National Aeronautics and Space Administration

EXPLORE MARS SAMPLE RETURN

Jeff Gramling
Director, Mars Sample Return Program

Humans to Mars Summit

May 17, 2022



GOAL —
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 the 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

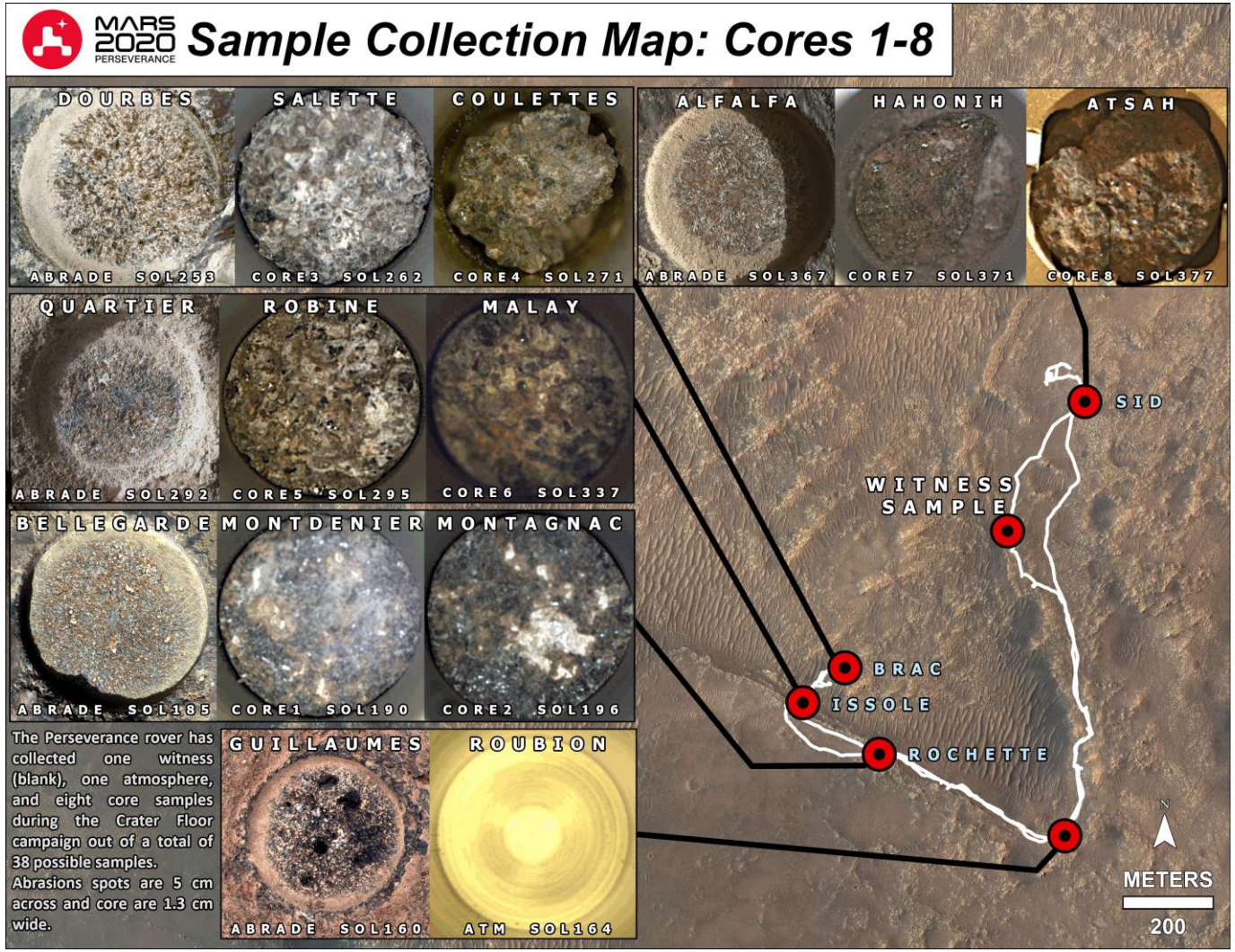
Samples Collected by Perseverance

Perseverance has arrived at the delta front. Has 8 rock samples collected during Crater Floor Science Campaign.

Total 10 tubes sealed:
1 Witness blank
1 Atmospheric sample
4 pairs of rock core samples

Engineering studies and landing site(s) characterization for the first cache depot at the “Landing Strip” are underway.

