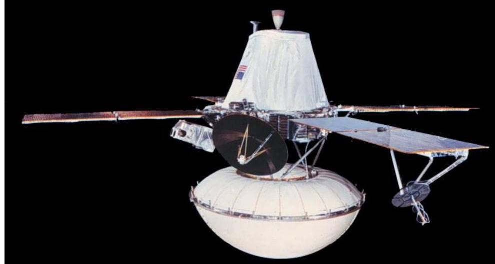
An Overview of Phobos and Deimos and their Exploration

Scott Williams & Jonathan Clarke

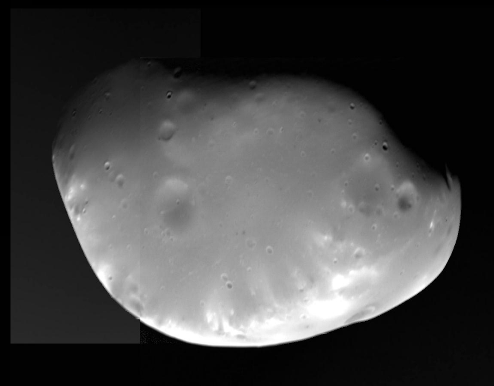
Deimos the Outer Moon

We've Flown There...



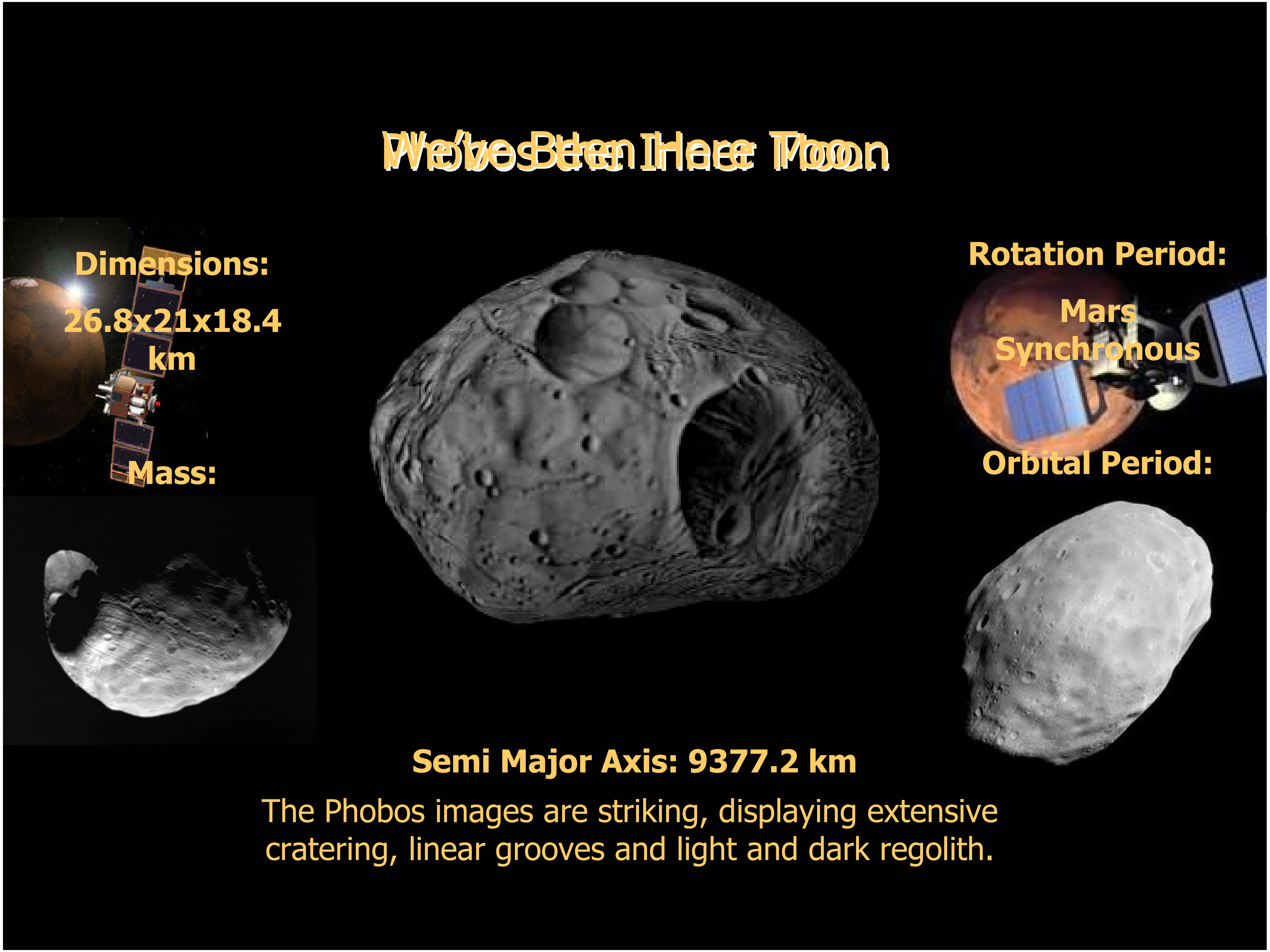
