  - Program Director (Jeff Gramling) reports directly to SMD Associate Administrator (Thomas Zurbuchen)
  - Close coordination remains with PSD and MEP
  - Joint endeavor with European Space Agency (ESA)

SMD Mars Exploration Organization

Science Mission Directorate

AA: Thomas Zurbuchen

Planetary Science Division

Director: Lori Glaze
Deputy Director: Eric Ianson

Mars Sample Return Program
Jeff Gramling, Director
Michael Meyer, Lead Scientist

Joe Gasbarre, Deputy PM - Tech
Rich Ryan, Business Manager
Ramon DePaula, PE
Erik Edwardson, PA

MSR Program Office (JPL)

Bobby Braun, PM

Mars Exploration Program

Program Director: Eric Ianson
Lead Mars Scientist: Michael Meyer
Deputy Program Director/Lead Program Executive (Acting): George Tahu

Mars Exploration Program Office (JPL)

Fuk Li, PM

Mars2020 (Perseverance)
George Tahu, PE
Mitch Schulte, PS
Adrian Brown, DPS

MRO/Odyssey
Ramon DePaula, PE
Mike Kelley, PS

MOMA
Dave Lavery, PE
Mitch Schulte, PS

Mars Express
Dave Lavery, PE

MAVEN
Ramon DePaula, PE
K.C. Hansen, PS

ExoMars
Ramon DePaula, PE
Michael Meyer, PS

MSL (Curiosity)
Dave Lavery, PE
Michael Meyer, PS

Ice Mapper International Collaboration
Rick Davis, PE

Mars R&A
Mitch Schulte, PS

Science/Exploration Integration
Rick Davis, Ass't Dir for Science and Exploration

Formulation Missions

Primary Operations Missions

Implementation Missions

Extended Operations Missions

Progress on Current Decadal Science Goals

Mars Sample Return

- ✓ Mars 2020 / Perseverance mission on its way to begin the first leg of a NASA/ESA partnership to implement a Mars sample return campaign
- ✓ Significant investments in key technologies (MAV, parachutes, rendezvous & capture, containment, planetary protection, etc.) enabled this initiative

Crosscutting Science Themes – Robust portfolio of results from operating & past missions and potential discoveries from ExoMars / Perseverance missions

Research Support – Mars Data Analysis Program, along with Solar System Workings and Habitable Worlds, provide research & analysis opportunities

Infrastructure & Technology – Relay payloads on orbiters; MarsCubeOne technology demonstration; relay network under study as part of Ice Mapper; technology development and infusion for M2020, MSR, and Mars Helicopter

Competed Mars Science opportunities provided through Discovery Program -- InSight addressing geophysical science at Mars

International Cooperation – In addition to the MSR campaign, NASA leverages partner contributions to NASA missions (Mars 2020, InSight) and opportunities on partner-led missions (ExoMars, MMX, Ice Mapper), as well as supporting a growing community of international explorers at Mars (MOM, Hope)

Connections to Human Exploration – Mars 2020 contributed payloads; resource reconnaissance; ongoing coordination and joint studies in Moon to Mars activities

Mars Exploration Status Updates (1 of 2)

- Operating missions did well in the 2019 Planetary Missions Senior Review. Odyssey, MRO, Curiosity, and MAVEN recommended for extended missions.
- Ongoing NASA missions are healthy and productive.
  - Odyssey: Continues to provide data on Martian geology, climate, and mineralogy, as well as thermal properties of Phobos. Also providing most of the relay support for InSight.
  - MRO: Providing radar 3D subsurface mapping of ice deposits and imagery and spectroscopy of surface features and weather; also supporting landing site assessments. Developing “Bent Pipe Communications” in support of Mars 2020 landing. Will continue to serve as major relay asset for surface missions (Curiosity, InSight, Perseverance, ExoMars).
  - MSL: Curiosity has traversed 23 km, climbed nearly 400 m, and just acquired a sample from its 29th drill hole. Continuing investigation of a clay-bearing unit on the side of Mount Sharp and will reach the transition to sulfate-bearing layers within several months.
  - MAVEN: Beginning 7th year in orbit; extended measurements have provided complete picture of global electric current system around Mars. Exciting science ahead during solar cycle 25; also providing relay for surface assets.
  - ExoMars/TGO (ESA): Providing ~50% of relay data from Curiosity & InSight
  - InSight (Discovery Program): Detected more than 150 marsquakes; measured the thickness of the crust for the first time; first observations of surface magnetic field; ongoing weather observations. HP^3 mole now beneath the surface; burrowing efforts to resume.

