National Aeronautics and
Space Administration

NASA-ESA Mars Sample Return (MSR) Campaign

Programmatic Environmental Impact Statement

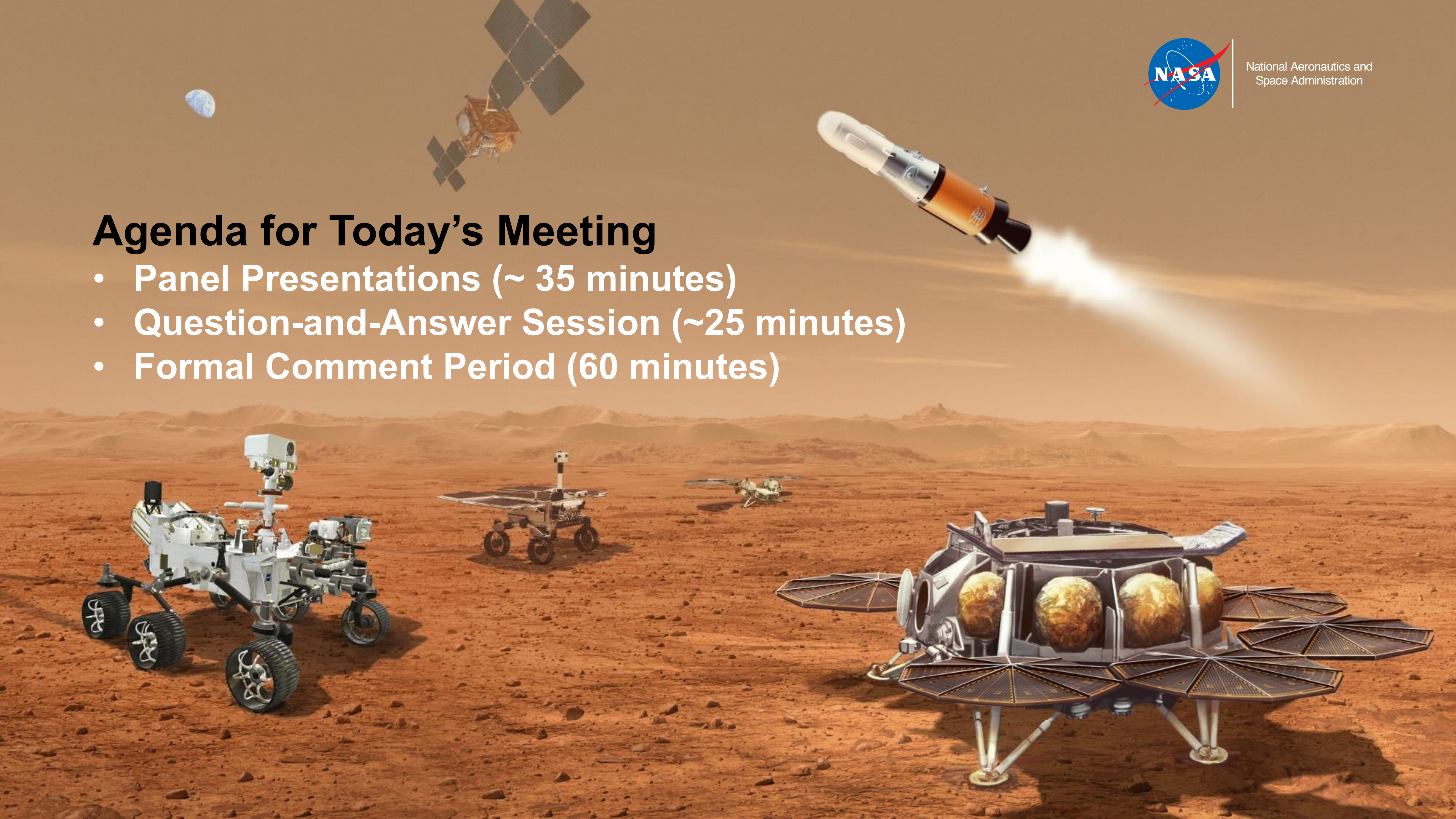
NEPA Scoping Public Meetings

May 4 and 5, 2022

National Aeronautics and
Space Administration

Agenda for Today's Meeting

- Panel Presentations (~ 35 minutes)
- Question-and-Answer Session (~25 minutes)
- Formal Comment Period (60 minutes)



Mars Sample Return (MSR) Campaign

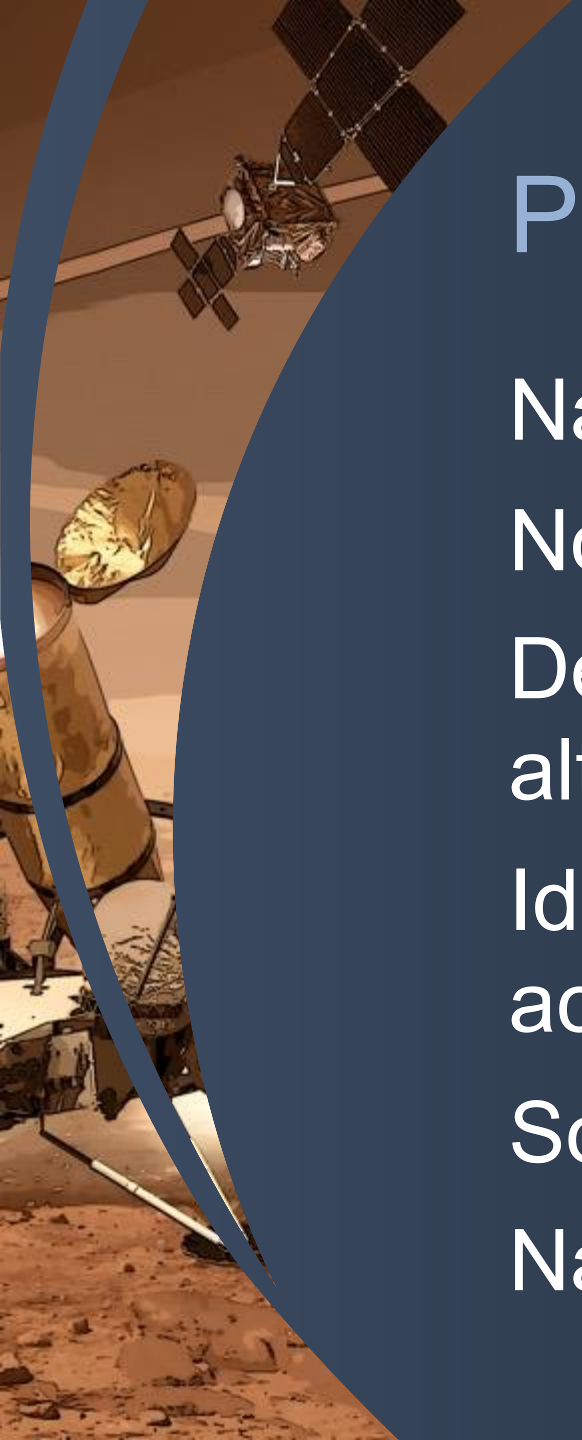
Programmatic Environmental Impact Statement NEPA Compliance

NEPA Manager: Steve Slaten

May 4 and 5, 2022

Agenda

- Purpose of Scoping Meeting
- Proposed Action and Alternatives Summary
- Programmatic Approach
- Potential Environmental Impacts to be Evaluated
- Project Schedule
- Opportunities for Public Involvement



Purpose of the MSR Scoping Meeting

- National Environmental Policy Act (NEPA)
- Notify and inform stakeholders and the public
- Describe the proposed action and potential alternatives
- Identify the potential resources impacted by the action
- Solicit input on the alternatives and resources
- National Historic Preservation Act

Proposed Action & Alternatives

Proposed Action – NASA and European Space Agency jointly conduct the Mars Sample Return Campaign

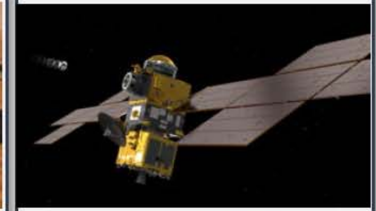
Previously Covered under Mars2020 NEPA	Tier I – Programmatic Analysis (Flight and Ground Elements)			
	Tier I – Site Specific Analysis Flight Elements		Tier II – Site Specific Analysis Ground Elements	
1	2/3	4	5	6

Sample Caching

- *Collect samples of rock and sediment*
- *Cache samples on the surface for retrieval*

Sample Retrieval

- *Retrieve samples cached by Mars 2020 rover*
- *Launch samples into orbit around Mars*



Earth Return

- *Capture and contain samples in Mars orbit*
- *Safely return samples to Earth for recovery at landing site*

Sample Transportation

- *Transport contained samples to Sample Receiving Facility*
- *Over the road and/or aircraft*

Sample Receiving

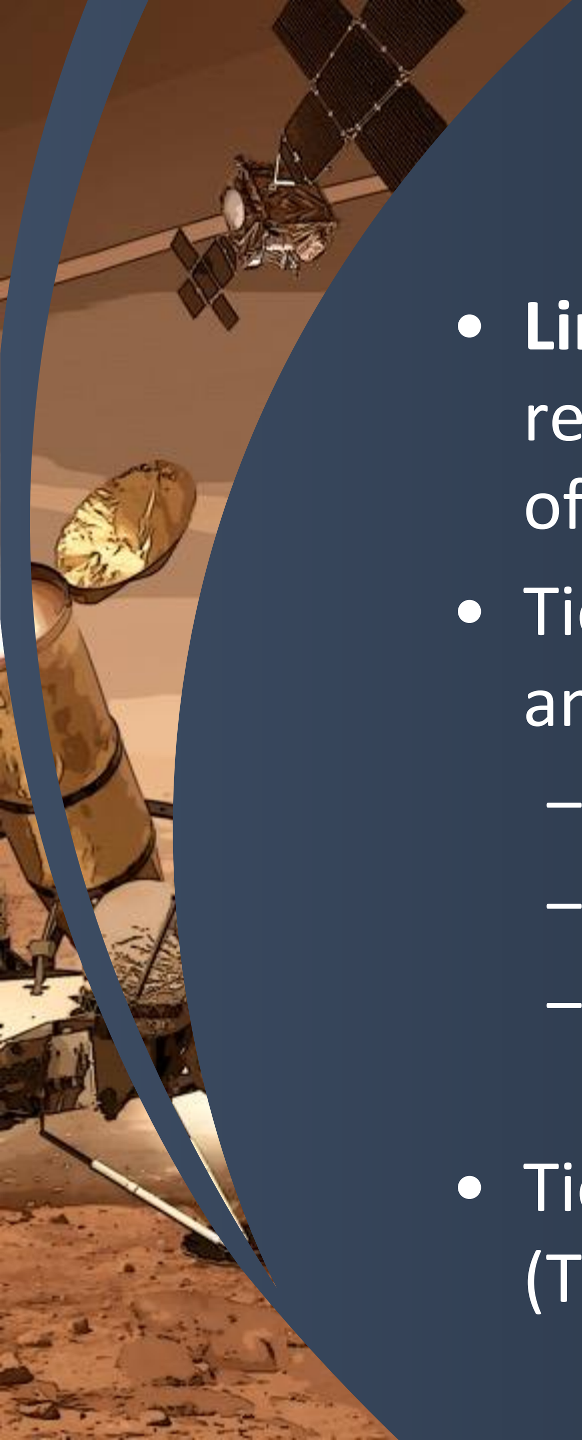
- *Safety assessment and sample containment*
- *Initial sample science and curation*

MSR Campaign Flight Elements (1–4)

MSR Campaign Ground Elements (5–6)

No Action Alternative

- Mars samples would not be returned from Mars to Earth; analysis of Mars would be limited.



Programmatic Approach

- **Limitations in available information** and **uncertainty** regarding the timing, location, and environmental impacts of subsequent implementing action(s).
- Tier I = Decisions to be made now with current info (Landers and Earth Return Orbiter)
  - Lander launches planned for 2028
  - Earth Return Orbiter launch planned for 2027
  - Sample return to Utah Test and Training Range planned for 2033
- Tier II = Decisions to be made later when info is available (Transportation and Sample Receiving Facility)

Potential Environmental Impacts to be Evaluated

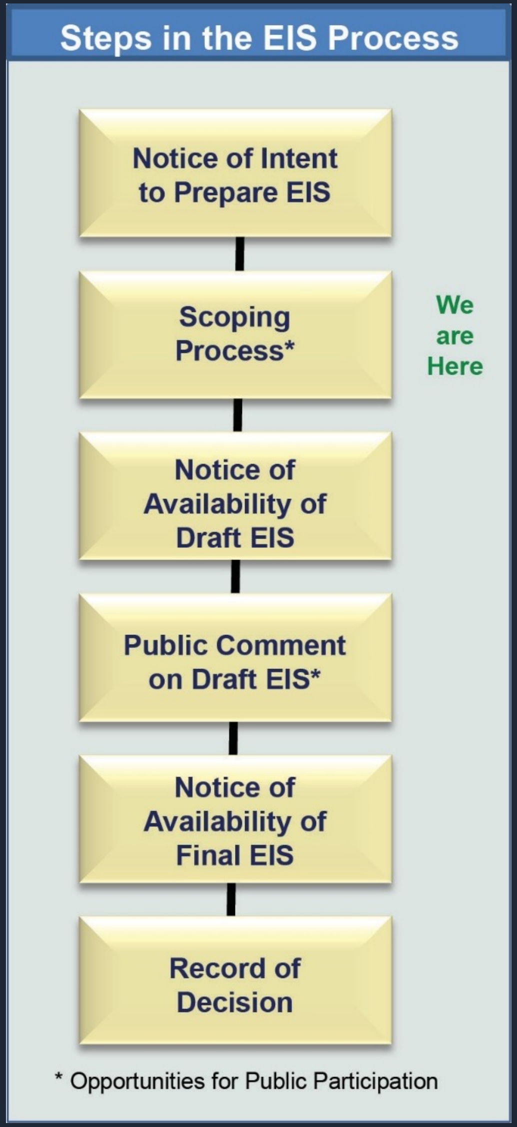
- NASA anticipates detailed analysis of the following resources:
  - Health and safety
  - Land use
  - Water resources
  - Biological resources
  - Hazardous materials
  - Cultural resources

- NEPA process requires consultation with outside agencies:
  - U.S. Fish and Wildlife Service regarding the Endangered Species Act
  - Utah State Historic Preservation Office and local Native American Tribes regarding the National Historic Preservation Act

Environmental impacts and consultations associated with Florida launches are already covered under previous National Environmental Policy Act documents.

Schedule and Key Milestones

- NOI Publication – April 15, 2022
  - Scoping Period: April 15 – May 15, 2022
  - Public Meetings: May 4 and 5, 2022
- Draft PEIS Publication – Fall, 2022
  - Public/Agency Review Period: Fall, 2022
  - Public Meetings: Fall, 2022
- Final EIS Publication – Spring, 2023
- Record of Decision – Summer 2023



Opportunities for Public Involvement

- Scoping Period (April 15 – May 15, 2022)
  - Chat Box or verbal during this meeting
  - Federal Docket online at http://www.regulations.gov
  - Mail to Steve Slaten, NASA Jet Propulsion Laboratory, 4800 Oak Grove Drive, M/S: 200-119, Pasadena, California 91109-8099

- Request Additional Information:
  - For questions regarding the Mars Sample Return PEIS, please contact Mr. Steve Slaten, National Aeronautics and Space Administration, by electronic mail at Mars-sample-return-nepa@lists.nasa.gov or by telephone at 202-358-0016.
  - For questions regarding viewing the Docket, please call Docket Operations, telephone: 202-366-9317 or 202-366-9826

- Mars Sample Return Campaign PEIS Information
  - *www.nasa.gov/feature/nepa-mars-sample-return-campaign*

The Science of Mars Sample Return

Dr. Lindsay Hays
MSR Deputy Program Scientist
May 4 and 5, 2022

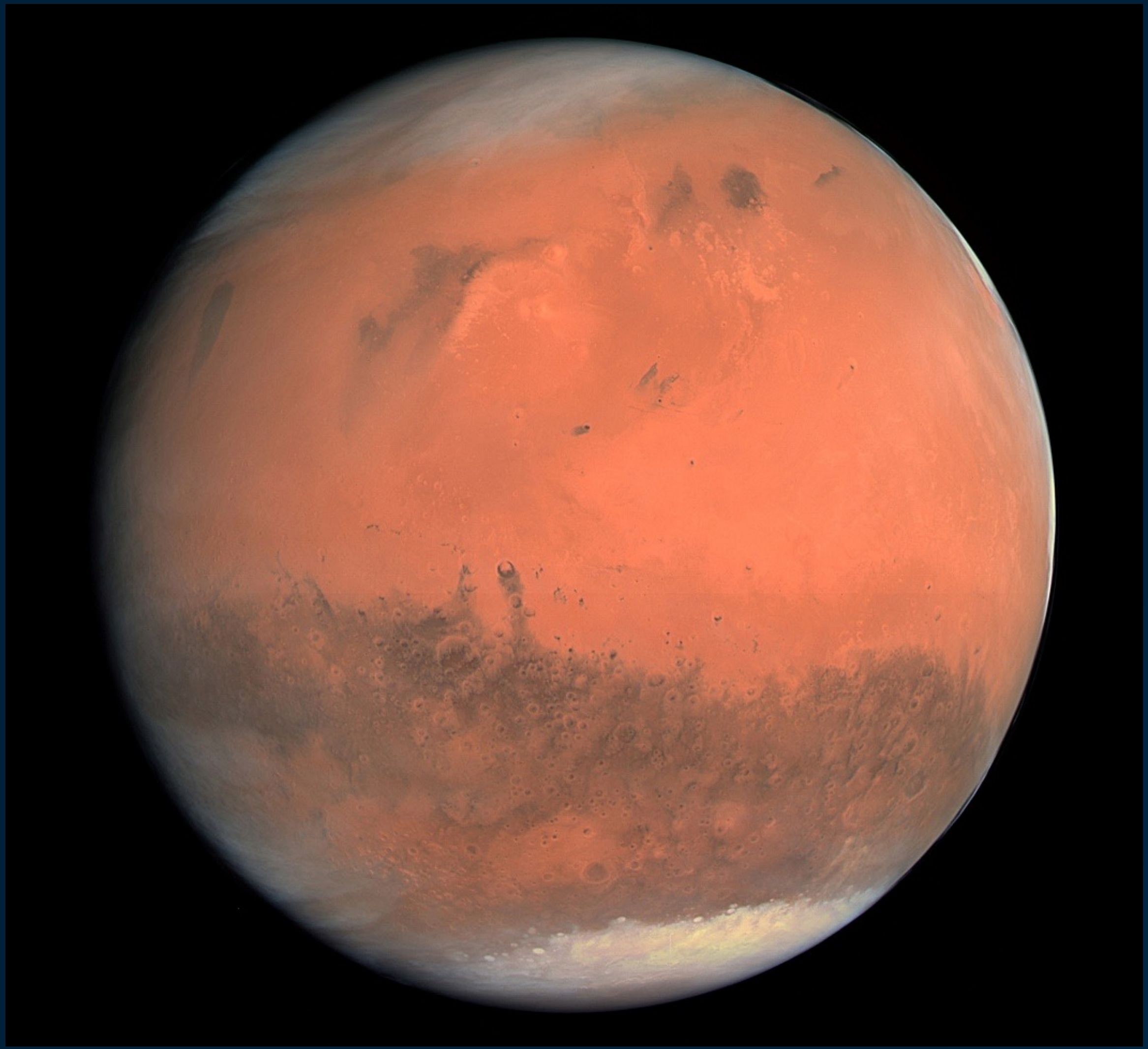
Mars Sample Return—
First Sample Return From Another Planet

A priority since 1980 and of three National Academy Decadal Surveys.
A first-step “round-trip” in advance of humans to Mars.