Rotation Period: Mars Synchronous

Orbit Period:



Semi Major Axis: 23,460 km

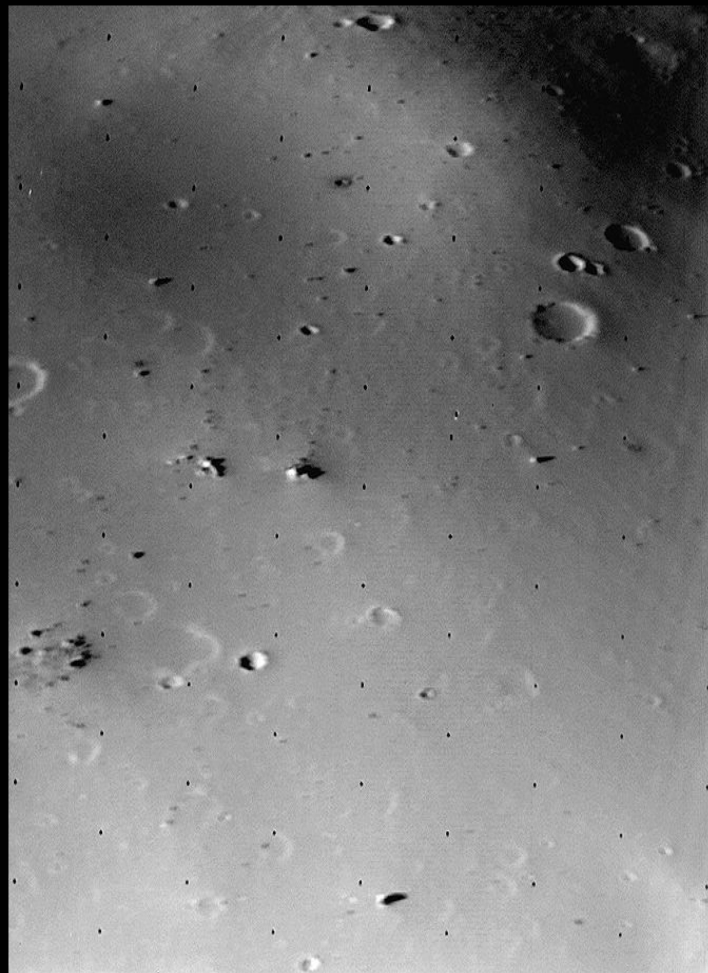
Early Mariner and Viking images of Deimos displayed a near featureless body, with a smooth and sparsely cratered surface.