Science Community Workshop for depot of the first sample set is being planned for last week in September 2022



Sampling Sites

Mars 2020

Perseverance Odometer: 11517 meters*
Ingenuity Log: 28 flights, 6909 m, 3254.9 sec*
*May 9, 2022

❖ Power of AutoNav Perseverance set multi-sol plan record distance 528.673 m (Sol 404-405)

❖ 28 successful flights & over 1 year of ops for Ingenuity!

Three Forks

Octavia E. Butler Landing Site

Crater Floor | Science Campaign Area

❖ Perseverance set single-sol record 319.786m (Sol 351)



NASA's Perseverance Mars rover looks back at its wheel tracks on March 17, 2022, the 381st Martian day, or sol, of the mission. Credits: NASA/JPL-Caltech

Map Scale
0 200m 500m 1000m

Longitude, Latitude 77.41584778°, 18.42294185°

MSR Campaign

Mars Sample Return Program

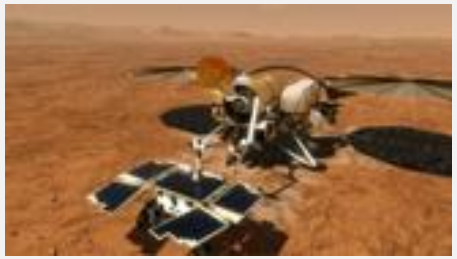
1



Sample Caching

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

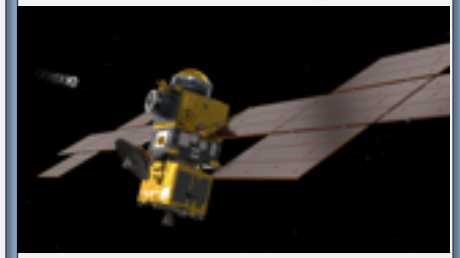
2



Sample Retrieval

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

3



Earth Return

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

4



Sample Receiving

- *Transport contained samples to receiving facility*
- *Safety assessment and sample containment*
- *Initial sample science and curation*

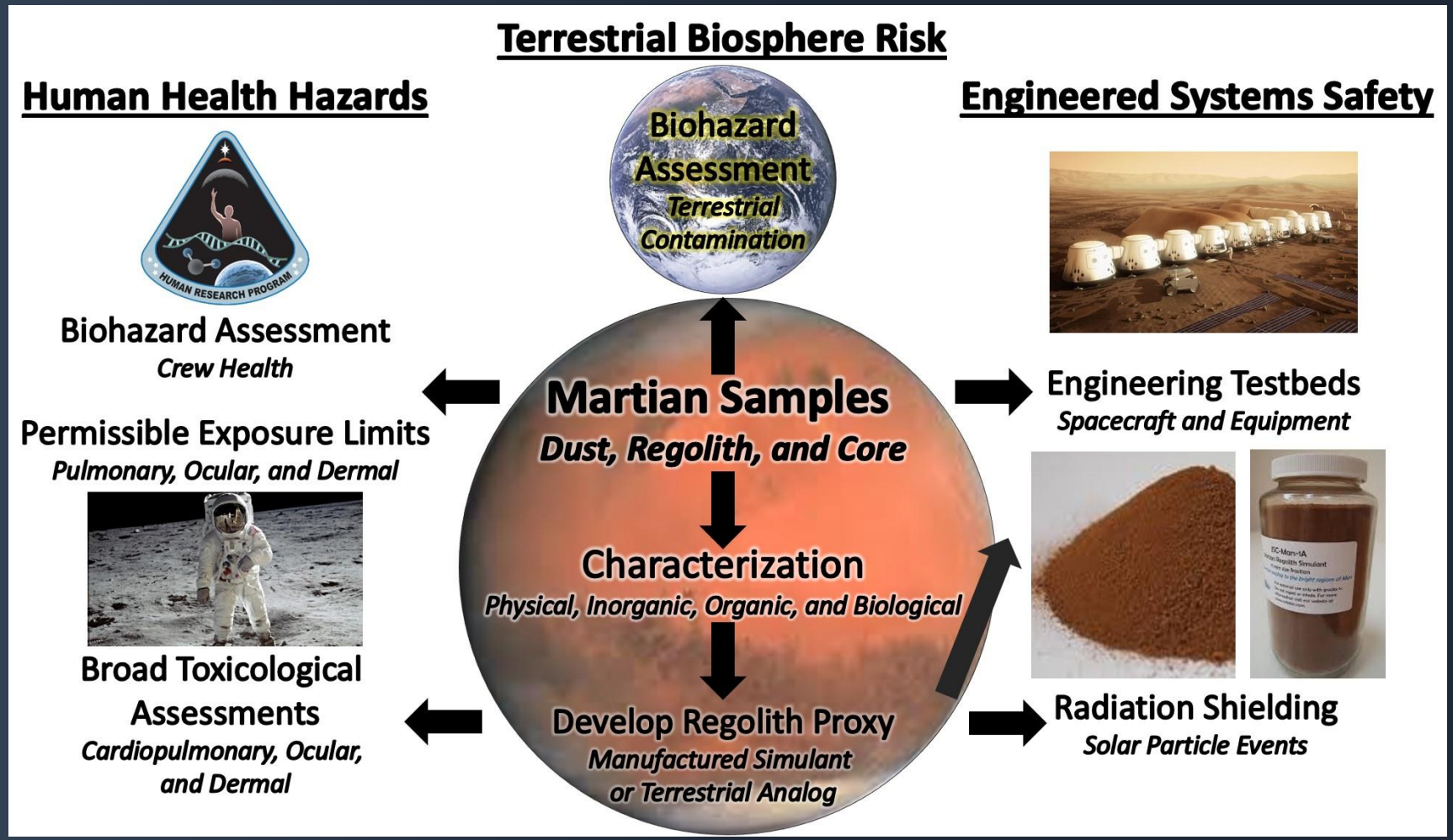
Long-term Curation & Science Investigations NASA/ESA