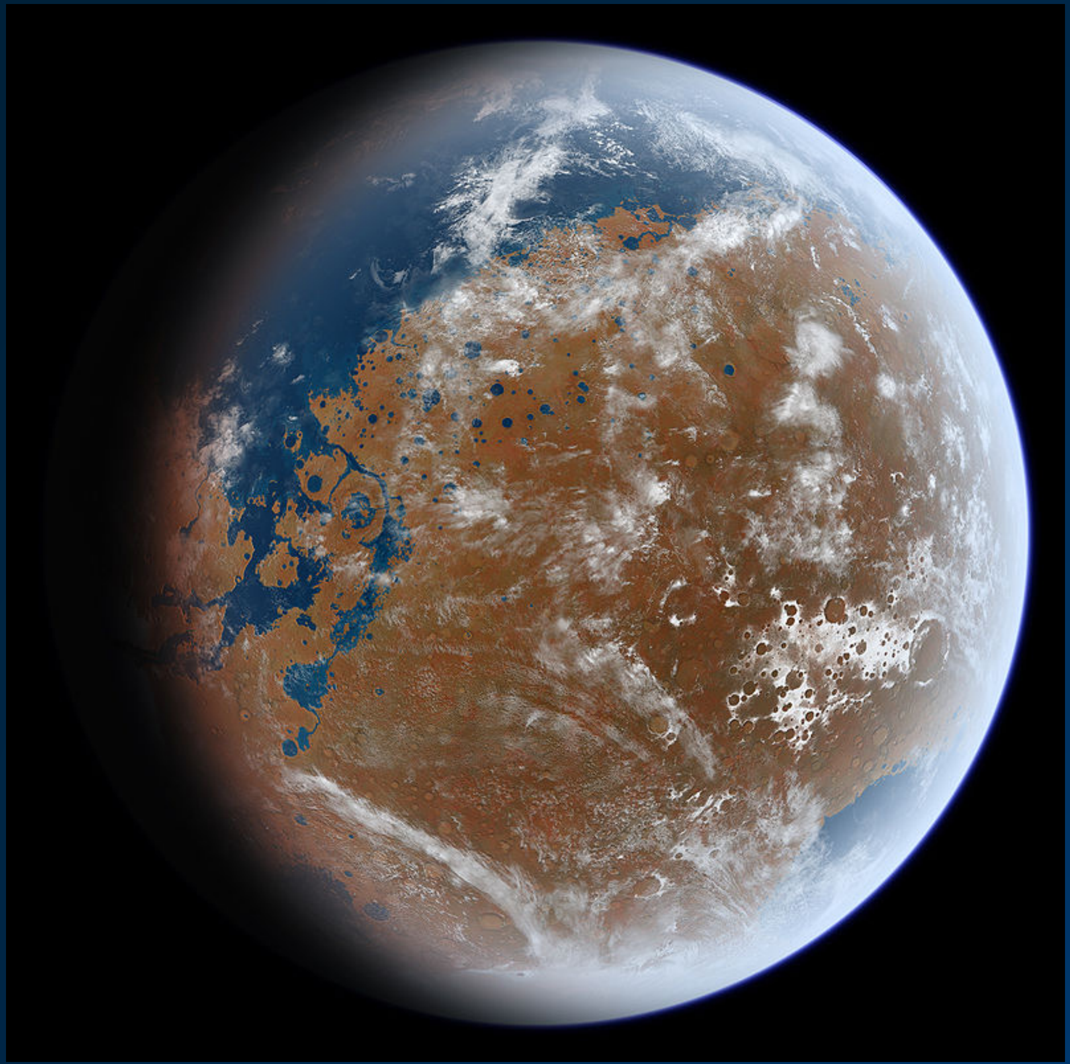
The oldest known life on Earth existed ~3.5 billion years ago,
a time when Mars was habitable.
Today, <<1% of the Earth’s surface is 3 billion years or older
>50% of Mars’ surface is 3 billion years or older.

The first billion years and life’s beginning in the Solar System:
The record is on Mars

Ancient Mars: Surface Liquid Water

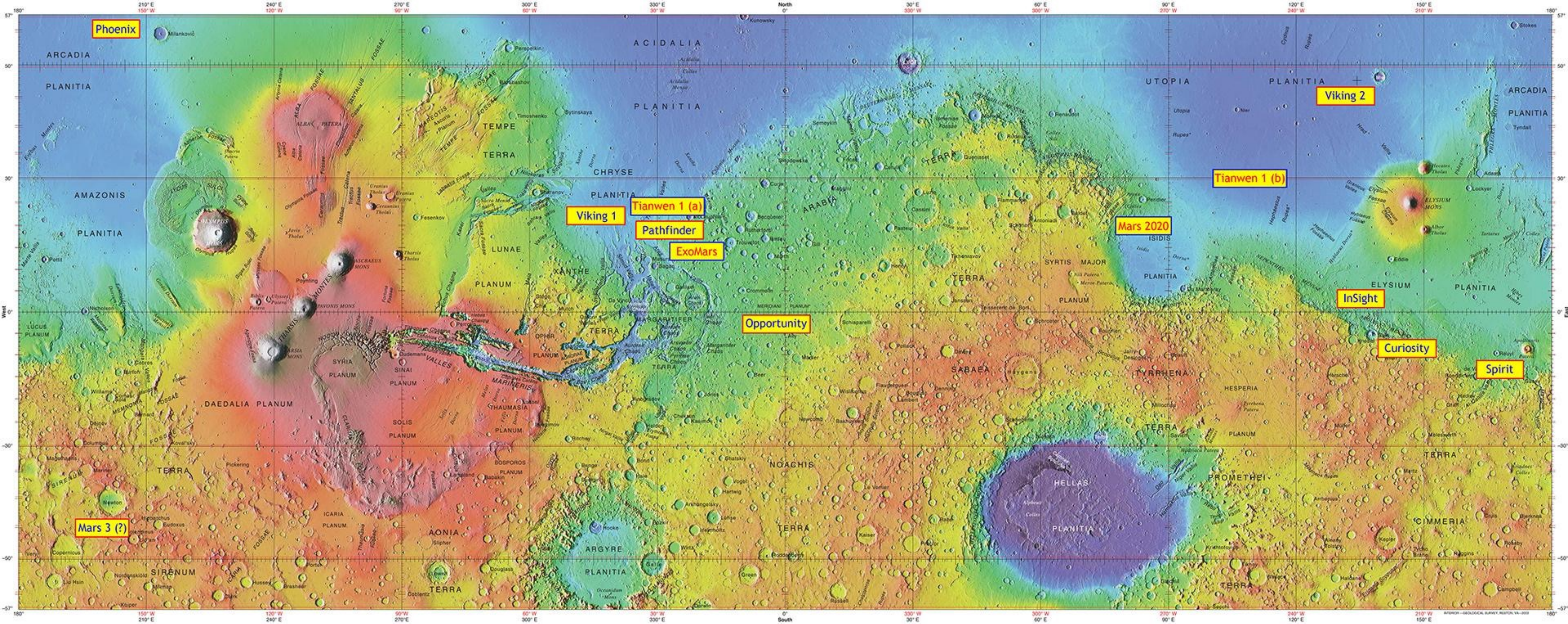


Modern Mars



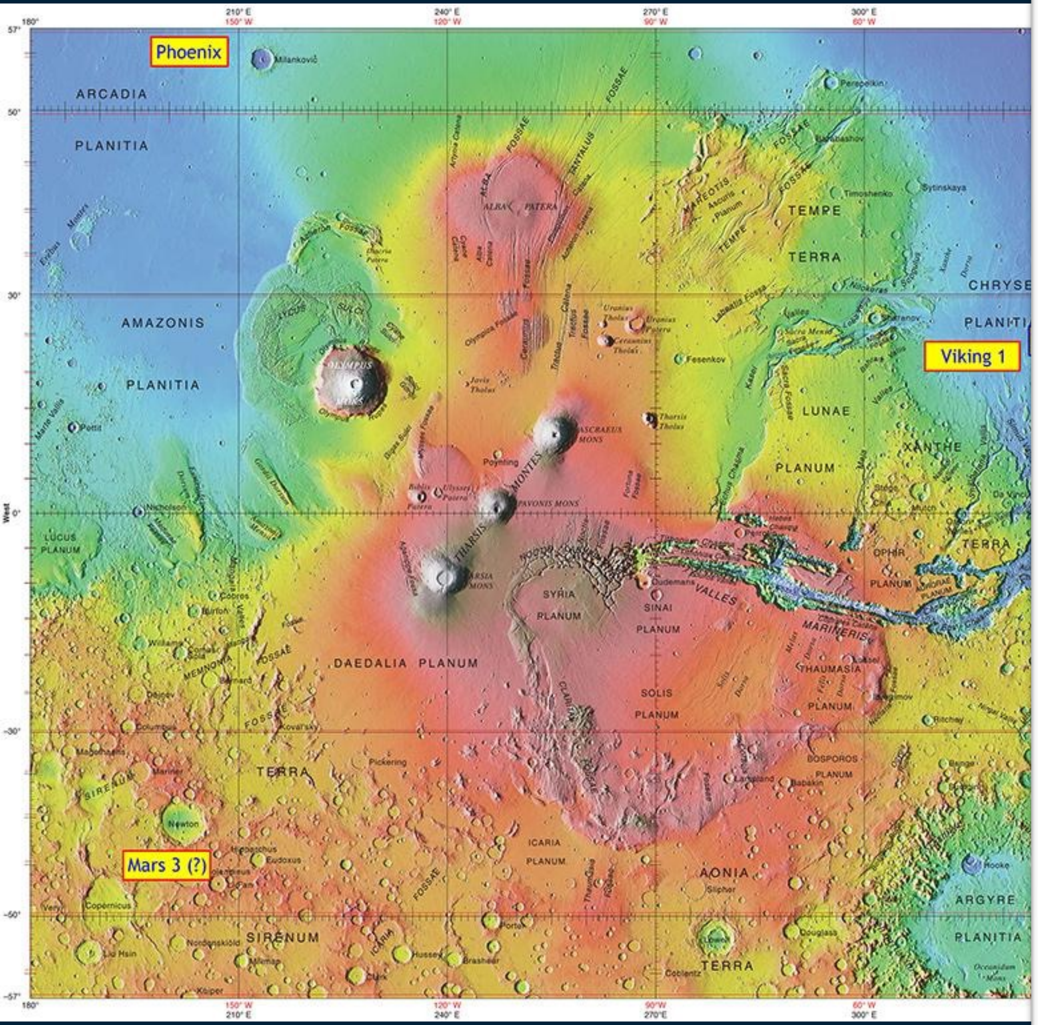
Mars ~ 3.6 billion years ago (?)