Phobos the Inner Moon
We've Been Here Too
Dimensions:
26.8x21x18.4 km
Mass:
Rotation Period:
Mars Synchronous
Orbital Period:
Semi Major Axis: 9377.2 km
The Phobos images are striking, displaying extensive cratering, linear grooves and light and dark regolith.

The Major Physical Characteristics

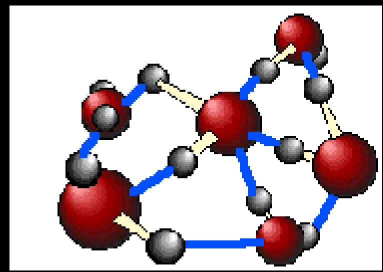
The Regolith of Deimos

- Creep movement down slopes
- Lighter material sourced from crater rims
- Most of the regolith is dark
- Global regolith coverage
- Deimos may retain much of its regolith due to its relationship to Mars

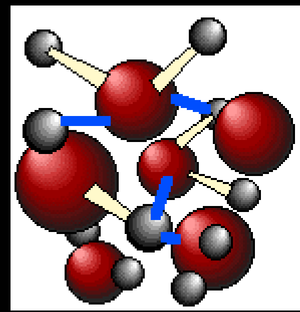


Water & The Moon's

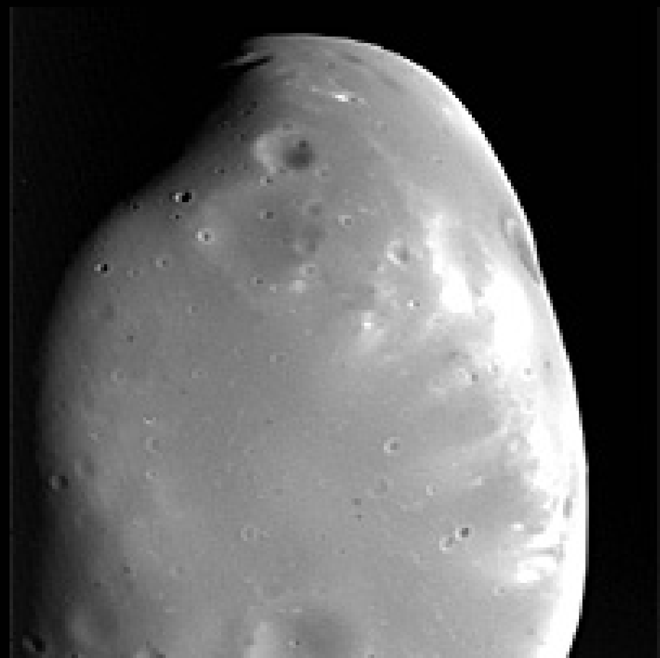
- Deimos and Phobos have low densities
- Water would provide a valuable clue to their composition
- Water would prove important for human Mars missions
- Uncertainties could be quashed if we could penetrate the surface
- However, there may be other explanations for low densities



Ice



Water



Composition of Phobos

- Much uncertainty exists without obtaining a sample
- Commonly thought to be a C-asteroid from the main belt
- Contemporary interpretation points toward an ordinary chondrite analogue
- Composition places important constraints on the moon’s origin
- Was Phobos captured from the main belt? or is it the remnant of a pre-existing body?

Grooves on Phobos

- Grooves predominantly run perpendicular to the rotational axis, but also radial from Stickney
- Can measure up to 50-200 m wide, 5-20 m deep, and 20 km long
- Possibly formed from striating impacters
- Alternatively, grooves may represent fractures in Phobos' structure
- Similar grooves have been observed on main belt asteroids