Mars Exploration Status Updates (2 of 2)

- Mars Architecture Strategy Working Group (MASWG) formed in response to Decadal Survey Mid-Term Review
  - Defined four “mission arc” scenarios as examples of cost-effective Mars exploration that could be pursued beyond (in addition to or after) the sample return campaign
- ExoMars 2020 (rover named Rosalind Franklin) ESA launch delayed to 2022
  - NASA MOMA-MS contribution delivered and integrated into ESA rover
- Martian Moons eXploration (MMX) partnership with JAXA for launch in 2024
  - NASA MEGANE instrument approved to enter Phase C in May 2020
  - NASA Pneumatic Sampler (P-Sampler) tech demonstration successfully completed Preliminary Design Review in May 2020
- Mars Ice Mapper
  - International partnership Statement of Intent expected to be finalized soon
  - Pre-Acquisition Strategy Meeting planned before the end of 2020
- Integration of Mars activities (HEOMD, SMD) across the Agency
  - NASA has established a Federated Board to better integrate Lunar and Mars activities
  - Significant studies are underway to better understand Moon-Mars exploration synergies and to guide future work and collaboration

Mars Sample Return

- **Mars 2020 Phase E operations remain under the Mars Exploration Program, reporting to the Mars Program Director**
- A separate, dedicated MSR program office will be established at JPL
  - Will report to MSR Program Director at HQ
  - Will be the system-level ‘project’ organization for MSR
- MSR continues to work towards two launches in 2026 (NASA lander + ESA orbiter) and is on track to enter Phase A this Fall
- MSR Program will end with the initial containment of the samples (and Earth Return Vehicle) at the Earth landing site
- **Returned Sample Receiving Facility, along with curation and sample science investigations, remains under the Mars Exploration Program**

MARS *Ice Mapper*

- Numerous studies have identified near-surface ice (top 10 m) as a critical element of the human exploration of Mars.
  - Accessible Ground Ice as Rich in Science Potential
    - Astrobiology, Geologic & Climate History, & Modern Processes for both remote sensing and eventual human investigations "in the (Martian) field"
  - Accessible Ground Ice as an In Situ Resource for Human Exploration
  - Accessible Ground Ice as a Potential Driver for Human Landing Site Selection
- Planning for Human Exploration in the mid-2030s requires knowledge about the location, character, and extent of accessible ice beforehand, in the 2020s

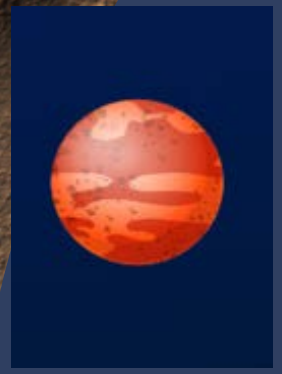
*Reconnaissance = "What We Need to Know Before We Go"
Relies on planetary science and contributes to it, with objectives targeted to high-priority science applications for human exploration.

- An emerging multilateral partnership is beginning to plan for the mission (launch as early as 2026), as well as studying next-gen communications needs that could provide robustness for Mars Sample Return and a critical infrastructure for all future Mars missions.
  - Leveraged prior NASA/CSA collaboration studies to jump start planning
  - Both NASA & CSA have received funding for planning and preparation
  - ASI, CSA, JAXA, and NASA are in the process of signing a Statement of Intent

MARS Ice Mapper

SCIENCE & RECONNAISSANCE QUESTIONS ADDRESSED

SCIENCE



MARTIAN HYDROSPHERE/ENVIRONMENT

FOLLOW THE WATER: What does subsurface water-ice reveal about the possibility of life and the identification of potential “special regions”?

What geologic features lie under all of the dust and dirt on Mars?

What do they reveal about the volcanic, fluvial, impact, & other processes in Mars’ history?