Jezero Crater: Perseverance's Field Site

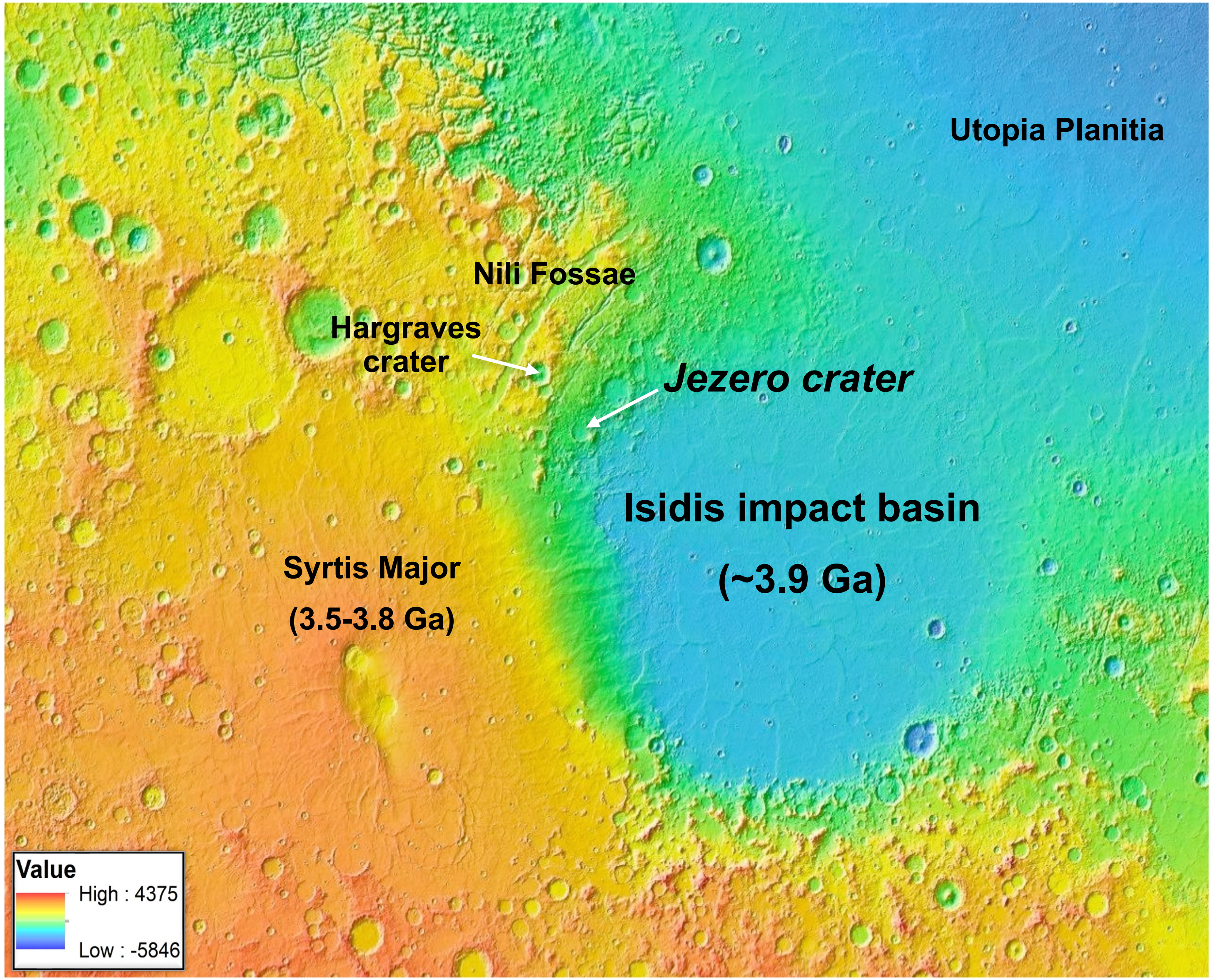


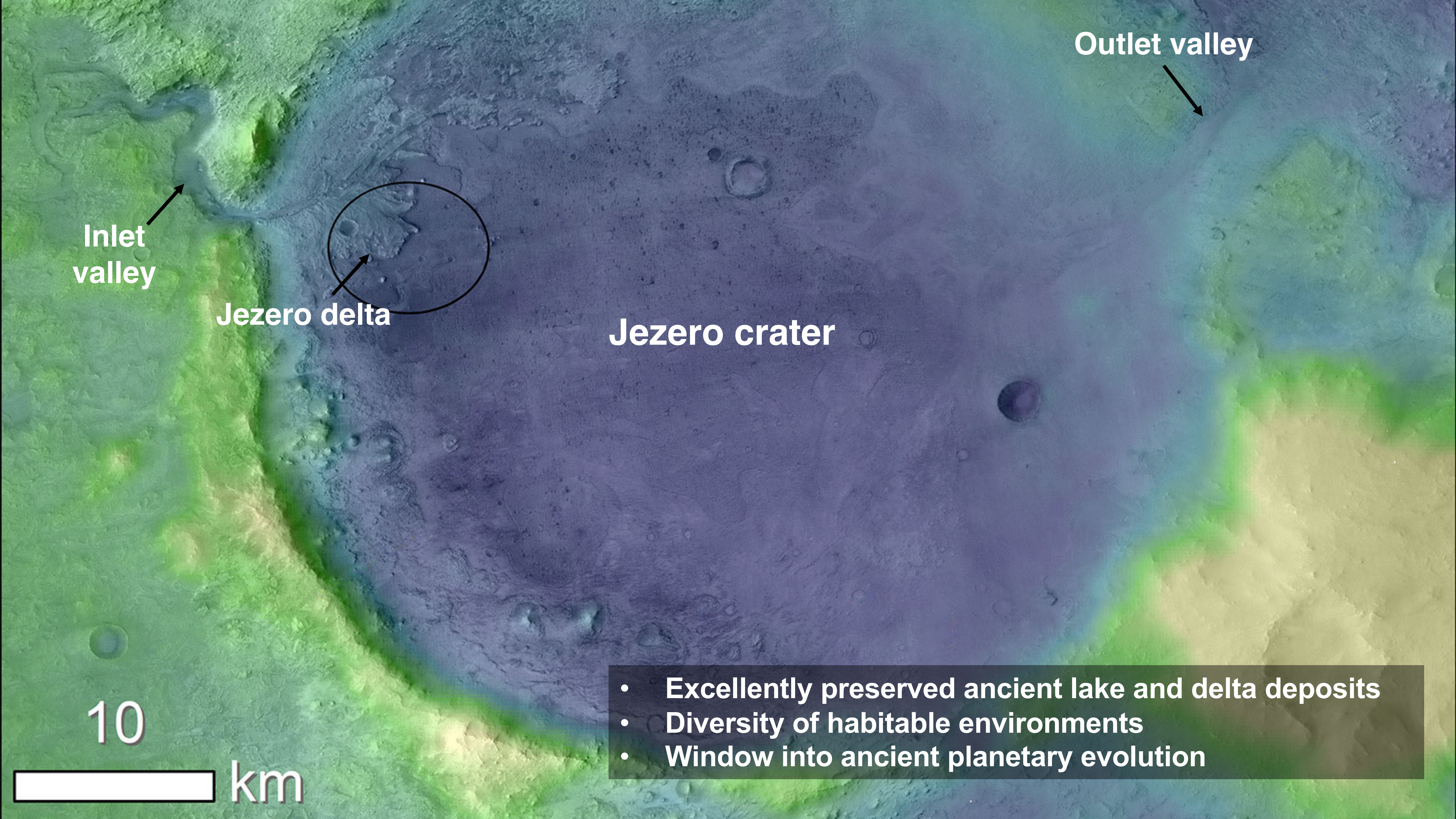
NASA/JPL/USGS-MOLA;DLR

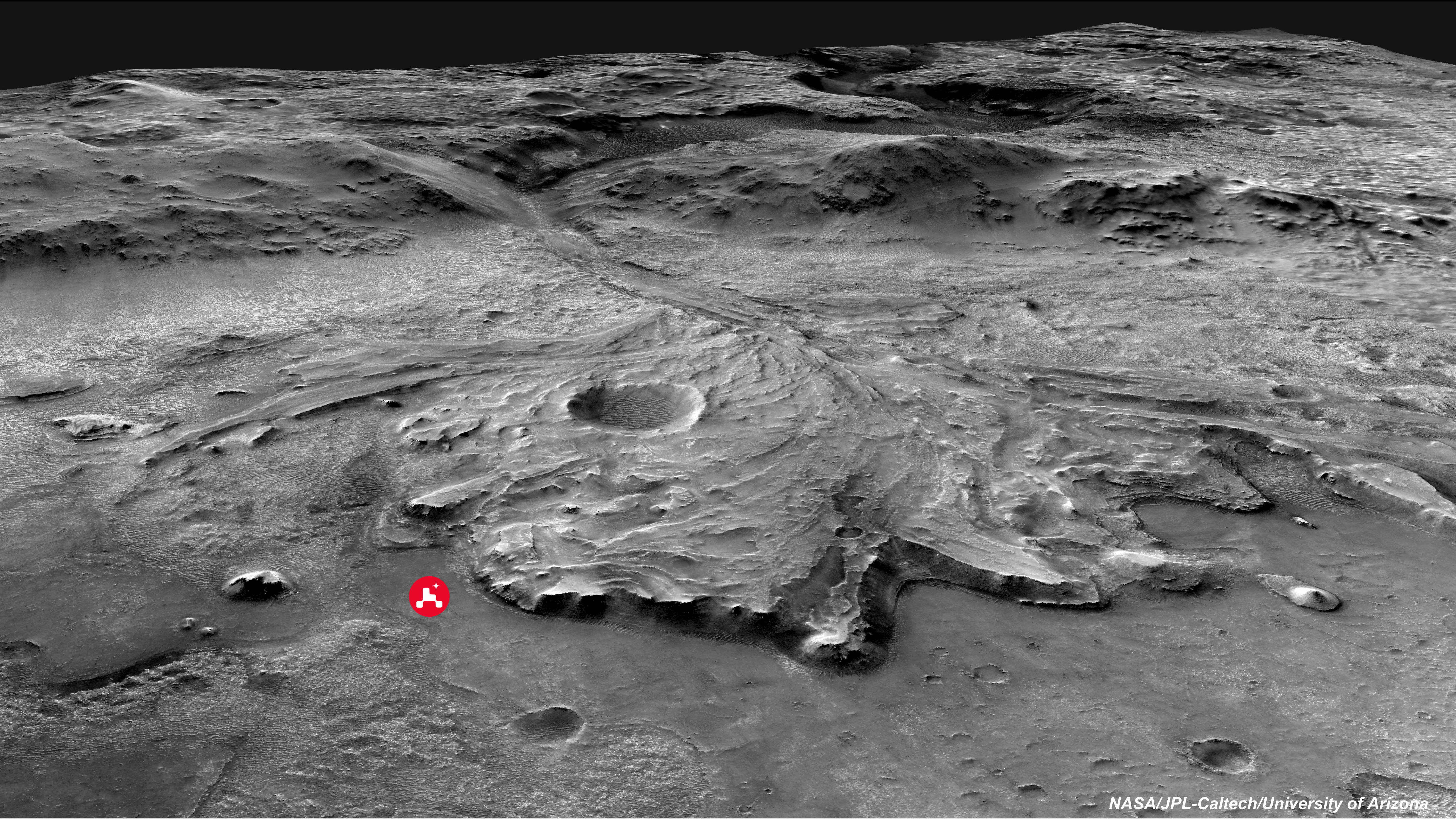
Jezero Crater: Perseverance's Field Site



NASA/JPL/USGS-MOLA;DLR




Outlet valley
Inlet valley
Jezero delta
Jezero crater
• Excellently preserved ancient lake and delta deposits
• Diversity of habitable environments
• Window into ancient planetary evolution
10 km


NASA/JPL-Caltech/University of Arizona

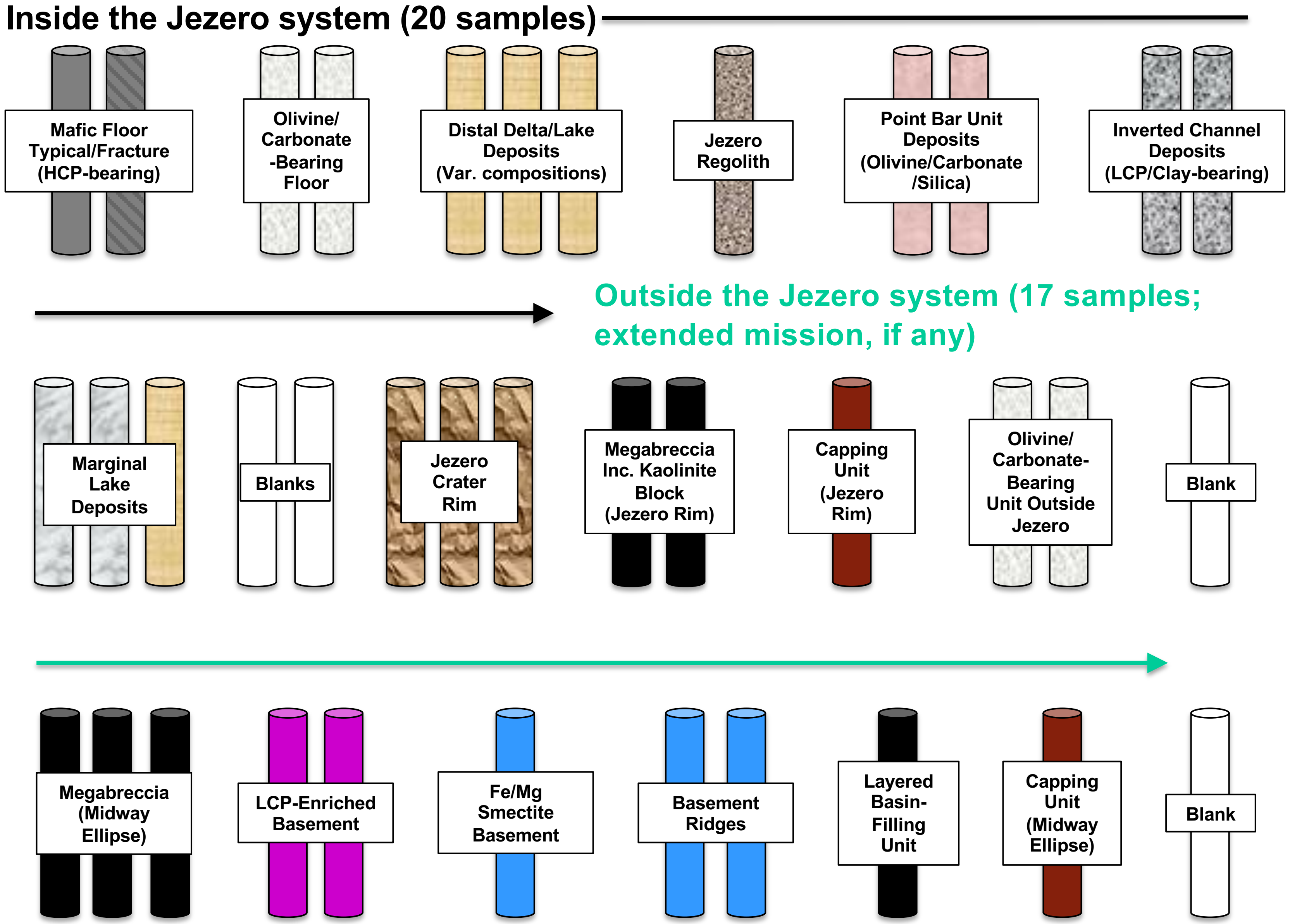
River Deltas Record Local and Remote Signals

Alaska runoff, NOAA

What Perseverance *might* cache…

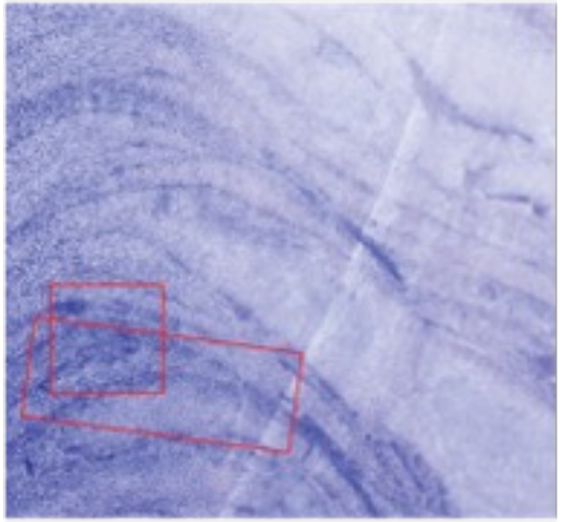
(plus atmospheric and witness)

<u>Sample Diversity</u> is key to a valuable cache



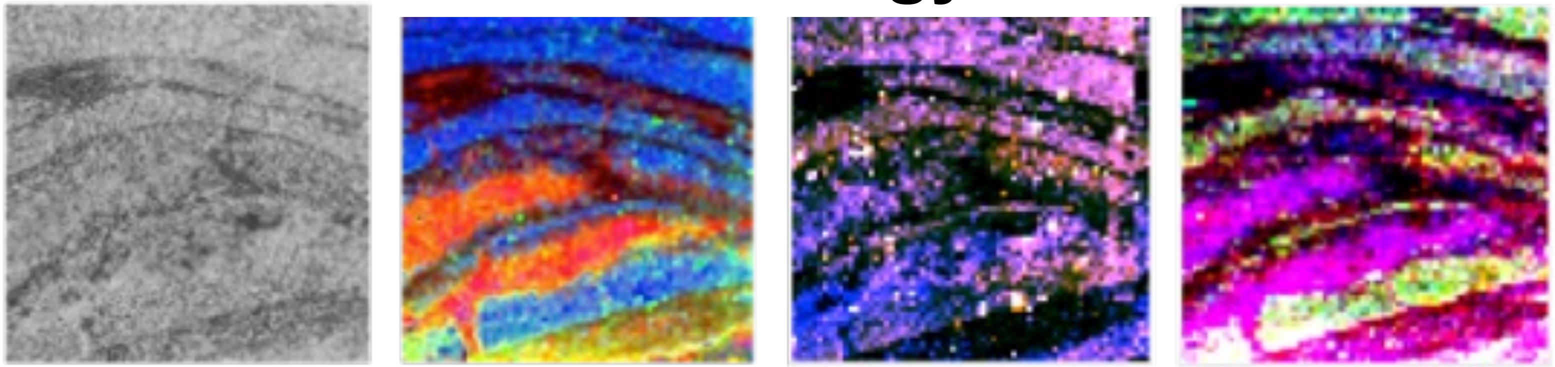
Adapted from Ken Farley (CAPS, 2019)

On-board Instruments Provide Context



2.72 Ga Stromatolites (Fortescue Gp., Western Australia)
Above: outcrop. Below: cut slab

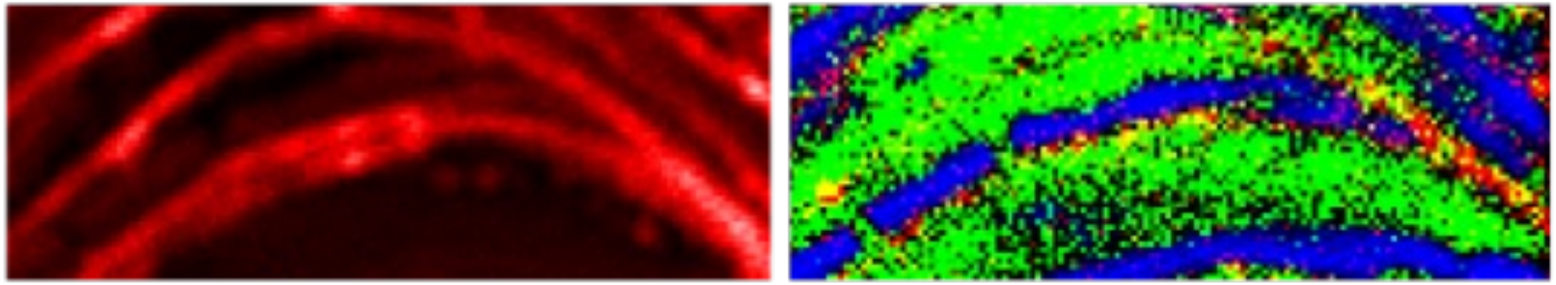
Mineralogy



Context

Chert OrganicsDolomite

Elemental Chemistry



Fe intensity

Ti Si Ca intensity


National Aeronautics and
Space Administration

Mars 2020 / Perseverance

First Step of a Mars Sample Return Campaign

George Tahu

Mars 2020 Program Executive

May 4 and 5, 2022

Mars Sample Return Campaign

Previously Covered under Mars2020 NEPA

Tier I – Programmatic Analysis (Flight and Ground Elements)

Tier I – Site Specific Analysis Flight Elements

Tier II – Site Specific Analysis Ground Elements

1

Sample Caching

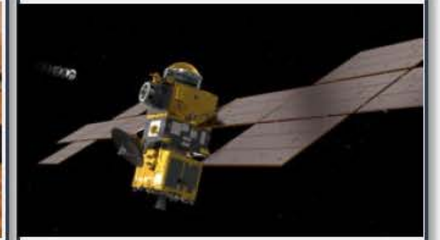
- *Collect samples of rock and sediment*
- *Cache samples on the surface for retrieval*

2/3

Sample Retrieval

- *Retrieve samples cached by Mars 2020 rover*
- *Launch samples into orbit around Mars*

4



Earth Return

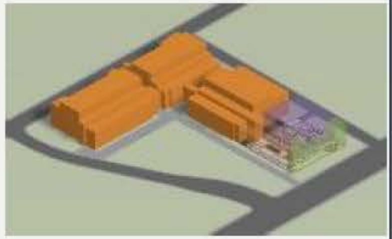
- *Capture and contain samples in Mars orbit*
- *Safely return samples to Earth for recovery at landing site*

5

Sample Transportation

- *Transport contained samples to Sample Receiving Facility*
- *Over the road and/or aircraft*

6



Sample Receiving

- *Safety assessment and sample containment*
- *Initial sample science and curation*

MSR Campaign Flight Elements

MSR Campaign Ground Elements

Long-term Curation & Science Investigations NASA/ESA

Time

Pre-decisional information for planning and discussion purposes only.