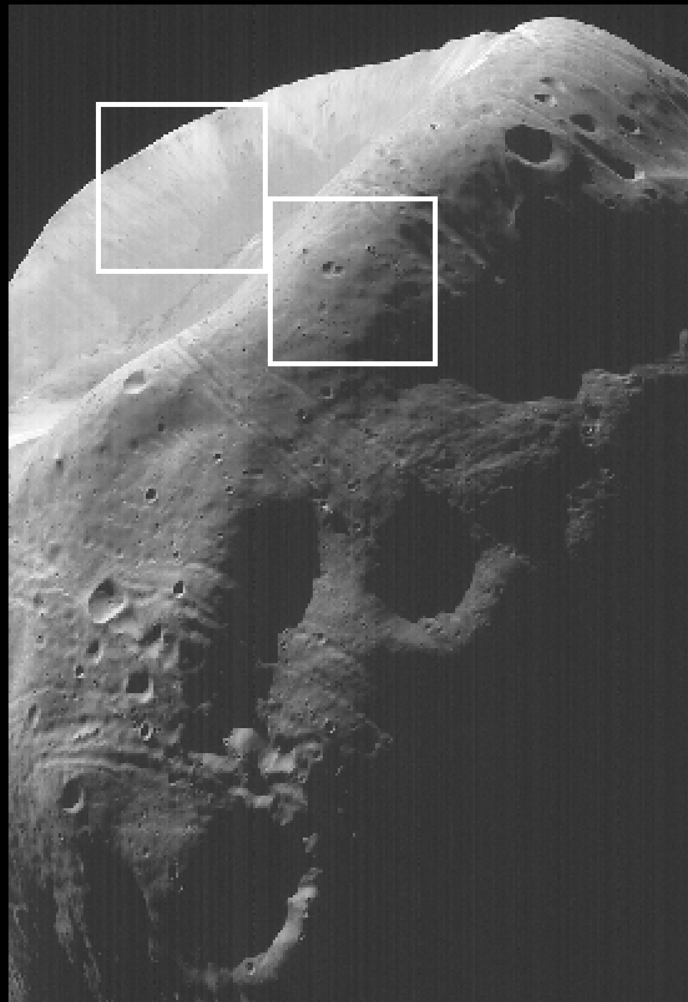
Bright Crater Rims of Phobos

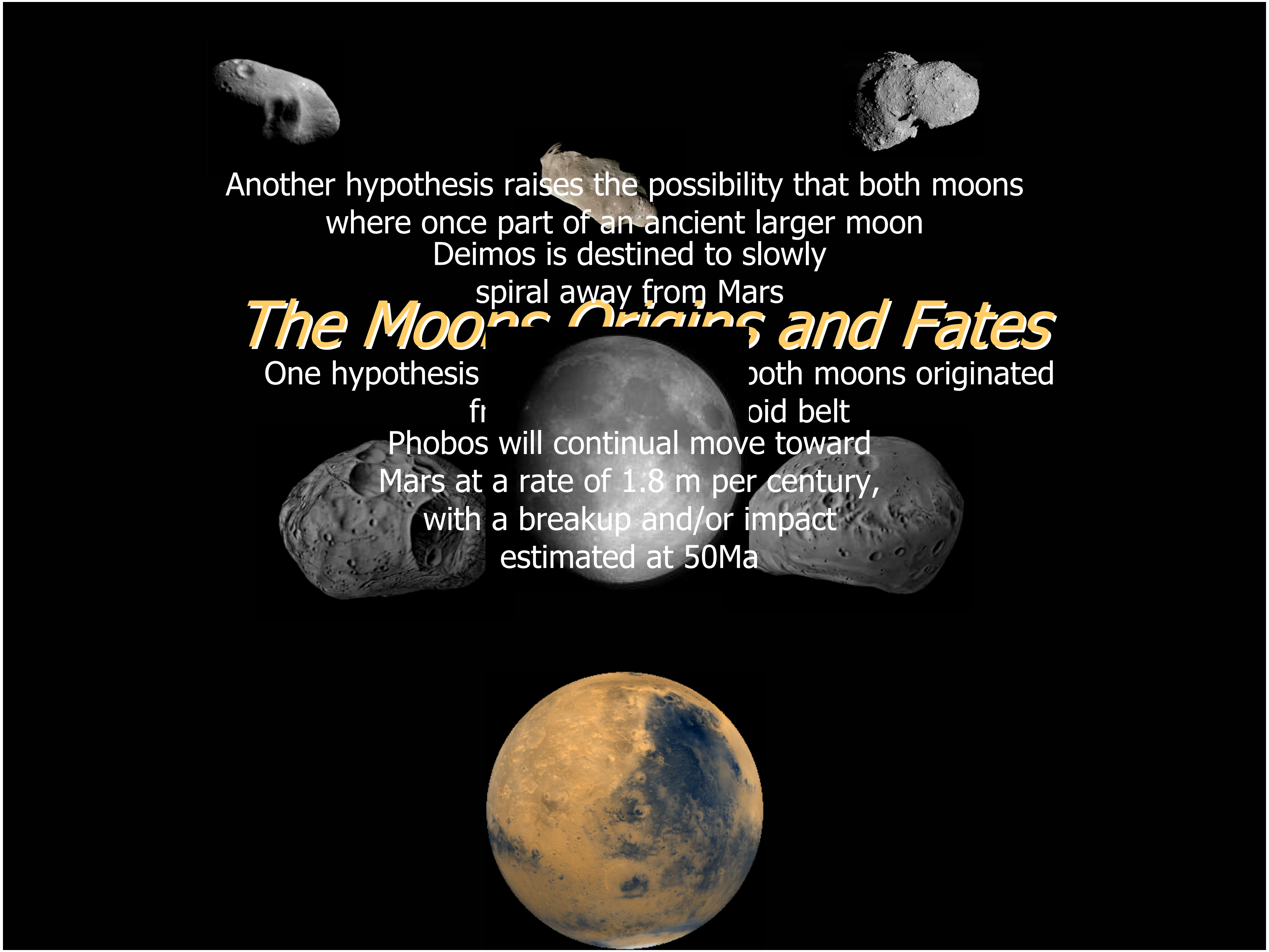
- Regolith at the rims of craters and grooves display higher reflectance than surrounding regolith

- Lighter Lunar regolith is of younger age

- Older regolith may be darker because it undergoes space weathering processes from solar particles

- Lighter regolith may be relatively freshly excavated samples of Phobos' interior




Another hypothesis raises the possibility that both moons
where once part of an ancient larger moon
Deimos is destined to slowly
spiral away from Mars
The Moo
and Fates
One hypothesis
oth moons originated
oid belt
Phobos will continual move toward
Mars at a rate of 1.8 m per century,
with a breakup and/or impact