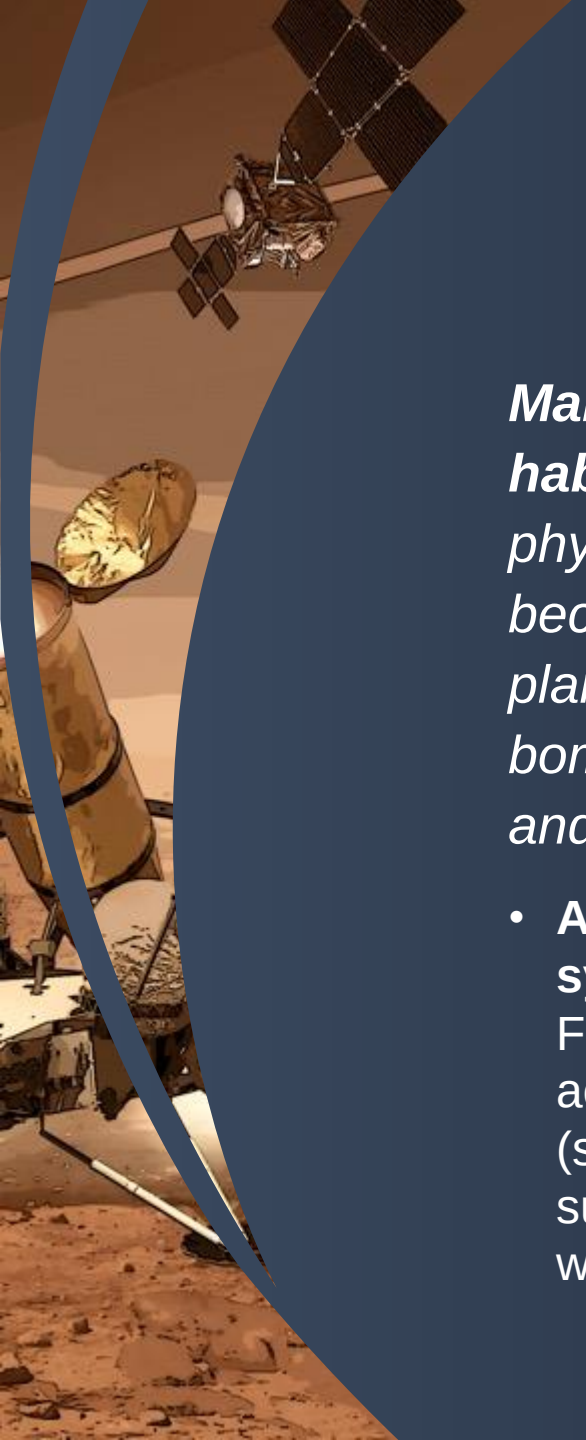
- The MSR Campaign spans flight elements and ground elements
- The MSR Program manages development and operations of Sample Retrieval and Earth Return and interfaces to Sample Caching and Sample Receiving; program concludes upon safe return at the landing site
- The MEP Program manages M2020 Phase E operations & is the home of the future Sample Receiving Project

