

National Aeronautics and
Space Administration



NASA's Mars Exploration Program & Expanding the Horizon of Mars Science

Dr. Lindsay Hays

Senior Scientist for Mars Exploration

Science Mission Directorate

Space Studies Week: Committee on Astrobiology and Planetary Protection

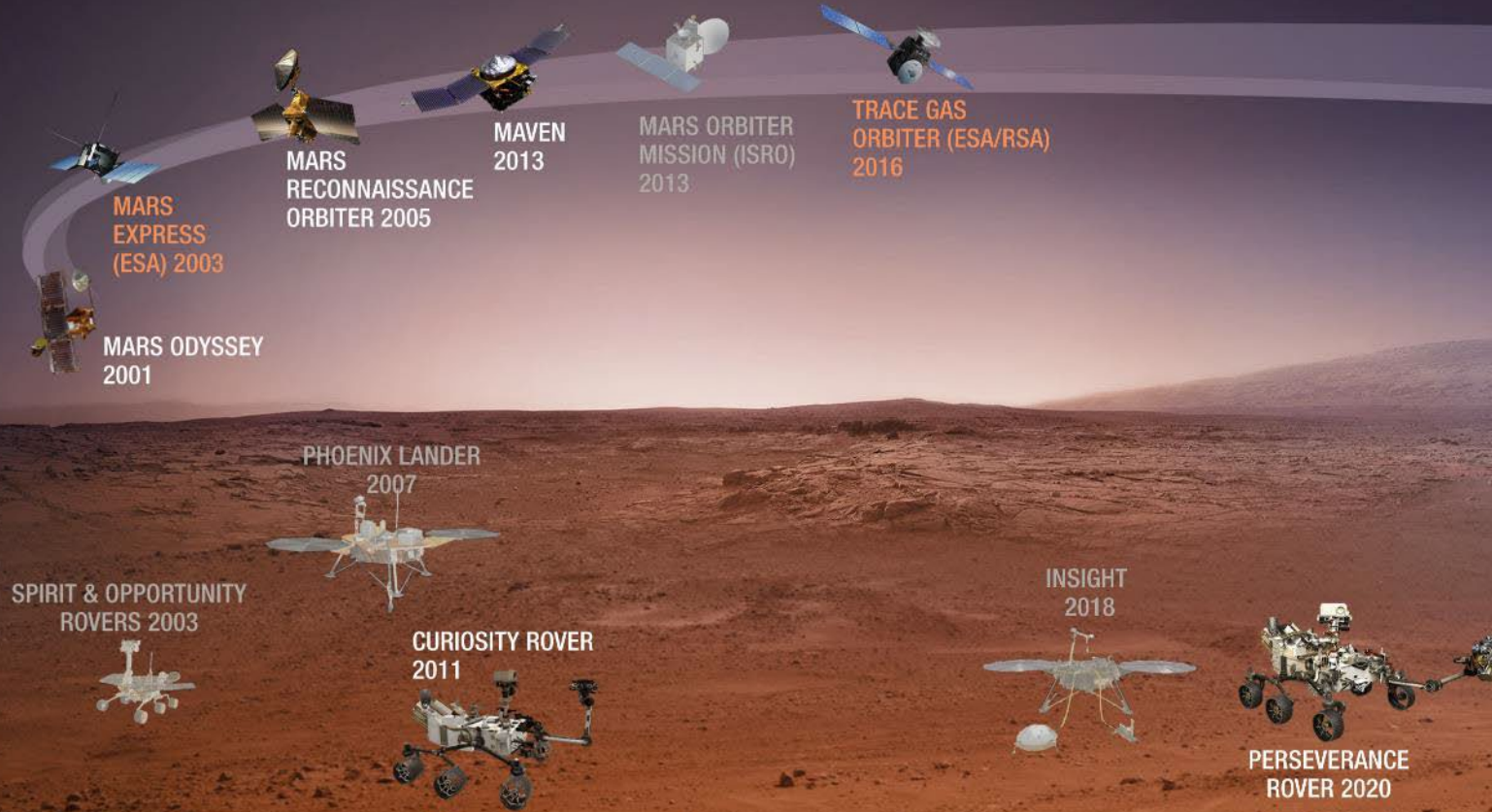
March 31, 2025



2001–2024

2026 AND BEYOND

■ U.S. MISSION
■ PARTNER MISSIONS
■ NON-OPERATIONAL

MARTIAN MOONS
EXPLORATION (JAXA)EARTH RETURN
ORBITER (ESA/NASA)ROSALIND
FRANKLIN ROVER
(ESA/NASA)SAMPLE RETRIEVAL
LANDER (NASA/ESA)

Follow the Water

Explore Habitability

Seek Signs of Life

Prepare for Future Human Explorers



Mars Exploration Program

NASA Operating Missions

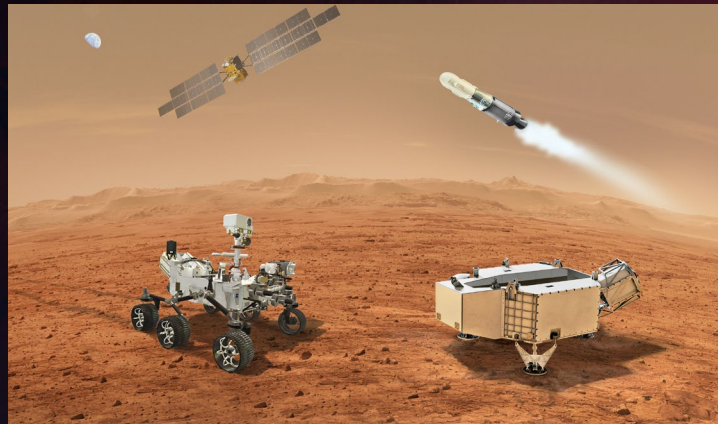


MARS SAMPLE RETURN CAMPAIGN



Mars 2020 Sample Caching

- Collect samples of rock, regolith, and atmosphere
- Cache samples on the surface for retrieval



Mars Sample Return Program

- First round-trip mission to another planet
- First launch from another planet
- First autonomous in-orbit rendezvous
- Brings scientifically-selected Martian samples to Earth for the first time
- Partnership between NASA and ESA



Sample Receiving Project

- Recover and transport contained samples to receiving facility
- Safety assessment and sample containment
- Initial sample science and curation



Expanding the Horizons of Mars Science

A Plan for a Sustainable Science
Program at Mars

MEP Planning Team

M. Syvertson*†
R. McCauley Rench* † †
N. Barba†
C. Carnalla-Martinez †
R. Davis † †
C. Edwards †
S. Hulme †

D. Lavery † †
S. Matousek †
L. Matthies †
M. Mischna †
H. Price †
M. Viotti †

*Co-Leads

†Jet Propulsion Laboratory,
California Institute of Technology

† † Science Mission Directorate,
NASA Headquarters

2024 – 2044



INTRODUCTION

1

Mars Exploration Program Context

- The Mars Exploration Program has implemented over two decades of successful missions to understand Mars and to search for past and present life through a series of orbiters, landers, and rovers
- As we approach three decades at Mars, we must address our critical/aging infrastructure
- Looking forward, we need to prepare for a human presence at Mars
- The space business environment is expanding, including broadening international participation and commercial interest/capability

2

Mars Sample Return

- Our current critical chapter in Mars exploration would culminate in the return of Martian samples to Earth - the community's highest Mars Exploration priority over the last two decades, as cited in the past three Decadal Surveys

3

Future Plan Development

- MEP is planning for the next two decades of equally profound scientific investigations with a new strategic paradigm designed to send lower-cost, high-science-value missions and payloads to Mars at a higher frequency
- This Plan incorporates inputs from several sources across the planetary science community, Mars science community, and engineering and technology communities