What can we learn about Mars’s climate from seasonal water ice/atmospheric exchanges?

RECON

WATER ICE RESOURCES

How much near-surface water-ice exists?

How thick/deep are the deposits?

Can robot-assisted human explorers core and sample the ice for high-value surface science investigations?

TERRAIN

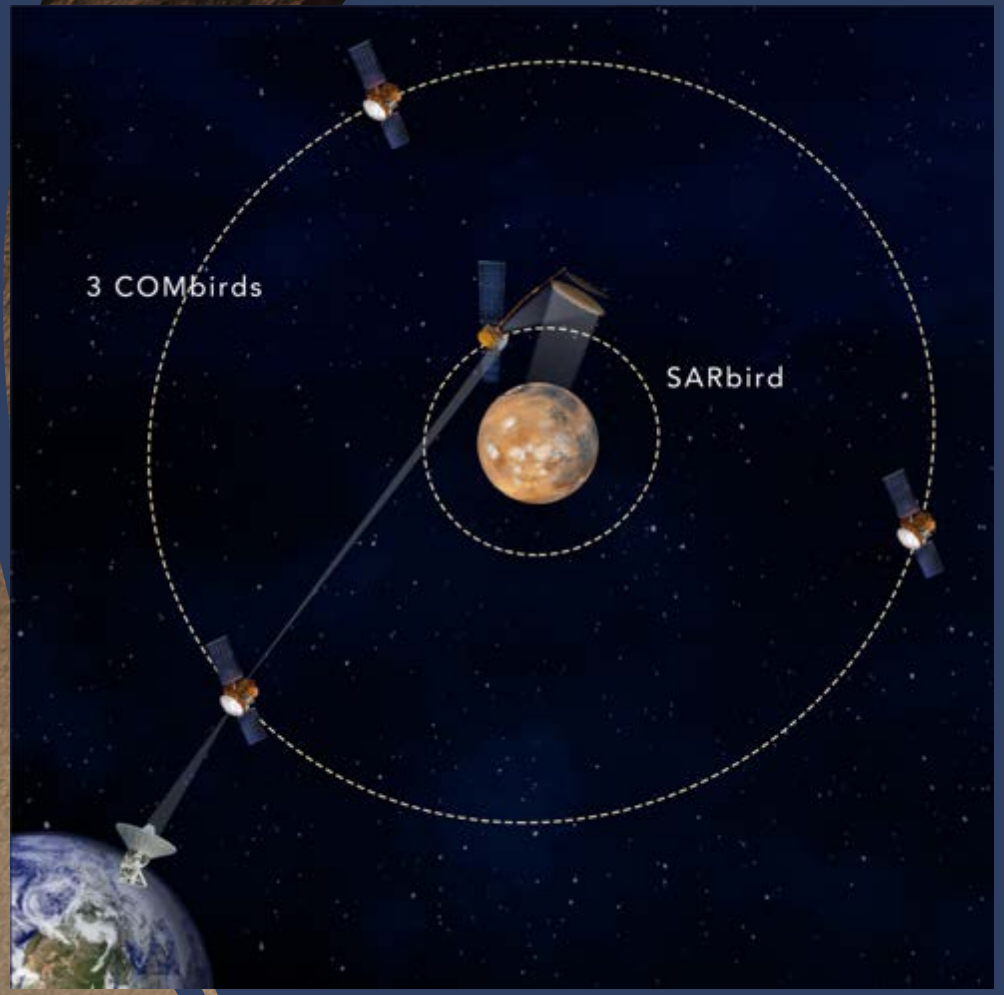
How much regolith is on top of water-ice resources?

What is the distribution of materials (e.g. bedrock vs. regolith)?

How porous is the soil at prospective landing sites?

How rough is the terrain?