Hazards to Future Martian Exploration

International MSR Objectives and Science Team (iMOST) Objective 6

- <u>Three primary gaps</u> in our knowledge about potential environmental hazards that could be addressed via the analysis of returned martian samples.





Mars Is A Compelling Target For Both Science And Exploration In Addition To Sample Return

Mars has a uniquely accessible archive of the long-term evolution of a habitable planet. *The well-exposed and preserved 4-billion-year record of physical and chemical planetary processes is unique in the solar system because of its preservation, accessibility, and importance to understanding planetary habitability. This record includes planetary formation, impact bombardment, interior and crustal processes, atmospheric and climate evolution, and potentially the origin and evolution of life on another planet.*

- **A compelling destination for human exploration and science-exploration synergism.** After the Moon, Mars is the next-most accessible destination for humans. Future human exploration and science investigations at Mars are complementary activities that can leverage advancements from each other. New science investigations (such as understanding the dust cycle and the formation of low-latitude ice deposits) support planning of human exploration activities. In turn, the arrival of humans at Mars will dramatically enhance our ability to achieve big-picture science objectives.

Vertically Ejected Controlled Tip-Off Release (VECTOR)

- VECTOR is a pre-ignition separation mechanism for the Mars Ascent System (MAS)
- VECTOR provides a MAS separation state with a vertical velocity and pitch rate
- MAS ignition occurs a set time after separation within an established window that allows for successful flyaway