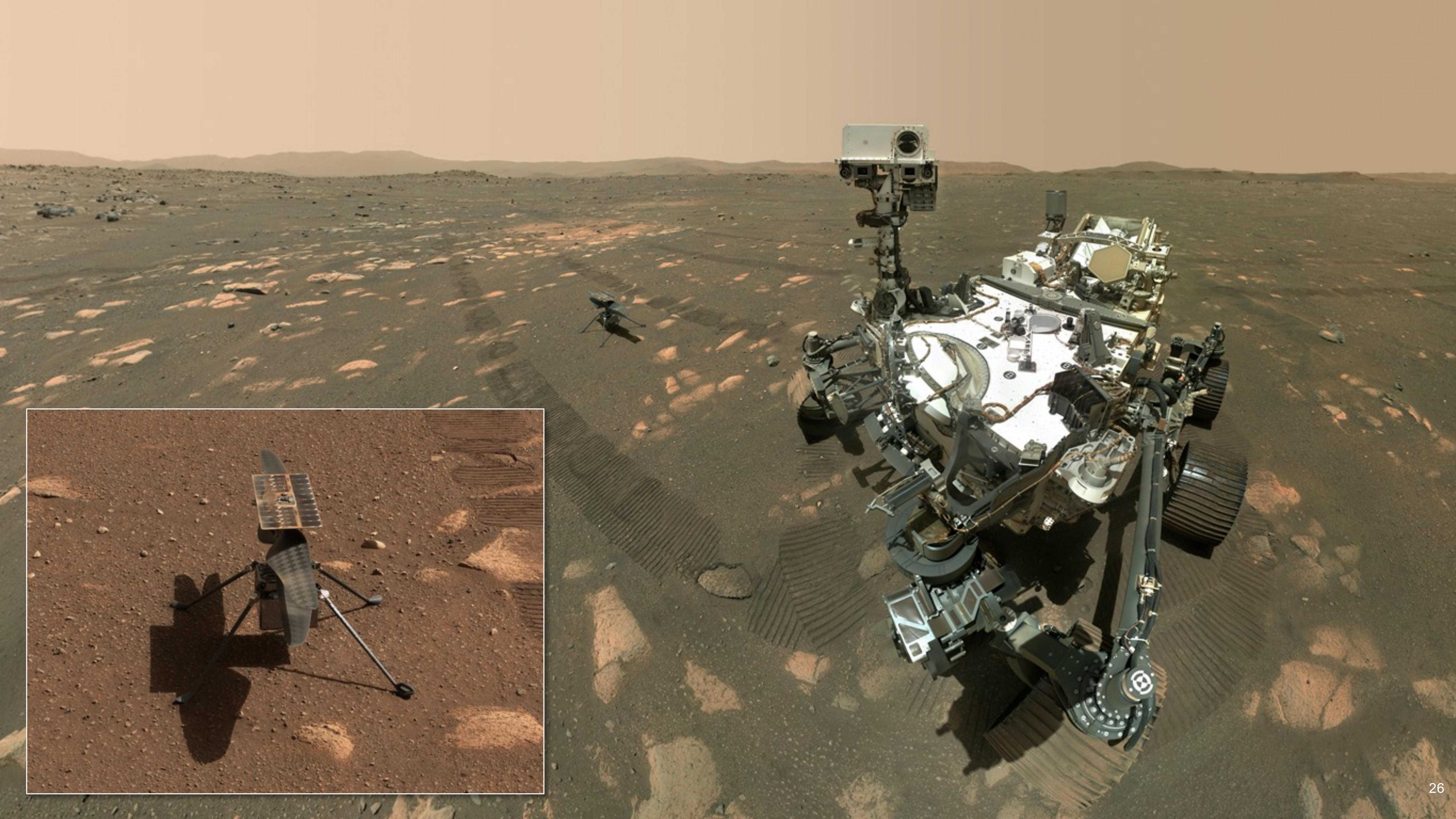
Mars 2020 / Perseverance - Atlas V Launch
July 30, 2020

Landed February 18, 2021

First image ever of a spacecraft landing on another planet

NASA/JPL-Caltech

Watch the landing video here:
https://mars.nasa.gov/resources/25628/perseverance-rovers-descent-and-touchdown-on-mars-onboard-camera-views/



MARS 2020: coring and caching

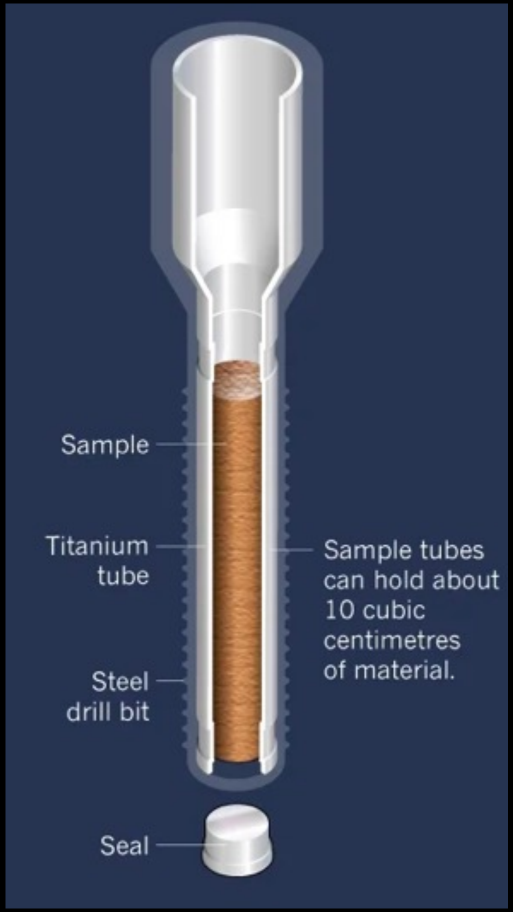
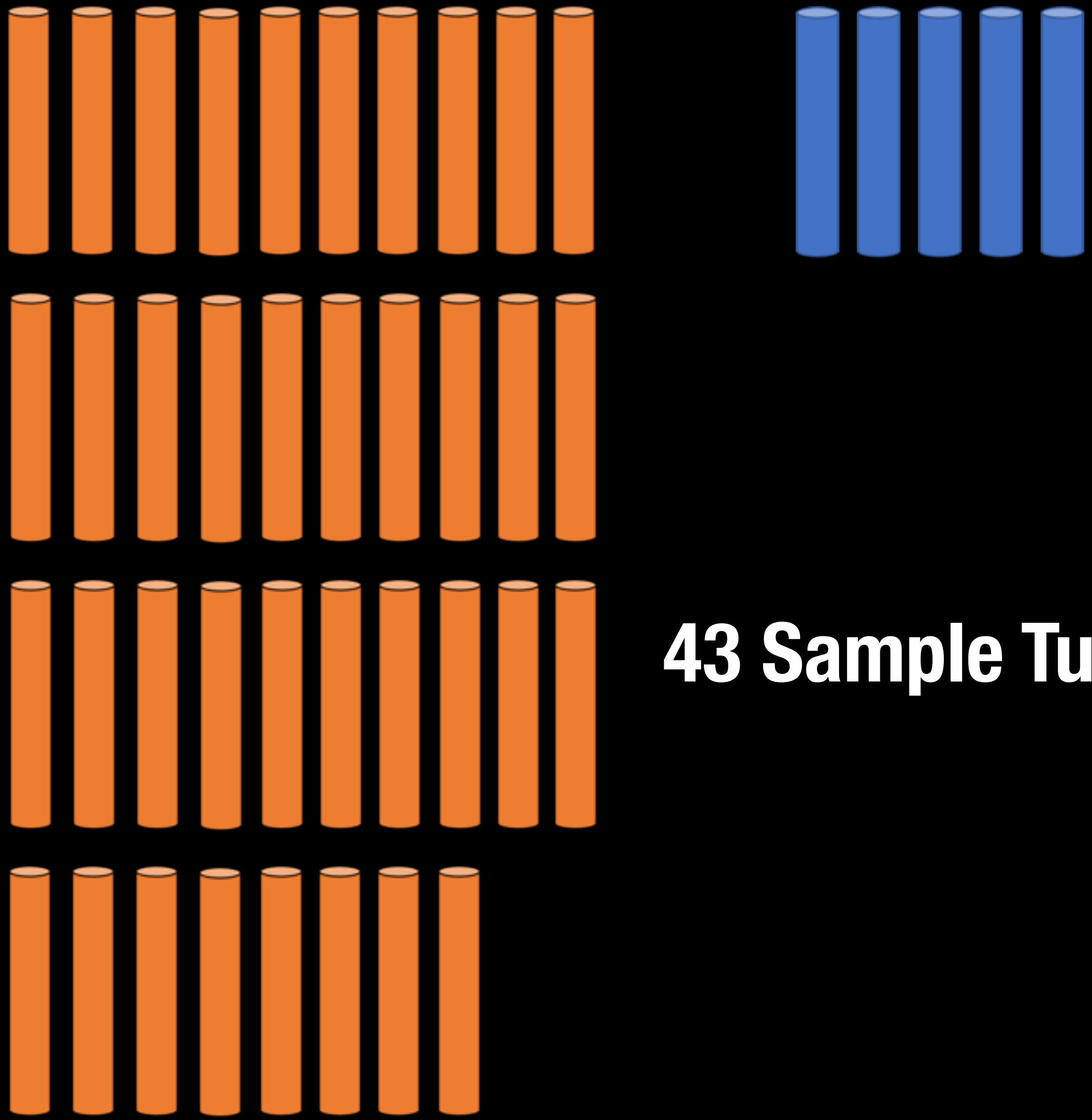


Image credit: Nature

NASA/JPL-Caltech

38 Tubes for Rock and Regolith

5 Witness Tubes

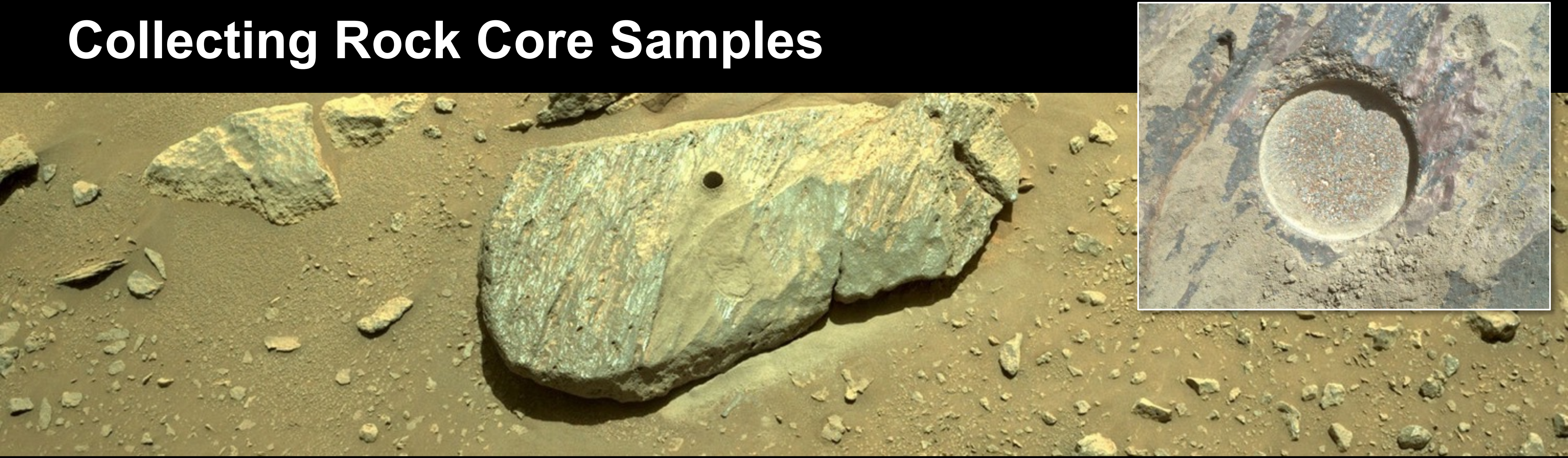


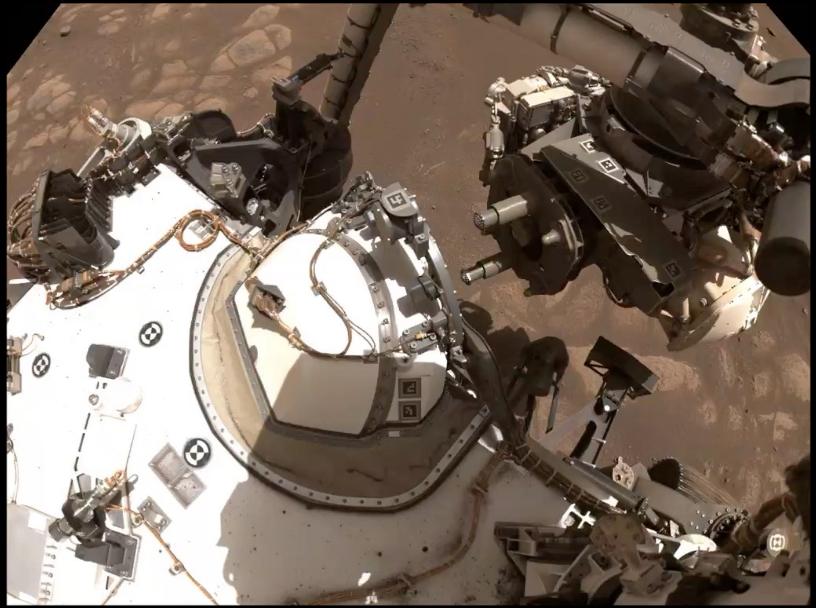
43 Sample Tubes

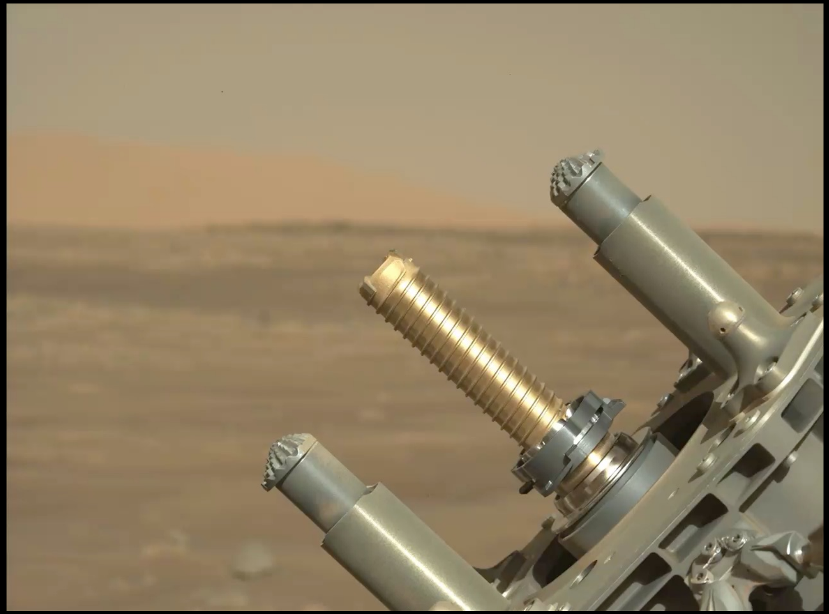
Robotic Arm Science

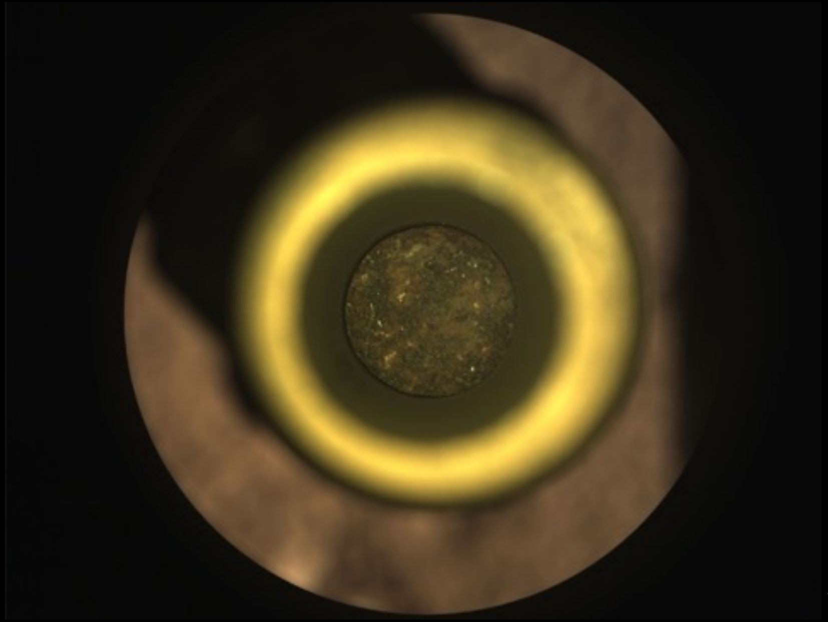
Hazcam sequence - Sol 138 – July 10, 2021