SCIENCE PRIORITIES

Explore the Potential
for Martian Life



Support Human
Exploration of Mars

Revealing Mars
as a Dynamic
Planetary System

PLAN INITIATIVES

1

EXPLORE



2

INFRASTRUCTURE



3

TECHNOLOGY



4

TOGETHER



International Collaborations - Public/Private Partnerships – Engaging the Community



INITIATIVE 1 : EXPLORATION

Expand Opportunities to Explore Mars through Competed, Lower Cost, and More Frequent Flight Opportunities

Establish a regular cadence of science-driven, lower-cost mission opportunities as a new element of the MEP portfolio to provide rapid and flexible response to discoveries, to address the breadth of outstanding Mars questions, and to enable increased participation by the Mars science community.

1.1 LOWER-COST MISSIONS	1.2 MEDIUM-CLASS MISSIONS	1.3 MISSIONS OF OPPORTUNITY
Enable broad, competed scientific investigations that address community-defined questions and encourage incremental development of networks.	Enable targeted or discovery-responsive scientific missions that address strategic, highest priority decadal class themes.	Open greater access to Mars for more participants by expanding lower-cost flight opportunities.
• Competed Small Missions • \$100M - \$300M level • Single instrument or small complement of instruments • Intent to select missions for every Mars launch opportunity • May select multiple smaller missions per launch opportunity • Draws on experience from COTS/CLPS programs	• Broad Science Investigations • More complex instrument suites, competitively selected or partner contributed • New technologies in sample acquisition, mobility, autonomy • Considering competition at either the mission or instrument level • Scalable to significant discoveries	• Competed Payloads • Potentially competed or directed • Could be science or infrastructure focused • Flown on international or commercial missions

INITIATIVE 2 : INFRASTRUCTURE

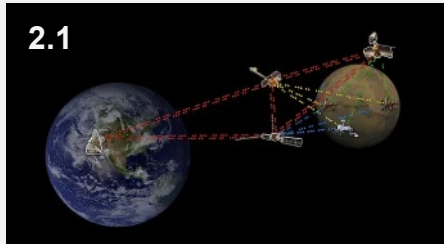
Strengthen and Broaden Infrastructure at Mars to Enable a Diverse Set of Missions & Opportunities for Partnerships

Enable infrastructure advancements that no one mission could likely achieve alone and that lower the costs and risks of and increase benefits for all Mars missions.

SCIENCE AND MISSION ENABLING

Requirements/implementation approaches coordinated with ESDMD, STMD, and SOMD, as appropriate.

2.1



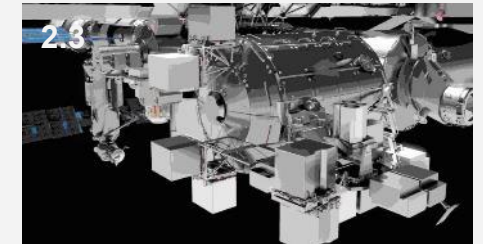
Mars Relay Network

2.2



Spacecraft Delivery (including Rideshares)

2.3



Payload Hosting Opportunities

2.4



High-resolution Imaging

2.5



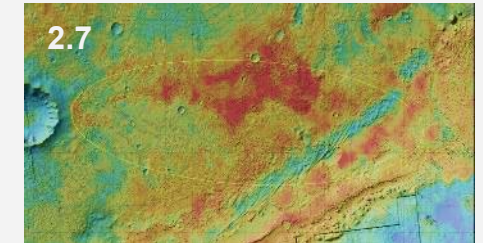
Global Meteorological Monitoring

2.6



Ground Receiving Networks

2.7



Data Infrastructure, Visualization, & Analysis



INITIATIVE 3 : TECHNOLOGY

Invest in Key Technologies to Enable Expanded Access to, and Scientific Understanding of, Mars

Provide continuing improvement in the capabilities of robotic science- and human-enabling missions that lower the costs of all Mars missions and build upon the developments and experience of Earth and the Moon-to-Mars initiative.

