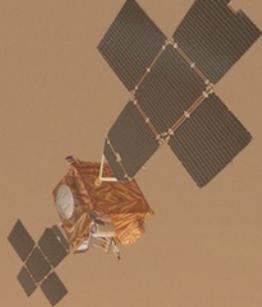




National Aeronautics and
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EXPLORE

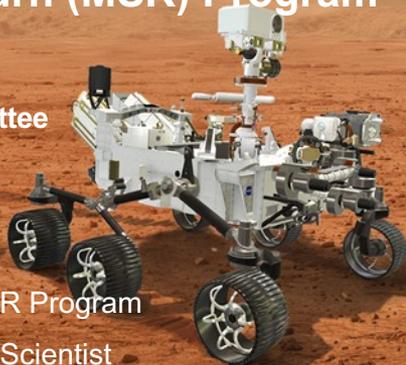


Mars Sample Return (MSR) Program

Planetary Advisory Committee
February 28, 2023

Jeff Gramling, Director, MSR Program

Michael Meyer, Mars Lead Scientist



The decision to implement Mars Sample Return will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process. This presentation is being made available for information purposes only.



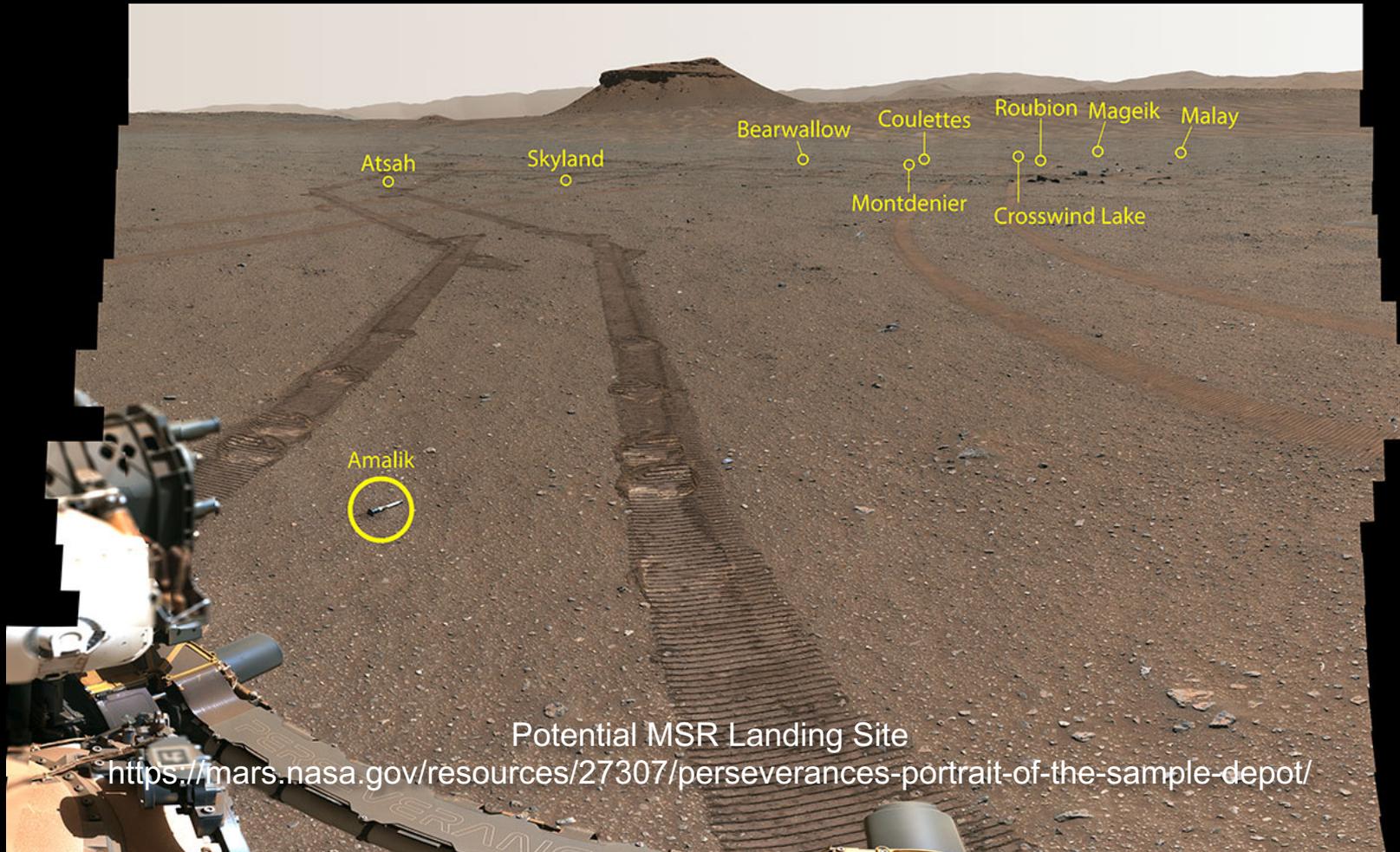
Executive Summary

Current Status & Key Accomplishments



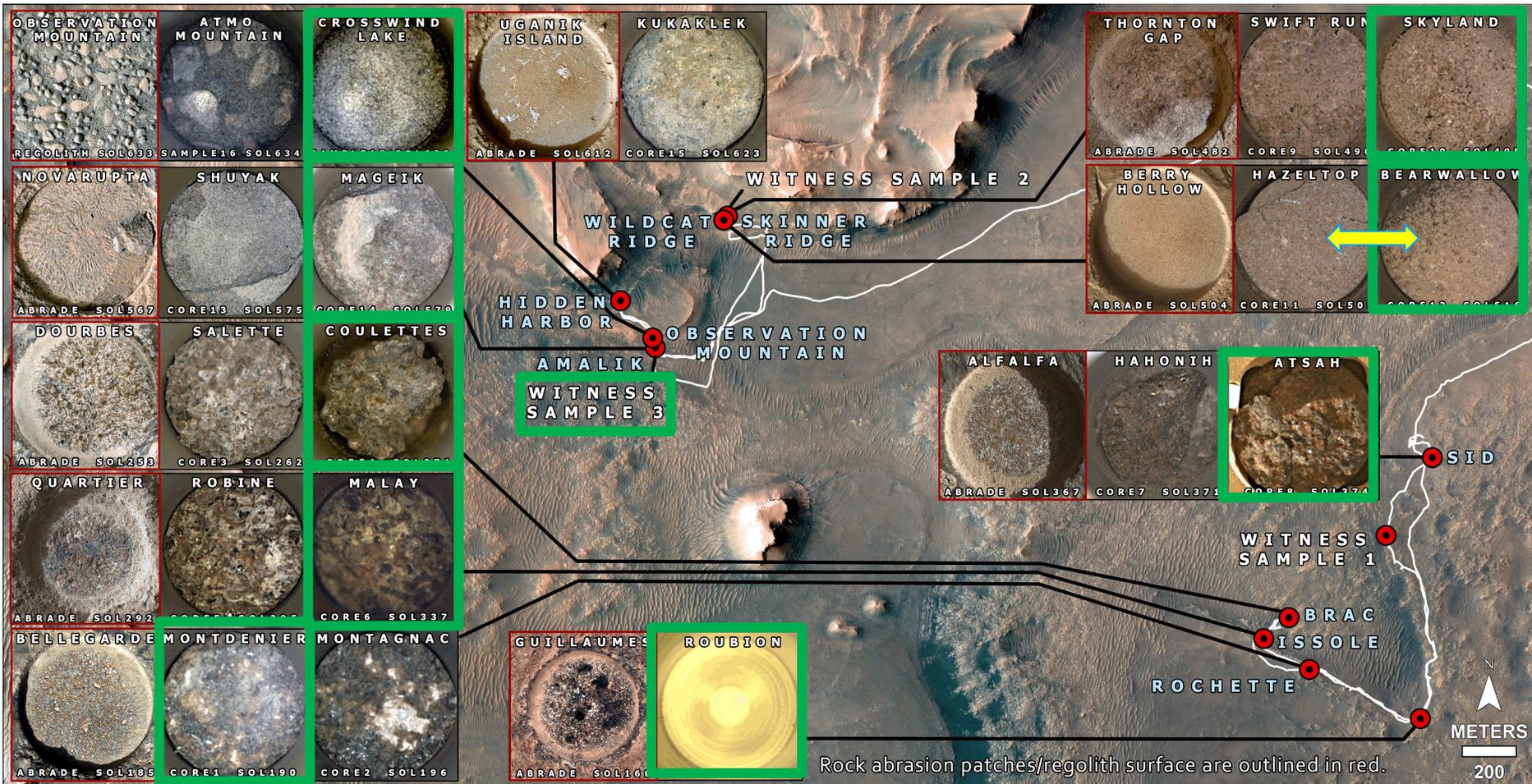
- Establishment of Three Forks cache provides critical mission resiliency against future issues with Perseverance
- Working toward MSR Confirmation this year (KDP-C)
 - Project element Preliminary Design Reviews (PDRs) in progress
 - Capture, Containment, & Return System (CCRS) PDR Part 1 (systems, project), Dec 13-16
 - Mars Ascent Vehicle Propulsion System (MAPS) PDR, Jan 3-6
 - Sample Retrieval Lander (SRL) Mechanical PDR- Jan 26
 - Closure on Technology Readiness Level 6 (TRL-6)
 - Mars Ascent Vehicle Propulsion System (MAPS) Stage 1, Supersonic Splitline (SSSL) Nozzle is the only technology development on MSR. The upcoming Demonstration Motor-1 Hot Fire test will demonstrate SSSL TRL-6
 - Validate program Cost and Schedule through independent review and estimates
 - Establishing MSR Response to Psyche Independent Review Board (IRB) Findings