estimated at 50Ma

The Significance of the Martian Moon’s

- Understanding their composition may greatly improve our knowledge of the Mars system and the early solar system
- Their regolith may retain invaluable samples of the ancient Mars surface
- Both moon’s may currently be the most easily accessible asteroid bodies in the solar system
- They could potentially play a significant role in establishing a foot hold for human exploration of Mars

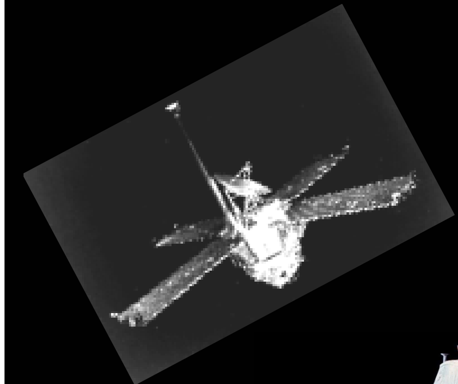
Deimos and Phobos play two major roles in human space exploration:

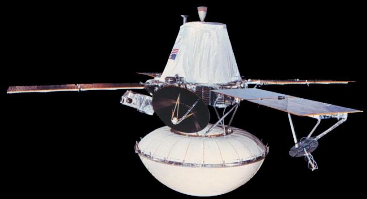
As catalysts to understanding the formation, processes and prospective resource availability of small bodies inside the main asteroid belt and/or in Mars orbit.