Collecting Rock Core Samples

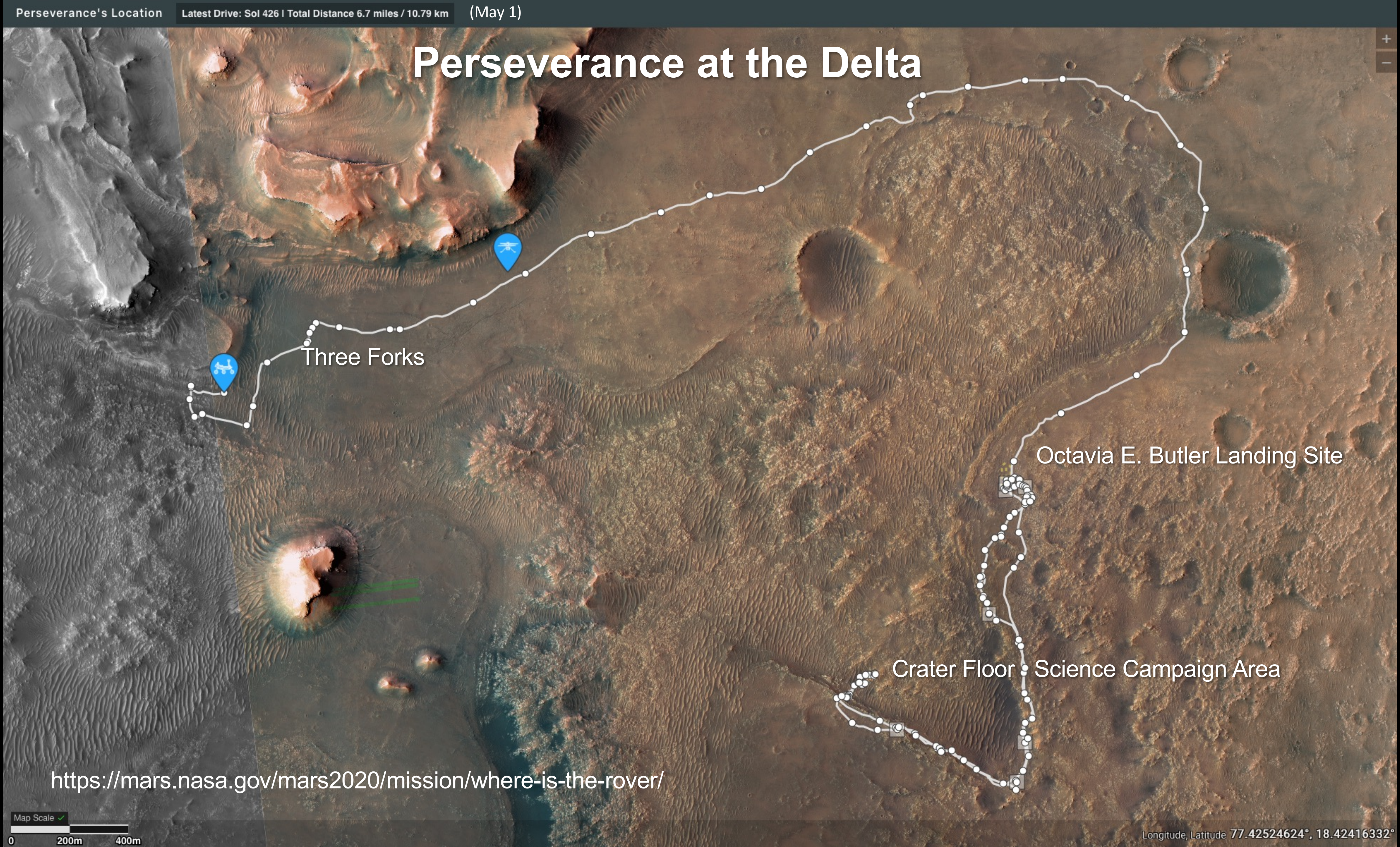






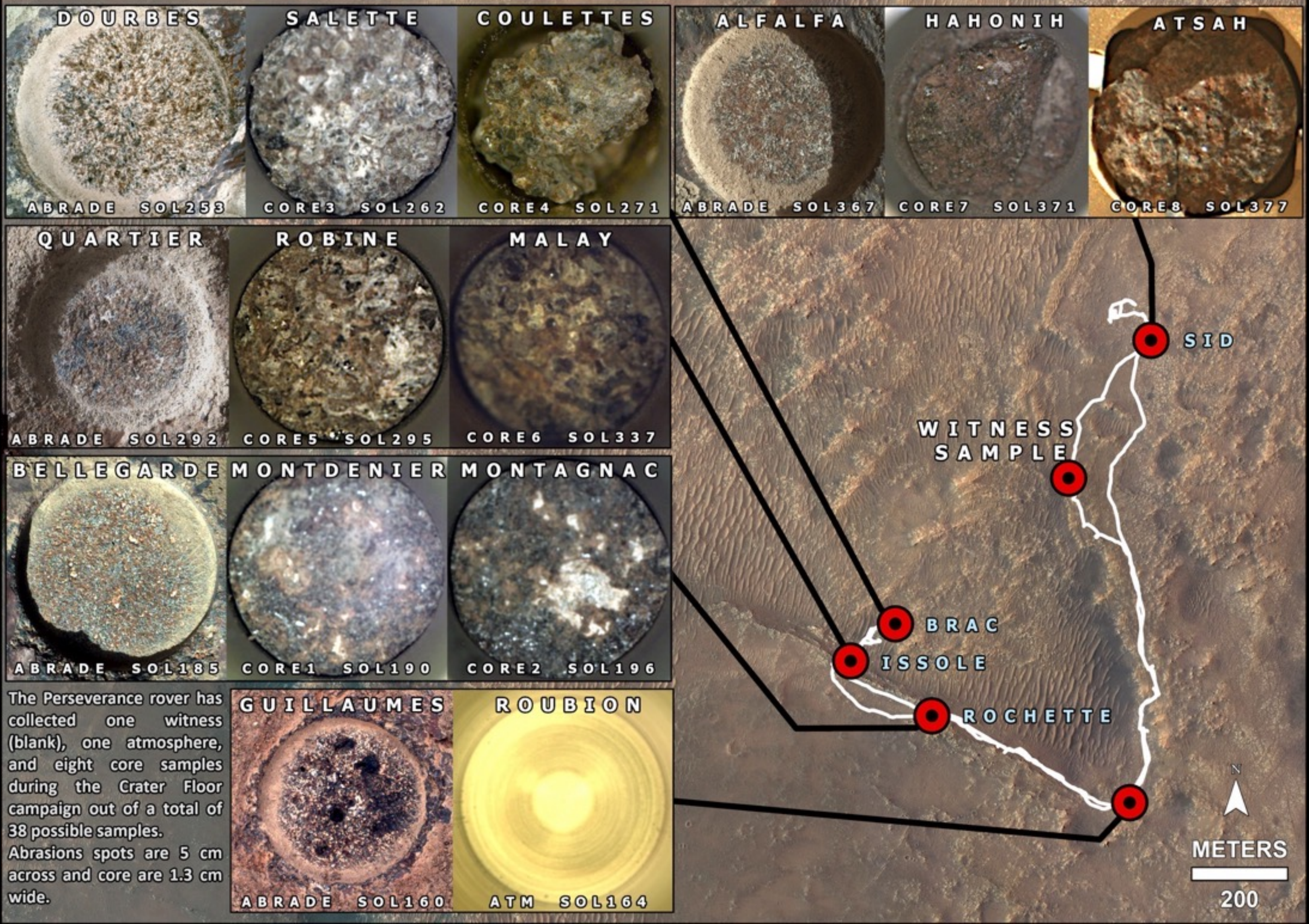


Perseverance at the Delta



https://mars.nasa.gov/mars2020/mission/where-is-the-rover/

Sample Collection Map: Cores 1-8



The Perseverance rover has collected one witness (blank), one atmosphere, and eight core samples during the Crater Floor campaign out of a total of 38 possible samples. Abrasions spots are 5 cm across and core are 1.3 cm wide.

Mars Sample Return Overview

Joe Gasbarre

MSR Deputy Program Director - Technical

May 4 and 5, 2022

Mars Sample Return Campaign

Previously Covered under Mars2020 NEPA	Tier I – Programmatic Analysis (Flight and Ground Elements)			
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- *Retrieve samples cached by Mars 2020 rover*
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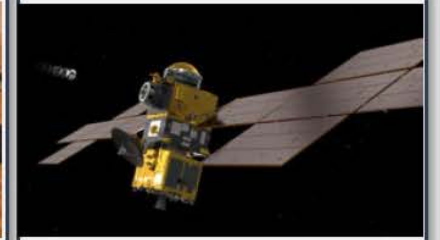

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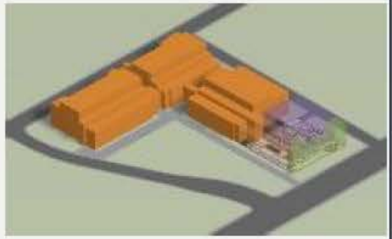


Sample Receiving

- *Safety assessment and sample containment*
- *Initial sample science and curation*

MSR Campaign Flight Elements

MSR Campaign Ground Elements

Long-term Curation & Science Investigations NASA/ESA

Time

Pre-decisional information for planning and discussion purposes only.

What is the Mars Sample Return Program?

The Mars Sample Return Program (MSR) is an ambitious, international science mission to collect and return rock and sediment samples from the Martian surface.

It has been a priority of the past three National Academy Decadal Surveys

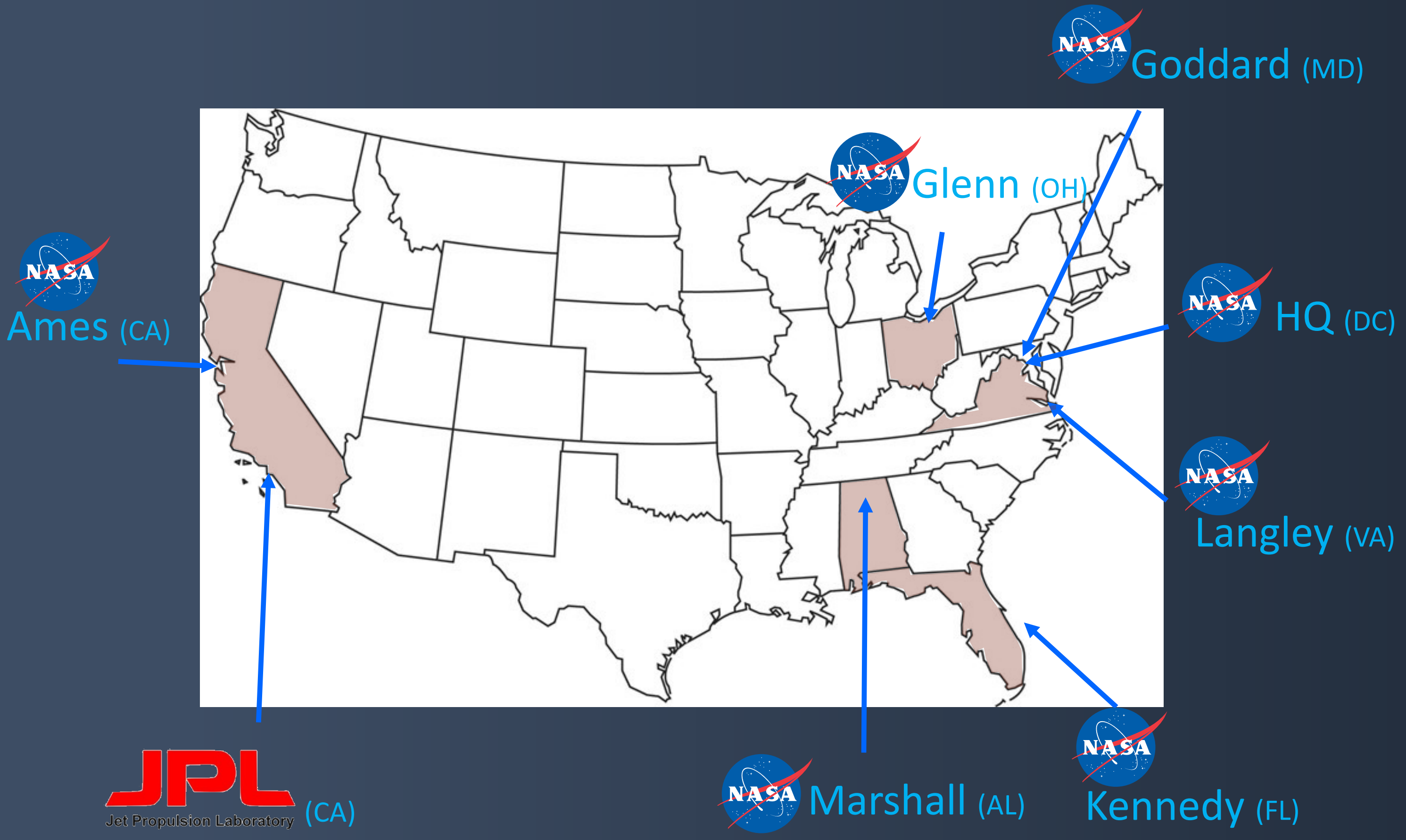
It will be the first “round-trip” to another planet, paving the way for future human exploration

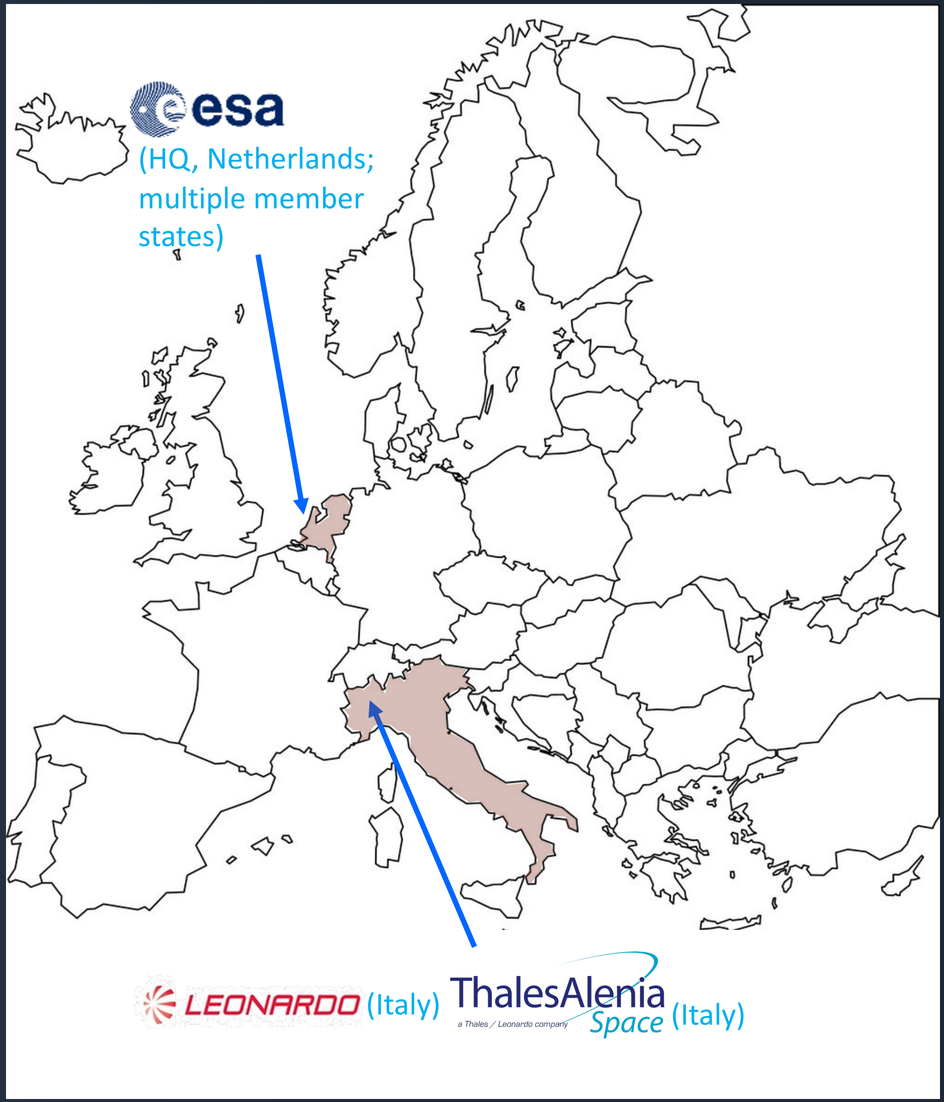
MSR is a complex mission.

Requires a set of capabilities that were not demonstrated 20, or even 10, years ago.

It is only possible today as a result of the investments and accomplishments made through the formulation, technology and operational projects of the past decades, coupled with a strong international partnership with the European Space Agency (ESA).

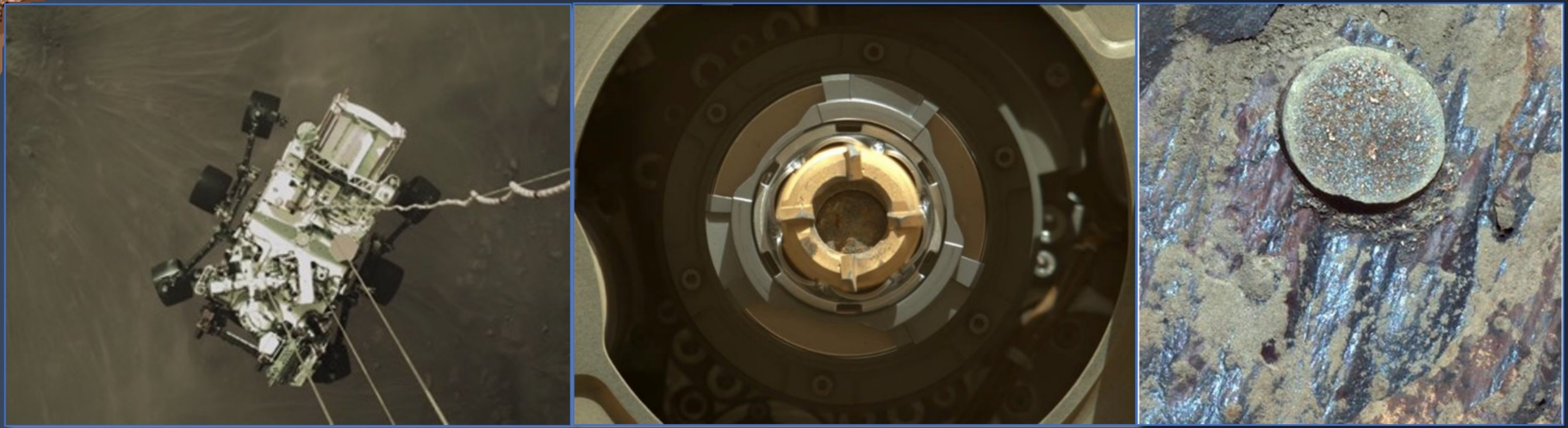
Organizational Map



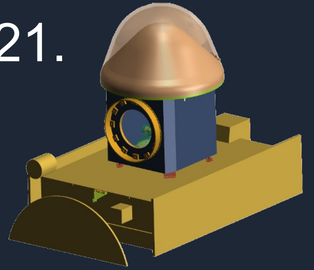


This presentation contains pre-decisional information for planning and discussion purposes only.