Earth Entry Vehicle

Manufacturing Demonstration Unit #1

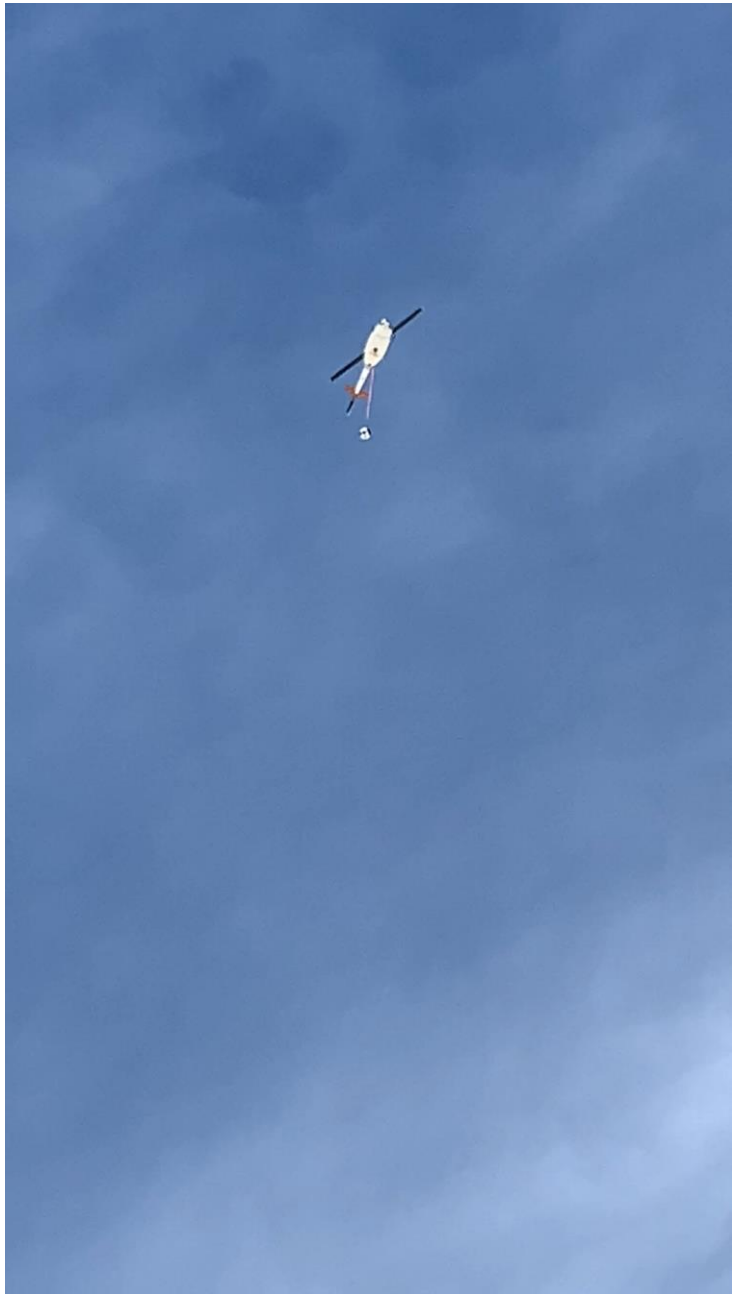
Drop Altitude: ~1000 ft

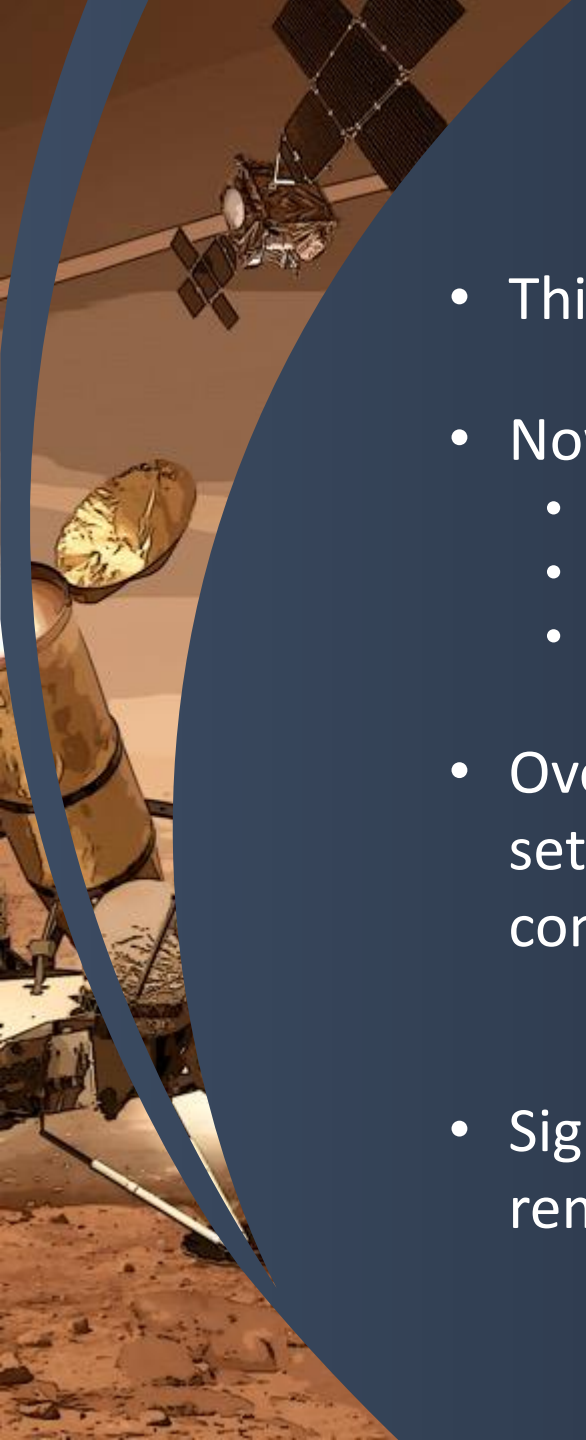
Terminal Velocity at impact: ~33 m/s / ~74 mph

Utah Test and Training Range – March 1, 2022



NASA / USAF Team Photo





Summary

- This is the most significant planetary science undertaking in a generation
- Now is the time
  - Perseverance on surface of Mars collecting samples
  - Orbital Relay assets in place around Mars
  - European Partnership in place with substantial mission contributions
- Over the past three years, the NASA-ESA team has considered a broad set of implementation options and developed a feasible baseline concept
    - Key technologies and engineering developments have been matured
- Significant work remains, but the team is on track to launch the remaining flight elements in this decade


EXPLORE
with us