National Aeronautics and Space Administration
300 E Street SW
Washington, DC 20546
USA

Perseverane: Direct Mars-to-Phobos Sample Return

Dear Sir or Madam,

The return of Martian samples represents one of the highest-priority objectives in planetary science and astrobiology. The samples collected by the Perseverance Rover provide an unprecedented opportunity to investigate past habitable environments and potential biosignature preservation on Mars.

In light of the increasing technical complexity, cost growth, and programmatic risks associated with the current Mars Sample Return architecture, I would like to present an alternative, modular mission concept:

Perseverane: Direct Mars-to-Phobos Sample Return

This concept introduces a two-stage return architecture in which already collected Martian samples are first transferred from the Martian surface to the moon Phobos, followed by a separate retrieval mission transporting them to Earth or cis-lunar space.

This approach reduces critical mission dependencies, increases system robustness, and enables a more flexible and scalable implementation strategy.

Furthermore, the analysis of returned samples would directly support the refinement and calibration of future Mars orbiter instruments, enabling more targeted and scientifically efficient exploration.

I would welcome the opportunity to further discuss this concept and its potential integration into future Mars Sample Return planning.

Sincerely,
Christian Dauck

🚀 Executive Summary

Perseverane: A Modular Mars–Phobos–Earth Sample Return Architecture

Overview:
Perseverane is an alternative Mars Sample Return architecture designed to complement or replace elements of the current Mars Sample Return campaign through a modular, two-stage approach.

Architecture Concept:

1. **Mars Surface → Phobos Transfer**
2. **Phobos → Earth / Cis-Lunar Retrieval**

Key Features:

- Elimination of complex orbital rendezvous in Mars orbit
- Decoupling of critical mission phases
- Increased operational flexibility
- Stepwise and scalable mission implementation

Technological Advantages:

- Use of Phobos as a logistical staging node
- Reduced synchronization requirements between mission elements
- Optional integration with existing infrastructure (e.g., Lunar Gateway)

Scientific Value:

- Calibration of orbital datasets using returned samples
- Improved development of future instrumentation
- Enhanced identification of biosignature-relevant targets

Strategic Impact:

Perseverane enables a more resilient and adaptable Mars Sample Return architecture while linking Mars exploration with emerging lunar infrastructure.

🛰️ Concept Description

1. Background and Motivation

The current Mars Sample Return architecture consists of multiple highly interdependent mission elements, including:

- Surface sample retrieval
- Launch via a Mars Ascent Vehicle (MAV)
- Orbital rendezvous in Mars orbit
- Earth return trajectory

This architecture requires precise synchronization across all mission phases and introduces significant technical and programmatic risks.

Perseverane addresses these challenges by structurally decoupling mission phases.

It explicitly builds on the fact that the Perseverance Rover is already operational on the Martian surface and has collected scientifically valuable samples. The concept therefore focuses exclusively on sample retrieval and return.

---

2. Mission Architecture

2.1 Phase 1: Mars Surface to Phobos Transfer

A dedicated lander system performs:

- Localization and collection of cached sample tubes
- Integration into a Mars Ascent Vehicle (MAV)
- Launch from the Martian surface
- Transfer trajectory toward Phobos

Operational Objective:

- Controlled delivery and placement of samples on Phobos
- Establishment of a stable intermediate storage location in low gravity

---

2.2 Phase 2: Phobos Retrieval Mission

A separate retrieval spacecraft will:

- Travel to Phobos
- Acquire the stored samples
- Transport them onward

---

3. Return Path Options

3.1 Direct Earth Return

- Shortest mission duration
- Direct atmospheric entry via Earth Entry System
- Higher planetary protection requirements

3.2 Phobos → Cis-Lunar Space → Earth

Integration into the Artemis Program:

- Transfer to the Lunar Gateway
- Option for orbital analysis
- Potential crew-assisted return

Advantages:

- Use of existing infrastructure
- Increased mission safety
- Expanded scientific flexibility

---

4. System-Level Advantages

- Reduction of critical single-point mission events
- Decoupling of mission timelines
- Increased robustness and adaptability
- Flexibility in budget and scheduling

Phobos functions as a stable logistical node outside Mars gravity, reducing operational complexity compared to orbital rendezvous scenarios.

---

5. Scientific and Technological Implications

The analysis of samples collected by the Perseverance Rover enables:

5.1 Calibration of Orbital Data

- Direct comparison between orbital measurements and laboratory results
- Reduction of ambiguity in remote sensing interpretation

5.2 Advancement of Future Instrumentation

- Improved spectroscopic techniques
- Enhanced biosignature detection capabilities
- Optimization of future Mars orbiter payloads

5.3 Targeted Exploration

- Data-driven refinement of landing site selection
- Increased scientific return of future missions

---

6. Conclusion

Perseverane represents a robust, flexible, and technically feasible alternative to current Mars Sample Return architectures. By utilizing Phobos as an intermediate staging point, the concept reduces mission complexity and enables a more resilient implementation strategy.

At the same time, returned sample analysis provides a direct pathway to improving future Mars exploration through enhanced instrumentation and data interpretation.

One-Line Statement

“Perseverane separates Mars Sample Return into a Mars-to-Phobos transfer and a subsequent retrieval mission, enabling a resilient and scalable Mars–Moon–Earth architecture.”