Activities to be planned in coordination with STMD



EXPANDING THE HORIZONS OF MARS SCIENCE

2024 – 2044

3.1 EDL

Increased Surface Access through Improved Entry/Deorbit, Descent, & Landing Systems

3.2 Mobility

New Improvements in Aerial Mobility and Surface Mobility

3.3 Operations

Revolutionary Advances in Avionics, Autonomy, and Power

3.4 Sampling

In Situ Sample Acquisition, Handling, Pre-Processing, and Analysis

3.5 Instruments

Remote Sensing, In Situ Science Instruments, and Search for Evidence of Life Measurements

3.6 Telecommunications

Direct to Orbit, Direct to Earth, & Proximity Link Telecommunications



INITIATIVE 4: TOGETHER

Enable Participation in Mars Exploration

Develop MEP objectives that support NASA's goals to train, sustain, and retain a qualified workforce, to develop scientific and technical literacy, and to foster a more inspired and informed society.

Develop
Mission-enabling
Partnerships

Leverage partnership opportunities and new models of engagement to lower costs and capitalize on capabilities.

Create Opportunities for
Public Participation in
Mars Exploration

Enable direct participation in Mars Exploration through innovative technologies, partnerships, and collaborations.

Respect Role in the
Stewardship of Mars

Be Mindful of Responsibilities in Exploring Mars.



Progress

Planning for Human Exploration of Mars

- NASEM Committee on *A Science Strategy for the Human Exploration of Mars*
 - Commissioned a National Academies study to identify science objectives for human campaigns to Mars
- Mars Surface Science Workshops (MSSW)
 - Create avenue for organized community involvement and participation in planning as it relates to human exploration of Mars
 - Generate referenceable content relevant to the conduct of science by robotic and human explorers on the surface of Mars
 - Inspired by Lunar series
 - Topics submitted by community, industry, and government through website



Progress

Identifying Priority Science in Advance of Humans

Science and Planetary Protection in Advance of Human Exploration Virtual Seminar and Workshop

1. Identify science priorities for robotic missions in advance of humans arriving on Mars
2. Inform development of planetary protection guidelines for crewed missions to Mars
3. Develop a framework for how forward and backward contamination control can be incorporated into human elements for Mars research activities

Key Findings

- Understand life at Mars through Mars missions and research on Earth
- Monitor surface weather at Mars to better understand dust movement and weather patterns to inform transport models for Forward PP/Contamination
- Leverage past missions to understand future PP requirements
- Develop advanced technologies, particularly in the areas of life detection, sample return, and robotic capabilities

Final Report Spring 2025

Path Forward

Near-Term Activities

- Achieve the objectives of the MEP Program of Record, including development of the Sample Receiving Project for the returned Mars samples
- Collaborate with ESA on the ExoMars Rosalind Franklin Mission
- Seek low-cost opportunities to address critical infrastructure needs (particularly communications relay and high-resolution imaging)

- Continue investments in key mission-enabling technologies, especially those enabling the search for life and subsurface access
- Develop public/private partnership arrangements, reinforce existing international partnerships, and explore new opportunities with established and emerging space organizations

Future Vision

- Implement a sustainable portfolio of low-cost competed missions, medium-class missions, infrastructure and technology investments, and missions of opportunity
- Implement science that is supportive of, and synergistic with, humans at Mars

The background of the slide is a detailed illustration of a Martian landscape. In the foreground, a deep, reddish-brown canyon rim is visible. On the plateau above the rim, several Mars rovers of different designs are parked. To the right, a helicopter is in flight, and a rocket is launching into the sky, leaving a bright trail. A lone astronaut in a full spacesuit stands on the right side of the plateau. The sky is a dramatic mix of orange, red, and yellow, with wispy clouds and a bright light source on the horizon.

THE EVOLUTION OF A MARTIAN



Thank you!