MARS *Ice Mapper* CONCEPT OF OPERATIONS



Schematic Diagram of Ice Mapper Concept

Synthetic Aperture Radar (SAR) reconnaissance spacecraft in Low Mars Polar Orbit (benefits highly from upgraded data pipeline below)

- Deliver on reconnaissance priorities while maximizing science return
- Survey the depth, breadth, and purity of water-ice in the upper 5-10m of Martian subsurface
    - ISRU for propellant, back-up life support, civil engineering, mining, manufacturing, and eventually, agriculture
    - Identify water-ice-rich sites for high-value human-led, robot-assisted science investigations at candidate human landing sites
    - Seek potential “special regions” for possible habitable refuges
- Reveal details of Mars’ geologic and climate history

Constellation of Linked Comm Relay Spacecraft in a High-altitude Equatorial Orbit

- Enable continuous connectivity from Mars surface and low Mars orbit to/from Earth
- Generate data rates and data return, orders of magnitude greater than present capability
- Provides robustness for Mars Sample Return as well as critical infrastructure for future Mars missions, including large SAR data sets.

Advanced Studies / Technology Development

Mars Program Office at JPL provides advance planning, assessment, and analysis of mission alternatives and concepts for future Mars missions. Recent activity includes:

- Mars Returned Sample Handling studies (ground recovery, receiving facility, etc.)
- Access to previously unexplored regions
  - Missions to date have been limited to surface and near-surface access in regions compatible with current lander/rover capabilities
  - Next phases of Mars exploration can be enabled by capabilities for accessing new regions (e.g., extreme terrain, subsurface sounding/drilling, aerial via rotorcraft)
- Low-cost Access to Mars
  - Small spacecraft missions have potential to achieve significant science objectives
  - Leverage emerging commercial cubesat/smallsat spacecraft subsystems
  - Utilize low-cost methods to reach Mars (rideshares, new low-cost launch, etc.)
  - Can be further enabled by improved relay capabilities for small landers/orbiters
- Connections with human exploration (water mapping, telecommunications relay)

Mars Technology Development effort offers opportunities for new initiatives to advance technologies towards successful infusion on future missions. Recent activities include:

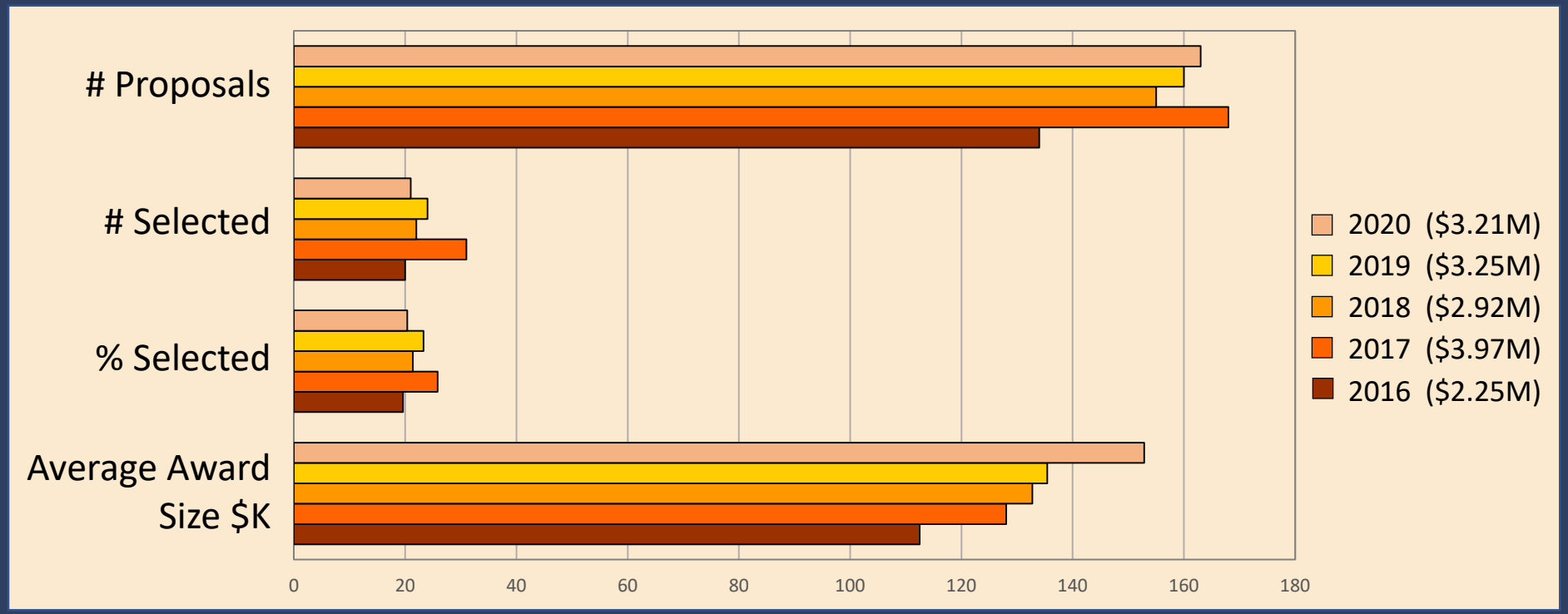
- Sample acquisition/caching/containment; Terrain Relative Navigation (TRN); fast traverse; MSR ascent; helicopter tech