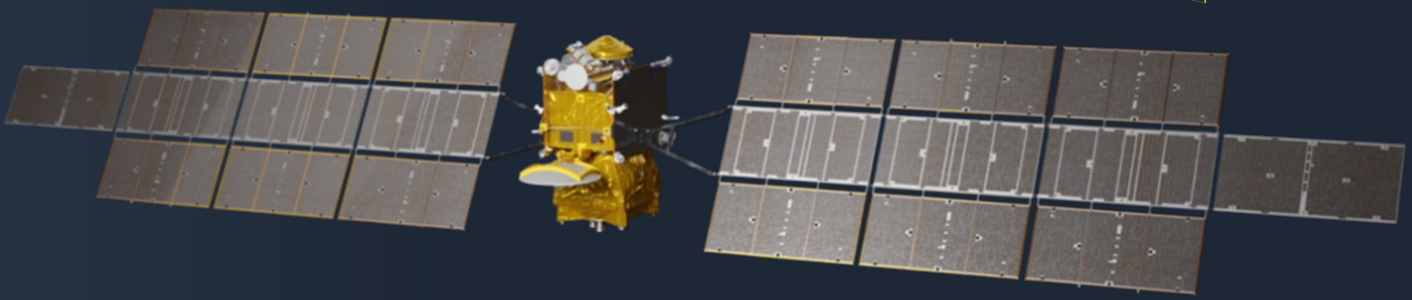
When is MSR Happening?



February 2021: NASA's Perseverance Rover landed on Mars in February 2021. It is collecting samples that could be returned to Earth.

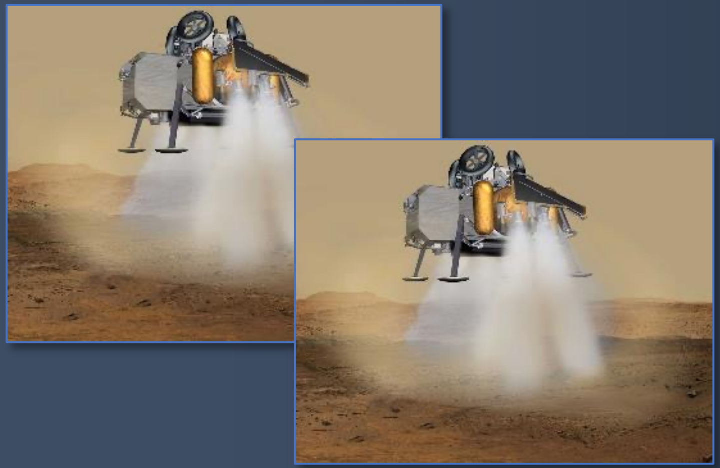


2027: ESA's Earth Return Orbiter would launch to Mars. Its payload is the NASA-provided Capture, Containment, and Return System (CCRS). It would receive the Martian samples and return them to Earth.

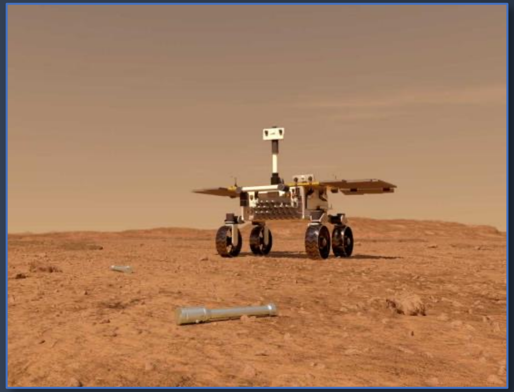


When is MSR Happening (continued)?

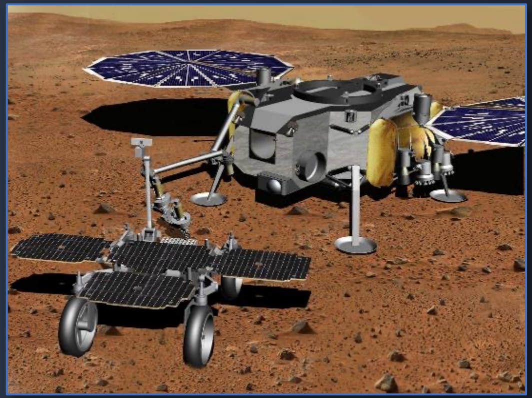
Lander(s) Touch Down



Samples are retrieved (Sample Tubes)



Tubes Are Transferred To MAV

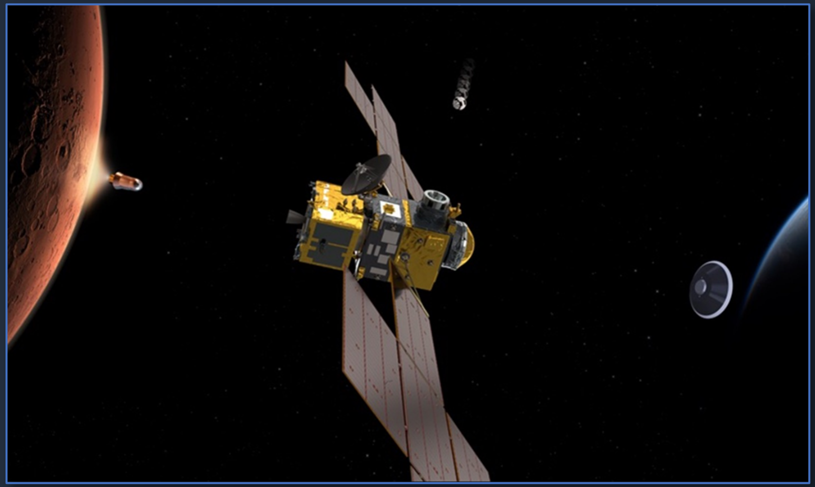


MAV Launches With Samples

2028: The Sample Retrieval Lander(s) would launch to Mars.

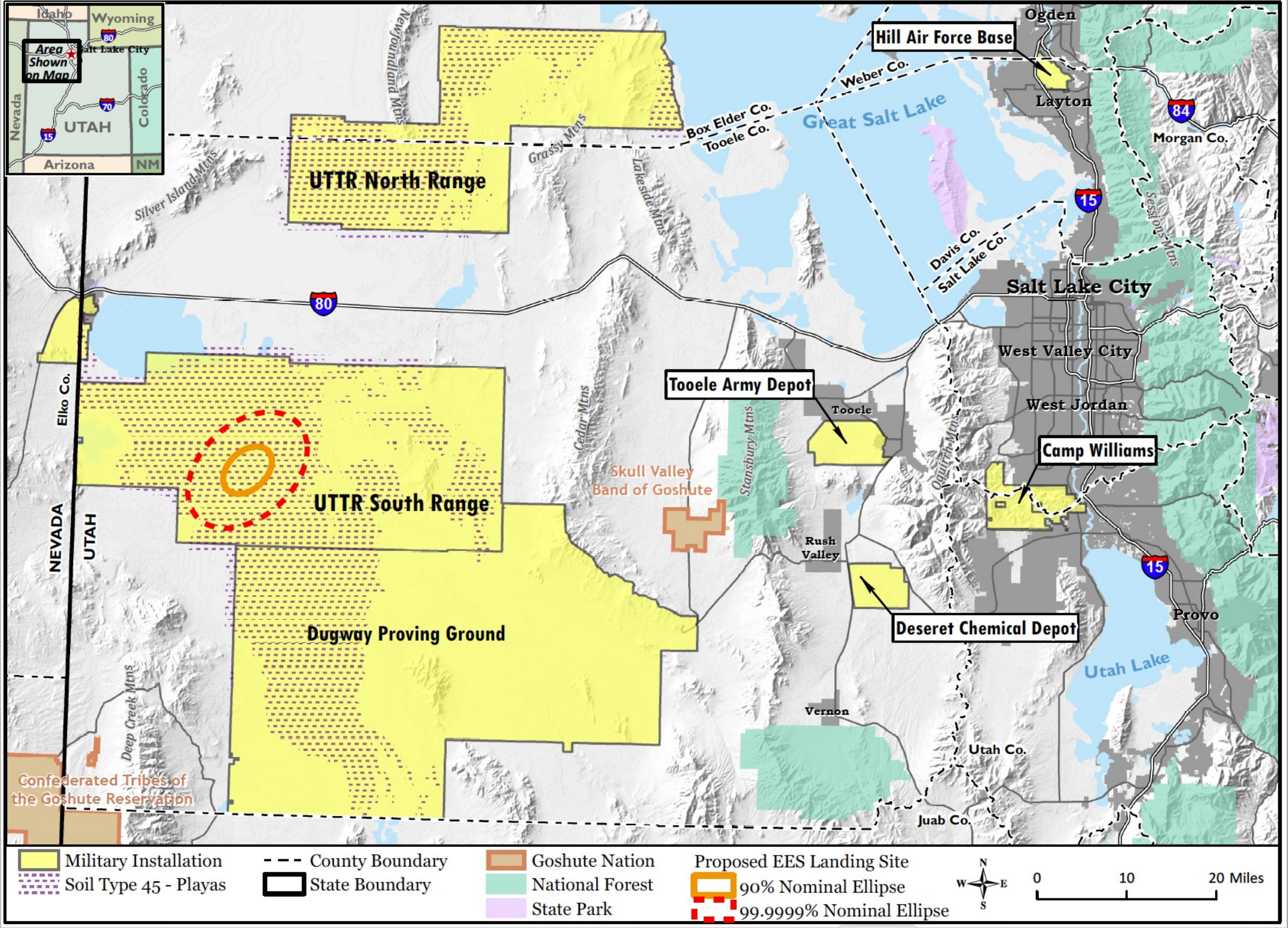
2030: Samples would be retrieved and launched off the Martian surface, then captured by the Earth Return Orbiter with its Capture-Containment-Return Payload. The ERO begins its journey back to Earth.

2033: The samples would touch down at the Utah Test and Training Range. Samples are collected for scientific handling.



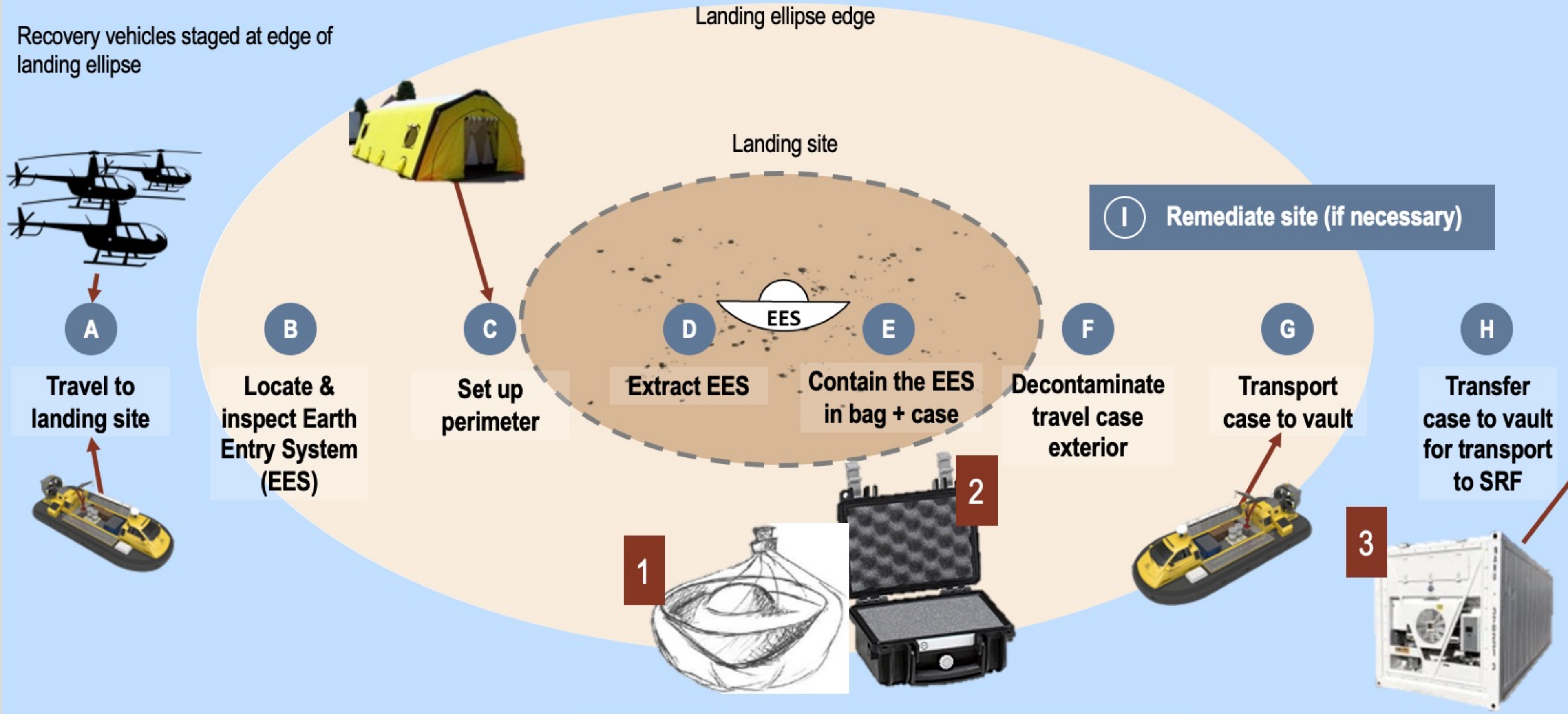
Proposed Earth Entry System (EES) Landing Site

Utah Test & Training Range (UTTR)



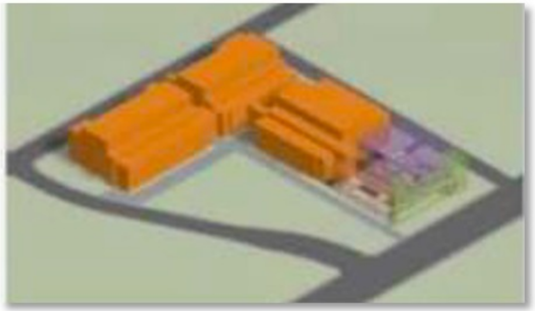
Pre-Decisional Information -- For planning and discussion purposes only.

Ground Recovery Concept of Operations



Three-Element Containment Approach	Element
	1. Biosafety Bag
	2. Travel case (2 x 2 meters in size)
	3. Vault for highway transport

Sample Receiving Facility (SRF)



- *EES disassembly and inspection*
- *Containment and environmental control*
- *Sample handling, safety assessment, and initial science investigations & curation*

EES Manufacturing Demonstration Unit #1 (MDU1) Drop Test

Utah Test and Training Range
March 1, 2022

NASA / USAF Team Photo

EES Manufacturing Unit #1 Drop Test Video

Drop Altitude: ~1000 ft
Terminal Velocity at Impact: ~33 m/s / ~74 mph

Utah Test and Training Range – March 1, 2022

Welcome

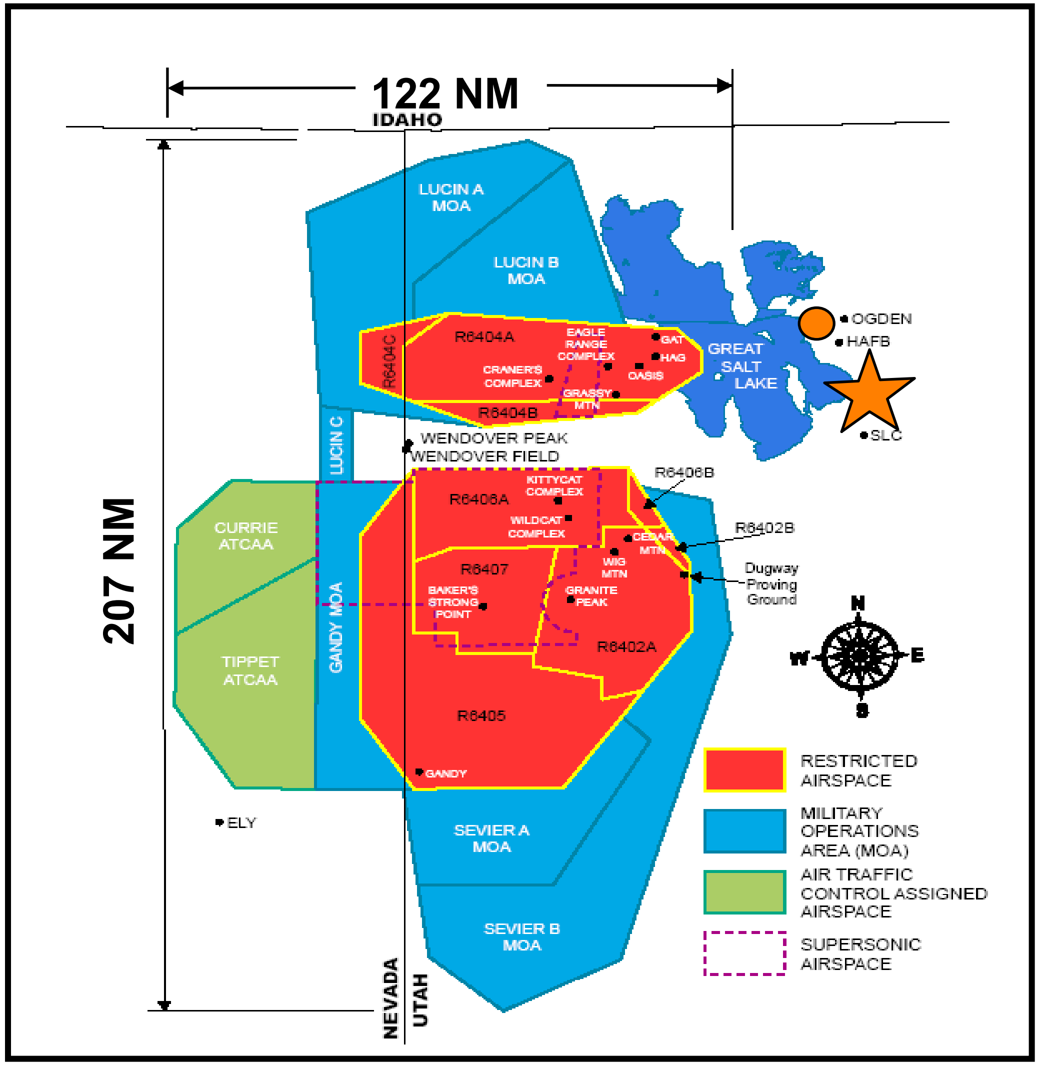
The overall classification of this briefing is: **UNCLASSIFIED**

Lt. Col. Jason Chugg
HQ UTTR / Director of Staff

"Providing war fighters with a realistic training environment and provide **test and evaluation of overland, large footprint weapons** to enhance combat readiness, superiority, and sustainability."