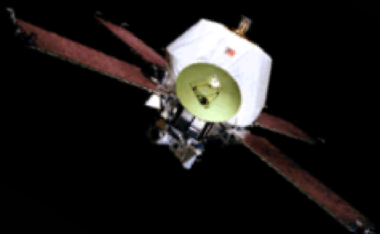
As space borne platforms, realistically accessible by current technological standards, providing an environment suitable for anchoring and conducting mission support activities in support of Mars exploration.

The Exploration of Phobos and Deimos

So far the moon's have been visited by remote sensing craft, though no soil samples have been collected as yet







Mariner 6, 7 and 9

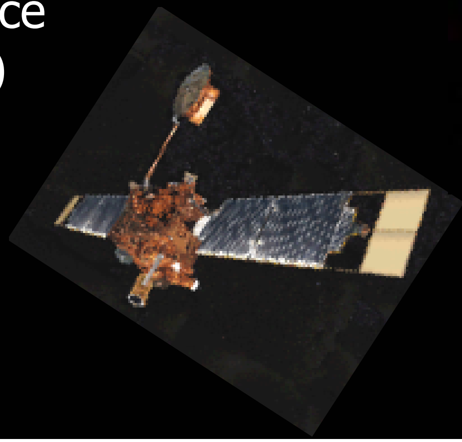
Viking 1 and 2

Phobos 2

Mars Global Surveyor

Mars Express

Mars Reconnaissance Obiter (expected)



A Proposed Multi-Function Mission to Phobos and Deimos

The Aim:

To gain a greater understanding of Phobos and Deimos, the Mars system and small bodies within the solar system. In addition, to assess the moon's resource potential and suitability to support human missions to Mars.

The Method:

To execute a multi-function mission with the capability to orbit both bodies, land on the surface of Phobos and penetrate to the sub-stratum.

Expected Result:

The acquisition of a suite of data, crucial for the understanding of the moon's surface and sub-surface properties.

The Orbiter

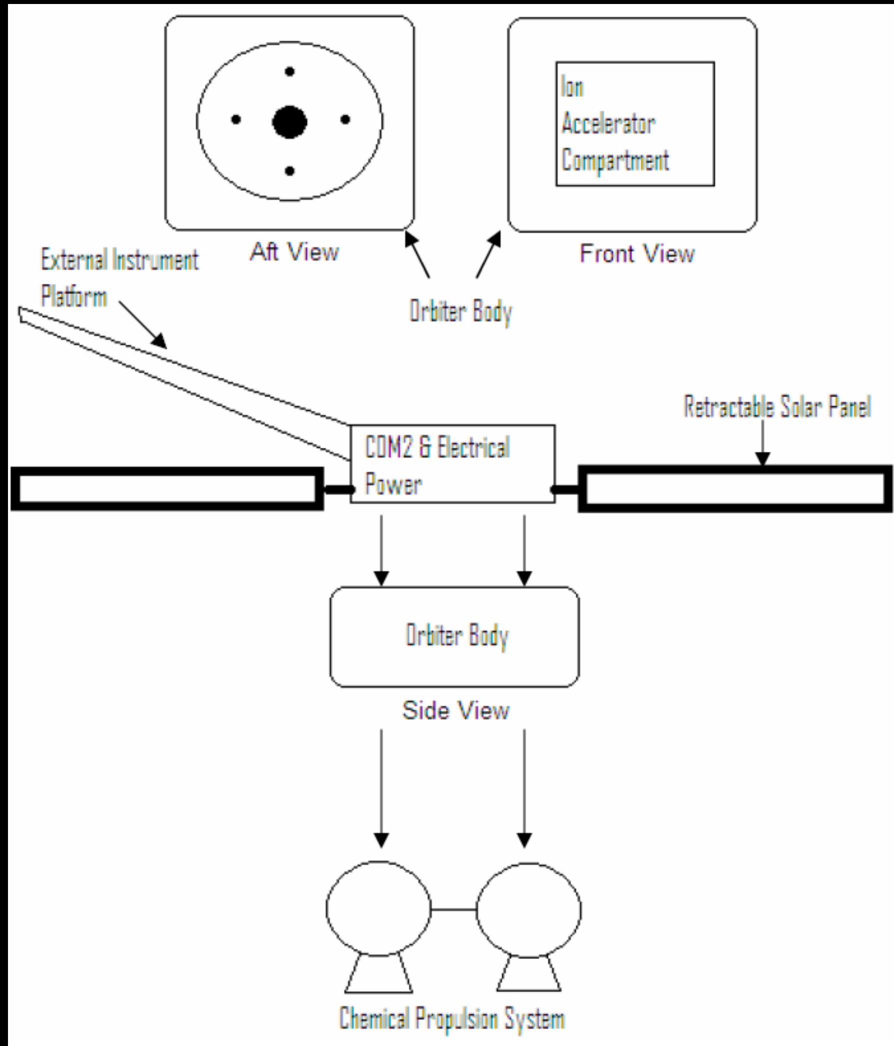
The control, communications and long distance transport hub for all components of the mission