Mars R&A / Mars Data Analysis Program

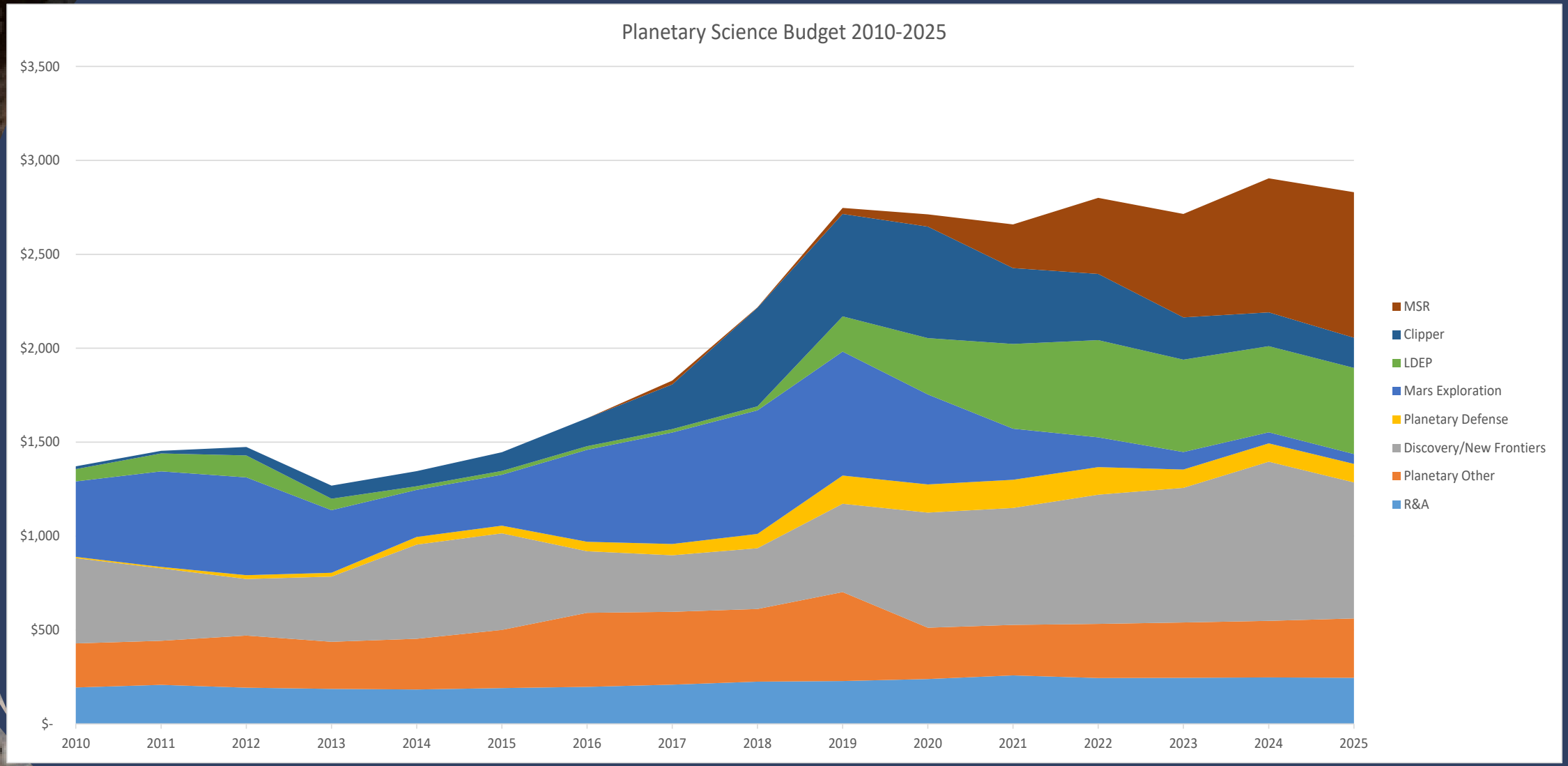
Funds the analysis of data returned from NASA and other missions to Mars.