Scientifically Return-Worthy Initial Cache Complete at Three Forks



Three Forks Cache Status

Green highlights tubes cached at Three Forks



Rock abrasion patches/regolith surface are outlined in red.



Ongoing Sample Integrity (SI) Work



- Ongoing meetings of Sample Integrity Working Group (SIWG) as a forum for discussing SI/science-related issues and concerns as they rise
- Reviewing flowdown and V&V planning for SI requirements for SRL and CCRS
- Participation across other domain working groups: Planetary Protection/Break-the-Chain and Returned Sample Tube Assembly (RSTA) requalification
- Collaboration with Mission Systems on Sample Record Inventory
- Providing input to the Program Contamination Control & Knowledge Plan as maturation continues
- Continuing implementation discussions for proposed Orbiting Sample (OS) container flight witness
- Monitoring ongoing thermal assessments for RSTA temperatures



Backward Planetary Protection (BPP) Implementation

- MSR is the first mission to implement challenging “break-the-chain” BPP method
- MSR is adopting an approach to BPP to manage <20 mg of uncontained aeolian dust exterior to the Orbiting Sample (OS) container that:
 - Recognizes the very low potential hazard of subcellular entities to Earth’s biosphere
 - Uses an alternative sterilization process (UV) for cellular entities that reduces risk to sample integrity (vs. heat)
 - Less complex implementation should enhance reliability
- BPP restructuring is consistent with NASA and international BPP policies to achieve a very low risk of harm to Earth’s biosphere from sample return
 - Developing a scientific consensus on sample return risks informed by modern genomics and confirming UV sterilization efficacy would improve planetary protection practices (e.g., for future Mars robotic and human missions)
 - Efforts to confirm scientific basis of key changes will continue over the next 6-18 months and are being worked with NASA’s Planetary Protection Officer to ensure compliance with NASA back planetary protection policy
- The restructured approach maintains redundancy for breaking the chain of contact with Mars
 - The system is tolerant to the failure of any one of the three protective elements: the primary container, the sterilization process, or the secondary container
 - The samples (~500 g) collected by Perseverance will be contained with even more redundancy, including the hermetically sealed sample tubes in addition to the primary and secondary containment.
- Independent review of this approach will be accomplished through:
 - 1) Independent panel review of MSR’s approach to subcellular entities and UV sterilization—commissioned by NASA Office of Chief Scientist
 - 2) Testing of UV sterilization efficacy in CCRS environment

MSR Campaign Science Group (MCSG) Update



Mars Sample Return

- MCSG provided rapid assessment and concurred with Mars 2020 project recommendation for depositing Bearwallow sample instead of the originally intended Hazeltop.
- MCSG in-person meeting at Centro de Astrobiología (CAB) on Feb 21-23 to discuss aspects related to future science investigations and Sample Receiving Project (SRP)
 - Review of science deliverables for SRP Mission Concept Review, and MCSG role
 - Discussion of potential Level-1 and Level-2 science requirements for SRP
 - Review instrument list for sample safety assessment, initial science observations, and curation
 - Review Measurement Definition Team Statement of Task
 - Report out of Sample Tube opening and sample extraction by Rock and Gas Teams
 - Sample Receiving Facility Contamination Panel intermediate report
 - R & D planning for SRP