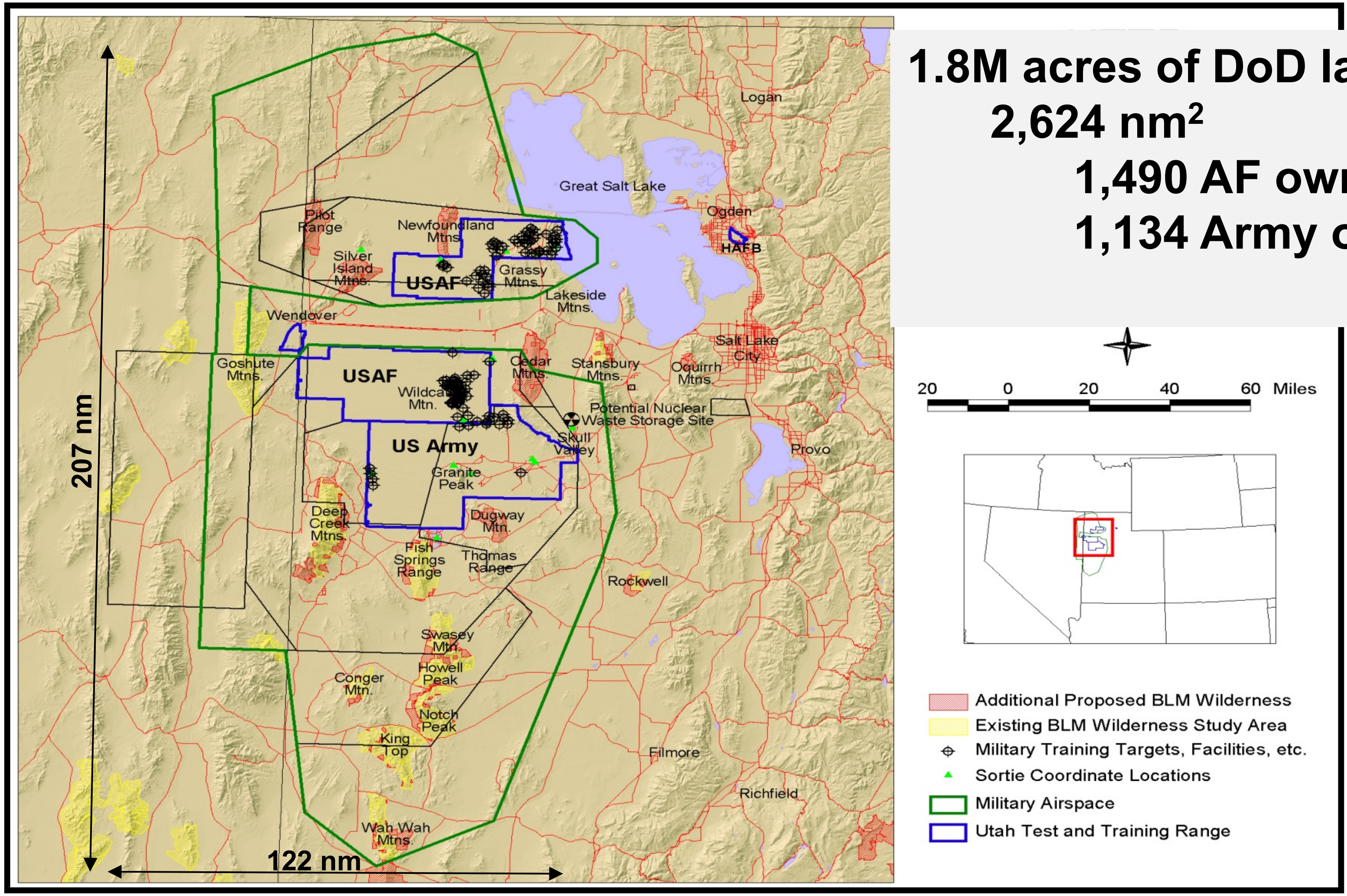
We Train Warriors and Test Weapons…

UTTR Airspace



Total airspace
19K sq nm
Restricted airspace
6K sq nm

DOD Land



1.8M acres of DoD lands

2,624 nm^2

1,490 AF owned

1,134 Army owned

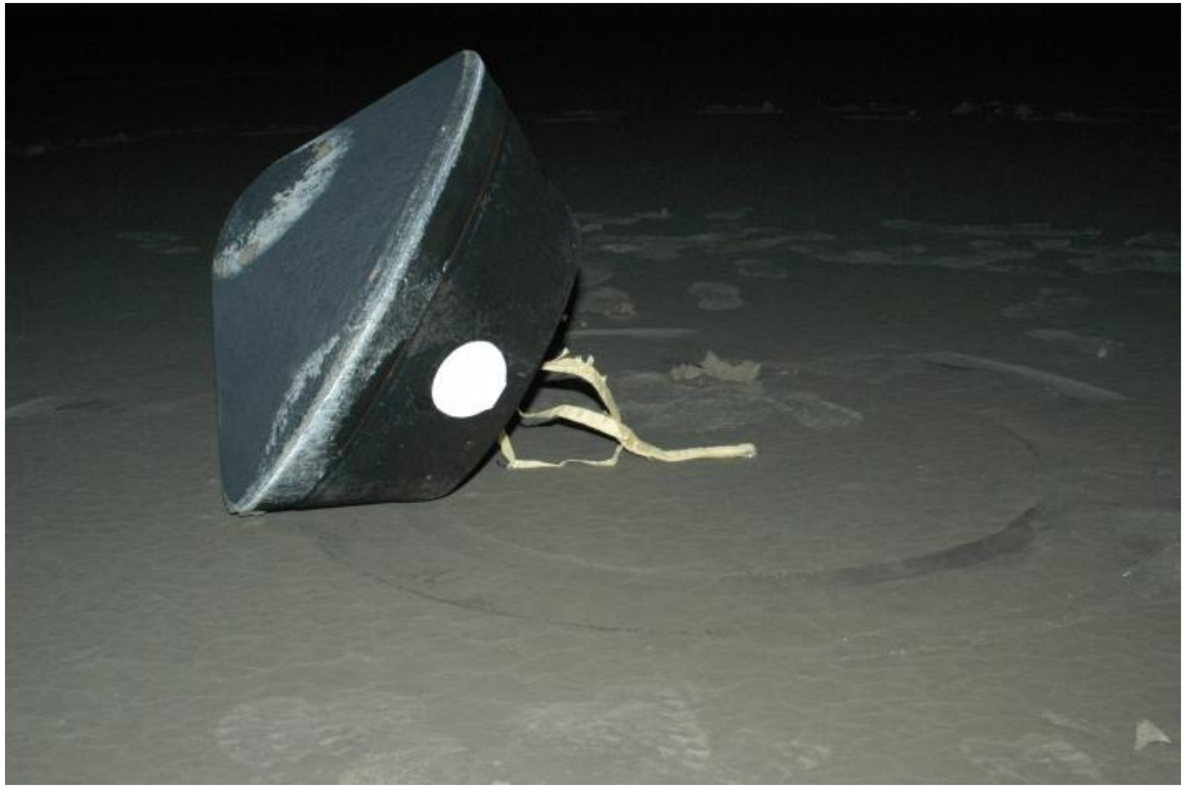
Capabilities

Libertas Vel Mors

- **Mission Assets**
  - **Mission Control Center - MCC** (T&E C2)
  - **Air Operations Center – AOC** (Training and T&E C2)
  - **3x ASR 9s** (TSPI)
  - **2x RIR-980s** (TSPI)
  - **Cine-Ts** (TSPI)
  - **9x TM Sites** (L / S / C / P Bands)
  - **Air Combat Training Systems** (P-5 / ARDS)
  - **Communications**
    - **Microwaves**
    - **Fiber**
    - **Radios** (G-A / S-S)
  - **TDLs** (Link-16 / SADL / LMS-16 / BOSS)
  - **VCAS / VMAS and Differential GPS Survey**
  - **Weapon Impact Scoring System**
  - **EW Systems** (DIADS / MUTES / MM / JTE / JTE-WB / Expendable)
  - **FTS / EFTS**
  - **FCA** (20 MHz – 18 GHz)
  - **Varying Target Complexes**

Fully Instrumented Test Range…

Questions



NASA Stardust comet sample return capsule after landing at UTTR

Mars Sample Return Safety

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Mars Sample Return Safety

MSR has two primary safety goals

- Maintain safe spacecraft operations – *protect people and property by landing in the safe target zone*
- Adhere to Planetary Protection policies – *protect Earth’s biosphere from any potential hazards posed by Mars material*

What is Planetary Protection?

Planetary Protection (PP) refers to spacecraft cleanliness and containment standards established by NASA to ensure science success and safety

Forward PP Goal: Prevent Earth life from interfering with our understanding of other planets

- *Guiding principle: Maintain our ability to detect signs of life beyond Earth*
- *Key strategy: Keep spacecraft biologically clean*

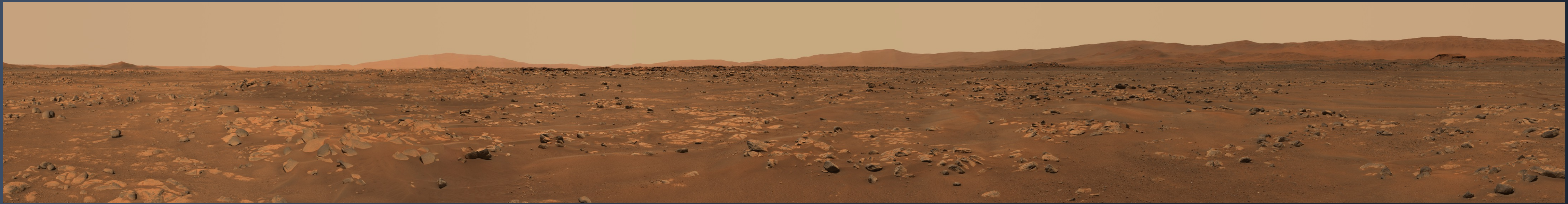
Backward PP Goal: Protect our biosphere from any potential hazard posed by extraterrestrial materials brought to Earth

- *Guiding principle: Safety First*
- *Key strategy: Contain or sterilize all material delivered from planets that may harbor life until the material is demonstrated to be safe*

Assessing Planetary Protection Risks

What is the potential hazard to Earth? *Extremely low*

- Several U.S. and international scientific panels have found that Mars samples have a low likelihood of risk
- Perseverance is sampling cold, very dry and highly irradiated areas on Mars; conditions inhospitable to biological and biochemical activity
- Mars rocks have landed on Earth as meteorites without any apparent adverse effects to our biosphere



What is the best approach? *Safety first*

- ‘Break the chain of contact’ between Mars and Earth
- Contain unsterilized Mars material before leaving for Earth
- Maintain robust containment through landing

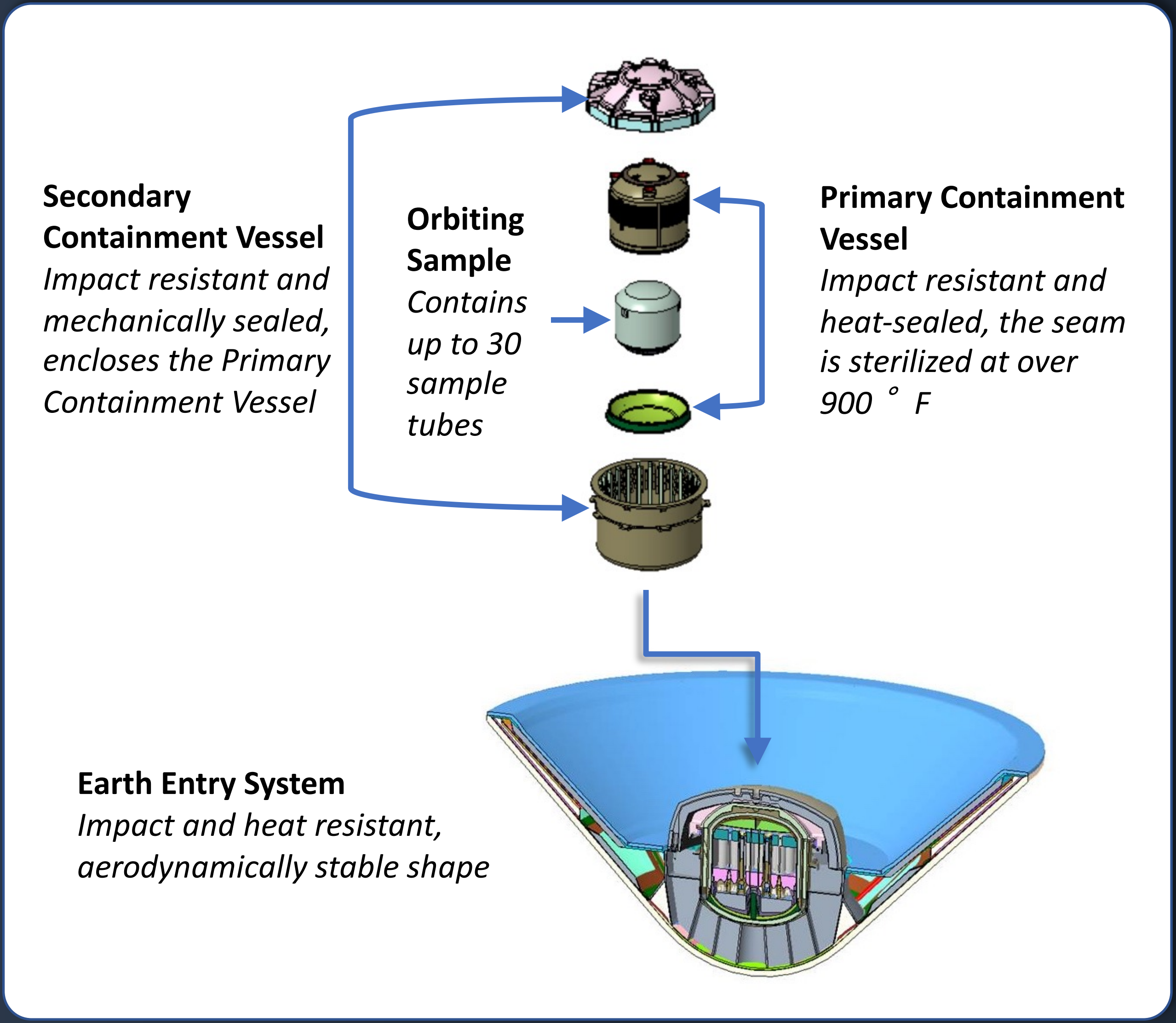
Safety Step 1: Contain and Sterilize

MSR "Breaks the chain of contact" with Mars

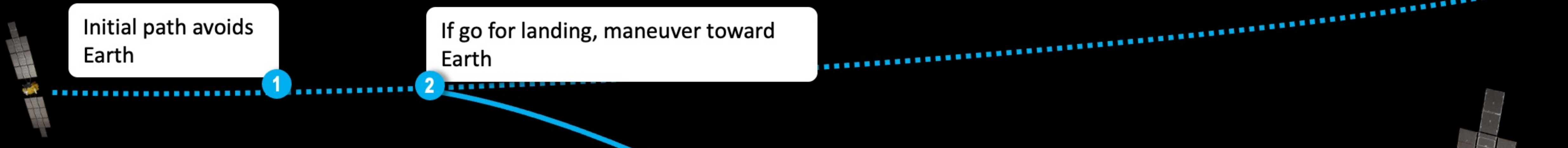
- Ensures Mars material is either contained within multiple layers or sterilized before leaving for Earth