Scientific Equipment –

Multi-spectral camera
TV camera
X-ray, IR, NIR, *n* spectrometer
Radio system
Laser Altimeter
Magnetometer
Radar
Dust Counter

Propulsion –

Ion propulsion system, complimented with a chemical propulsion system.



The Lander

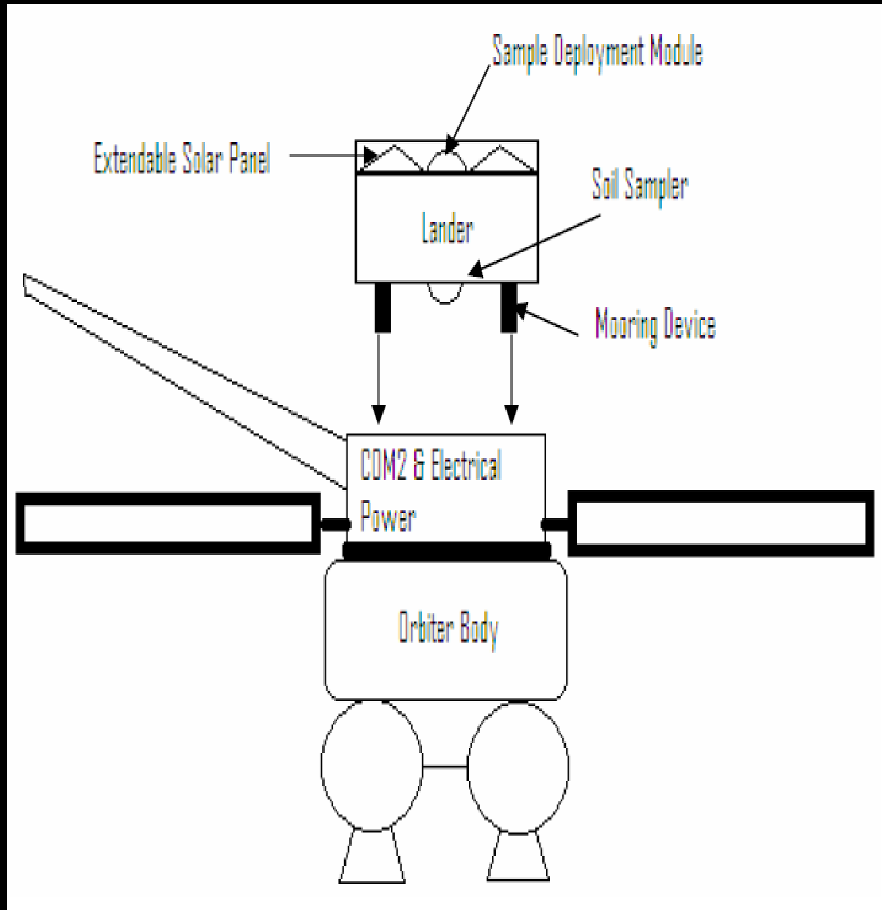
To carry out in-situ measurements and experiments, measure seismic waves and obtain a soil sample