SRL Hardware & Testing Accomplishments

“Workpony” Mortar Testing



Sample Recovery Helicopter Mobility Testing



MAV Spin Motor Testing at Northrop Grumman



CCRS Hardware & Testing Accomplishments



a. Earth Entry System Drop Test



b. Capture Lid Mechanism, Engineering Development Unit Testing at Newton prior to APL tests

c. Thermal Protection System

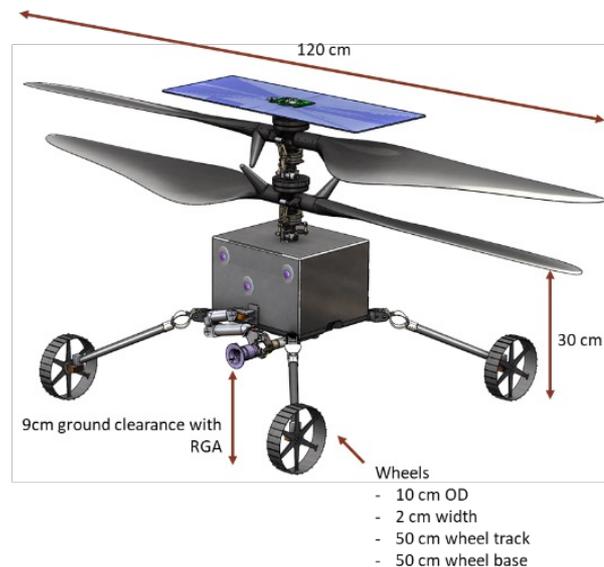


Sample Recovery Helicopter (SRH)

- Vacuum chamber testing of an engineering model is underway (to be completed end-February) at JPL to demonstrate the SRH capability to retrieve samples cached on the surface by Perseverance.
- A range of parameters within the SRH design envelope are being tested; one or a combination of changes from Ingenuity heritage in blade design, speed, mobility, software, and overall mass would meet requirements.

Ingenuity-like rotorcraft with:

- Ground mobility
- Tube manipulator
- Stereo vision
- Inflight, absolute localization



Technology Readiness Level 6



- Major technology development on MSR approaching completion in Phase B
 - Mars Ascent Vehicle Propulsion System (MAPS) Stage 1 Solid Rocket Motor and Supersonic Splitline (SSSL) Nozzle on track to reach required development milestone by the end of March with Hot Fire test
- MAPS has initiated a series of tests leading up to the full scale static hot fire test of Demonstration Motor-1 (DM-1) scheduled for March 2023.
 - Propellant / Igniter testing complete
 - Nozzle bench testing Feb 2023
- Full scale DM-1 testing at Edwards AFB scheduled for March 2023 (Achieves TRL 6)



- Hot fire test in a relevant environment → TRL 6

National Environmental Policy Act (NEPA) Compliance Status and Key Milestones



- 45-day public comment period on Draft Programmatic Environmental Impact Statement ended Dec 19, 2022
 - ~70 comments received on regulations.gov;

- Public comment meetings conducted in Nov-Dec 2022
 - Two virtual meetings on Nov 30
 - Two in-person meetings in Utah Dec 6-7
 - Brinkman Service Club in Wendover
 - Clark Planetarium in Salt Lake City

	Milestone	Revised Dates
✓	Release of Letter to Tribal Councils	25 Mar 22
✓	Notice of Intent Publication	15 Apr 22
	Public Scoping Meetings (virtual)	4/5 May 22
✓	Draft Programmatic EIS Notice of Availability Publication	4 Nov 22
✓	PEIS Public Meetings	30 Nov 22 (virtual) 6-7 Dec 22 (Utah)
	Final EIS Notice of Availability Publication	20 June 23
	Record of Decision (ROD) Signature	1 Aug 23



Path to Confirmation (Key Decision Point - C)

- Element and Program Reviews planned for Phase B
 - Earth Return Orbiter (ERO): Spacecraft PDR completed June 2021
 - Sample Transfer Arm (STA): PDR conducted November 2022
 - Capture, Containment, & Return System (CCRS):
 - PDR Part 1 (Systems, Project) conducted Dec 2022
 - PDR Part 2 (Flight Segment, Programmatic)
 - Sample Recovery Helicopter (SRH): System Requirements Review (SRR), conducted Feb 2022
 - Mars Ascent Vehicle (MAV): PDR scheduled for April 2023
 - Sample Retrieval Lander (SRL): PDR scheduled for May 2023
 - MSR Program/system PDR – June 2023
 - Confirmation/KDP-C – late summer/early fall 2023