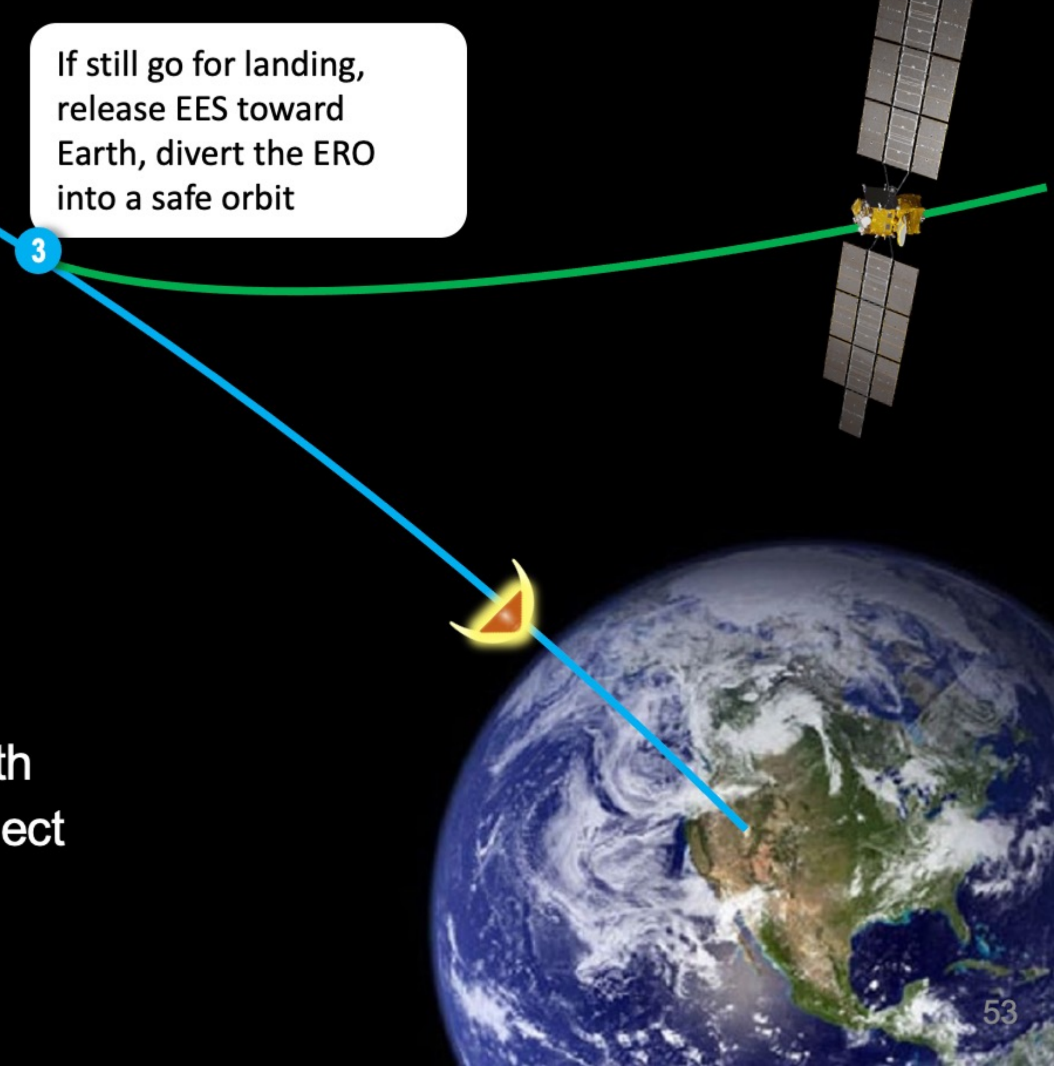
Containment in a "container within a container" is completed in Mars orbit

- Containment begins after the ERO captures the Orbiting Sample and is confirmed before leaving Mars orbit
- All hardware that has contacted Mars is heat-sealed in a primary containment vessel, sterilizing the seam
- The primary containment vessel itself is placed inside a secondary containment vessel
- The two containers are then placed inside the Earth Entry System



Safety Step 2: Approach, Deliver, and Divert





Best practice: Don't point!

- The ERO remains pointed away from Earth until six days before the EES landing
- The ERO is monitored constantly; NASA and ESA proceed with Earth entry only if safe to do so

Deliver the EES onto a precise trajectory

- Ensures the EES is on the correct trajectory and lands as expected, protecting the public and mission personnel

Divert the ERO away from Earth

- Diverting away from Earth ensures any uncontained Mars material on ERO has a low probability of ever reaching Earth
- ERO then enters an orbit around the sun that doesn't intersect Earth for over 100 years

Safety Step 3: Land on Target, Maintain Containment

MSR has a smaller, more precise landing footprint than prior sample return landings

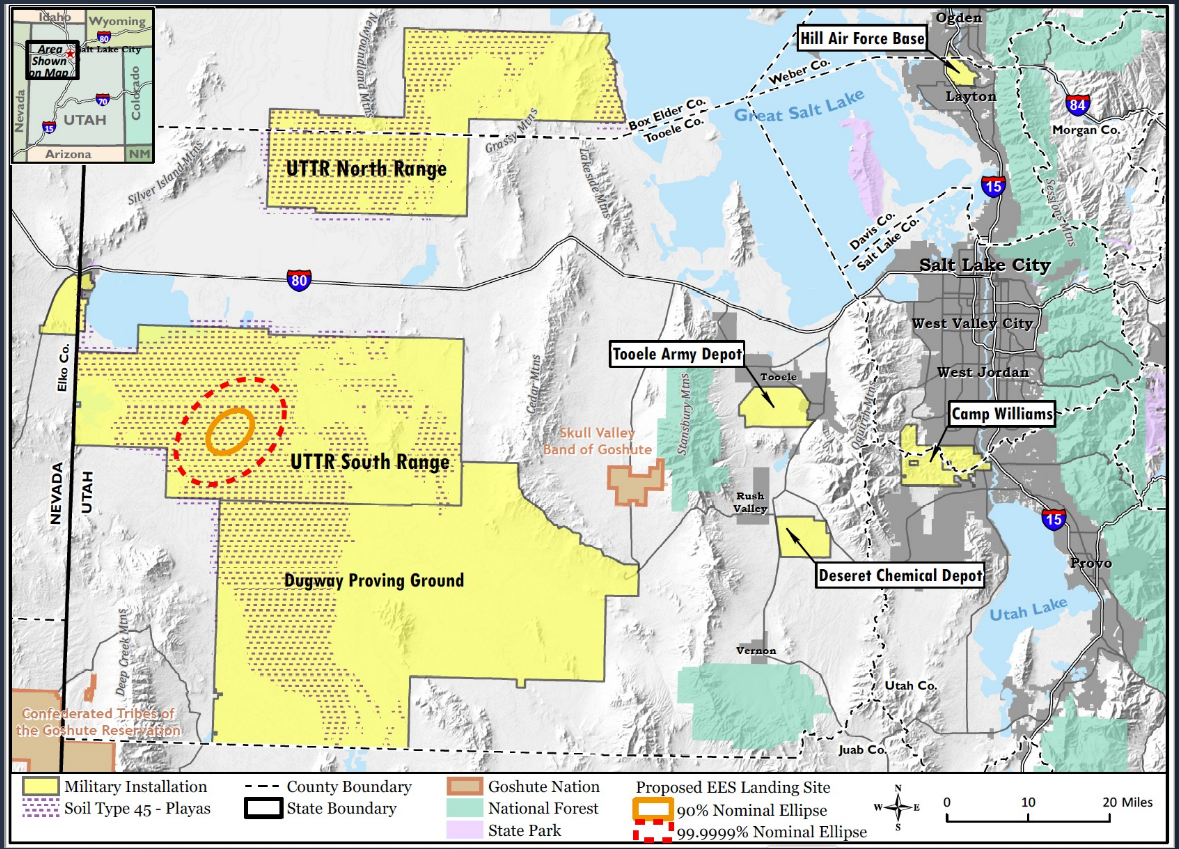
- Precision release, flight path controlled by Earth's gravity
- Once the EES reaches the atmosphere, its shape slows it rapidly and along a predictable path

The precision entry and landing ensures safety

- The landing ellipse is entirely within the designated safe area, protecting people and property
- A known landing surface equals well-understood landing forces which means we can design the EES for success

MSR engineers are already testing the EES design

- Real world and lab tests are verifying our understanding of landing forces leading to refined, robust containment



Potential UTTR Landing Site and MSR Landing Ellipses

Safety Step 4: Recover and Preserve

After landing, the focus is safety and sample preservation

- Containment, handling, cleanup and transport protocols adapted from those used for regulated biological materials

The recovered EES would be enclosed within additional layers and transported promptly to a sample receiving facility

- Current containment concept: a gas-tight envelope, in a protective case, inside a secure transport vault

Samples would only be accessed within the sample receiving facility

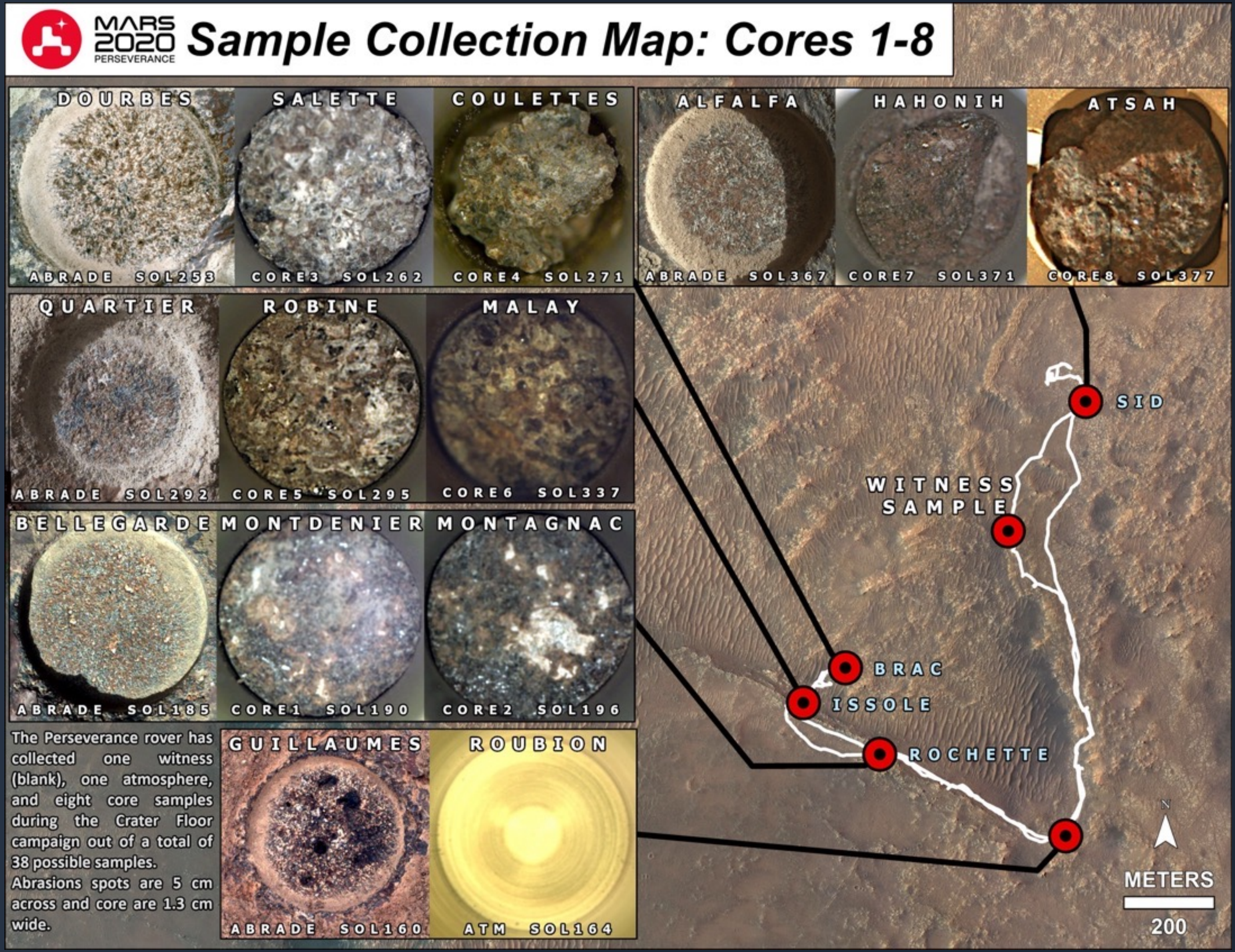
- All Mars material would remain under containment until demonstrated safe

MSR’s Safety First Approach

Key Points

- Low likelihood hazard + a conservative, safety-focused engineering approach
- MSR breaks the chain of contact in Mars orbit, utilizing redundant containment and sterilization
- ERO remains on a path to miss Earth unless it is determined that “all systems are go” for EES delivery
- The EES lands with high precision, in a safe area, on a well-understood site
- Full containment of Mars material is maintained through delivery to a secure laboratory

A close-up of Apollo 17 lunar core sample 73001 being taken out of its drive tube for the first time since it was collected by Apollo astronauts in December 1972 at NASA's Johnson Space Center in Houston.
Credits: NASA/Robert Markowitz



National Aeronautics and
Space Administration

NASA-ESA Mars Sample Return (MSR) Campaign

Programmatic Environmental Impact Statement

NEPA Scoping Public Meetings

Question-and-Answer Session

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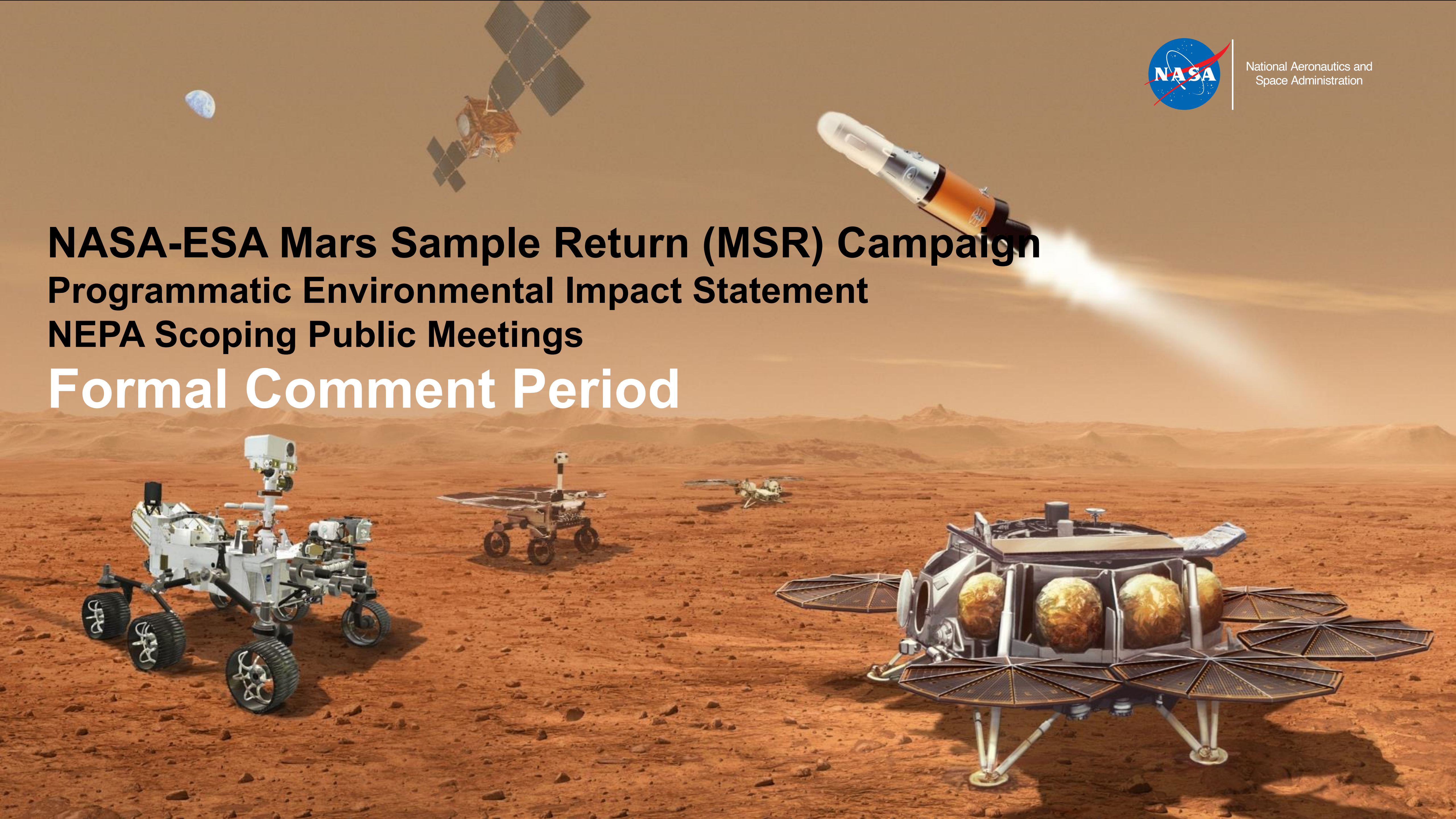
Formal Comment Period



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THANK YOU FOR ATTENDING

Ways to Provide NEPA Scoping Comments

- Chat Box or Verbal Comment during today's meeting
- Federal Docket online at http://www.regulations.gov
  - Docket Number NASA-2022-0002-0001
- Mail to: Steve Slaten, NASA Jet Propulsion Laboratory, 4800 Oak Grove Drive, M/S: 200-119, Pasadena, CA 91109-8099