- Enhances mission scientific return
- Broadens scientific participation in the analysis of mission datasets
- Funds high-priority areas of research that support planning for future missions

Mars-related research also supported by Solar System Workings, Habitable Worlds, and planetary instrument technology development programs.

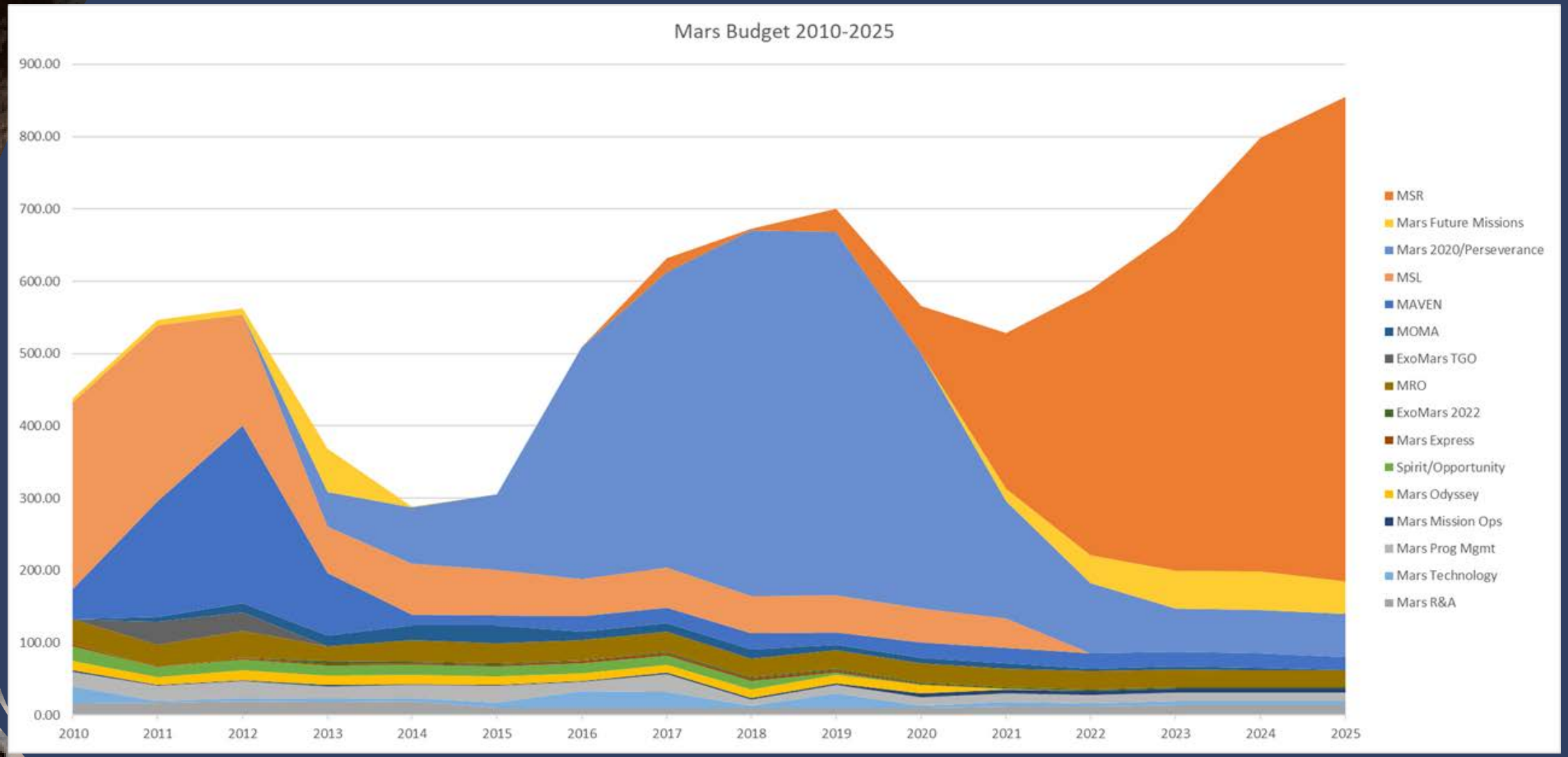


Planetary Science Division Budget



Future budgets are reflective of the FY21 President's Budget Request to Congress

Mars Budget (including MSR)



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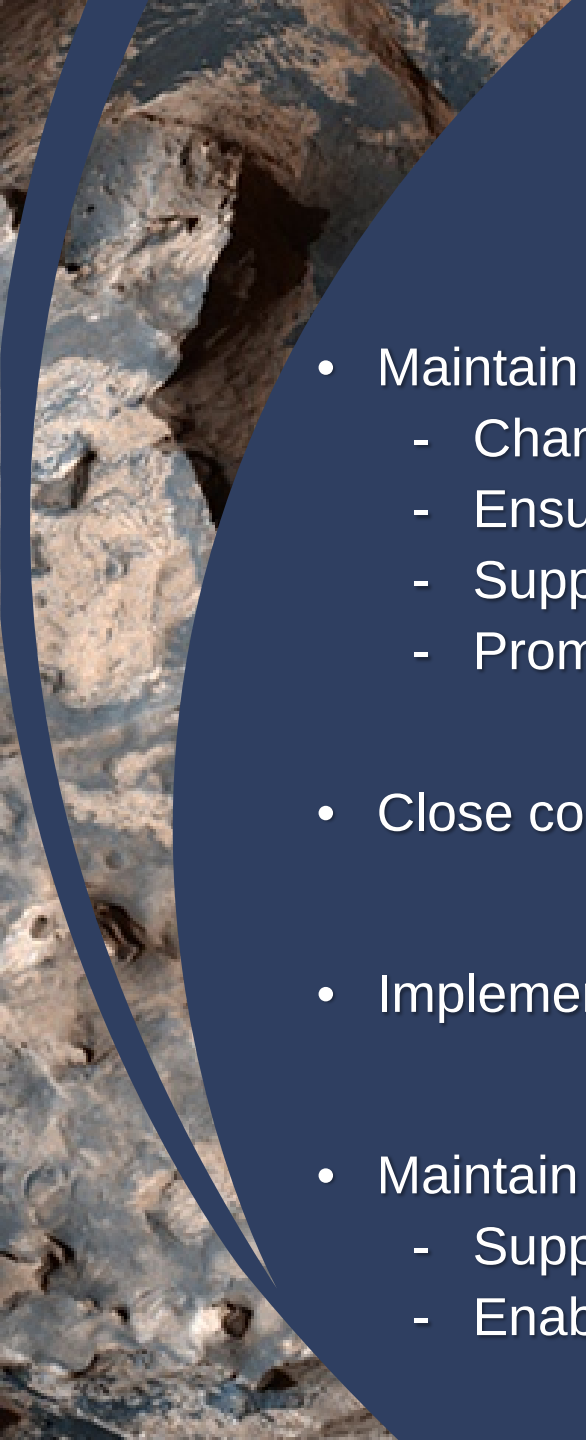

Priorities for Mars Exploration Program

- Maintain NASA's position as a world leader in Mars exploration
  - Champion the interests of the Mars science community
  - Ensure continued successful operation of existing orbiters, landers, and rovers on Mars
  - Support and cultivate existing and future international partnerships
  - Promote future mission opportunities for Mars science
- Close coordination with the Mars Sample Return program and Planetary Science Division
- Implement priorities established through the 2022 Planetary Science Decadal Survey
- Maintain fiscal discipline to deliver a healthy Program within available resources
  - Support existing efforts
  - Enable future capabilities