Scientific Equipment –

Panoramic camera
Alpha-X ray-Gamma ray spectrometer
Mossbauer spectrometer
Gas analyser
Microscope camera
Radio system
Seismometer
Sun sensor
Soil sampler

Power and Propulsion–

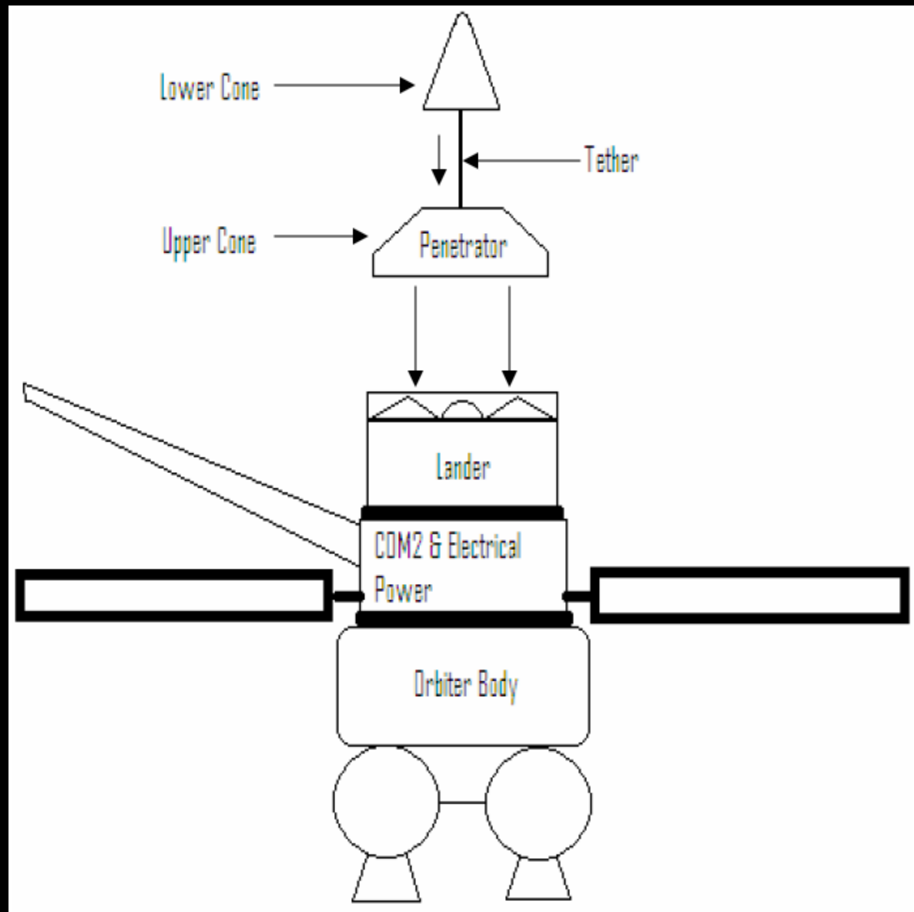
Extendable solar panels complemented by auxiliary battery.
Small chemical propulsion and thruster cell.



The Penetrator

To breach surface material and infiltrate subsurface stratum, and cause sufficient shock to produces seismic waves to be registered by the lander

Scientific Equipment –
Alpha-Xray-Gamma ray spectrometer
Water content analyser
Gas analyser
Temperature analyser
Neutron detector
Aft camera
Laser environment sensor

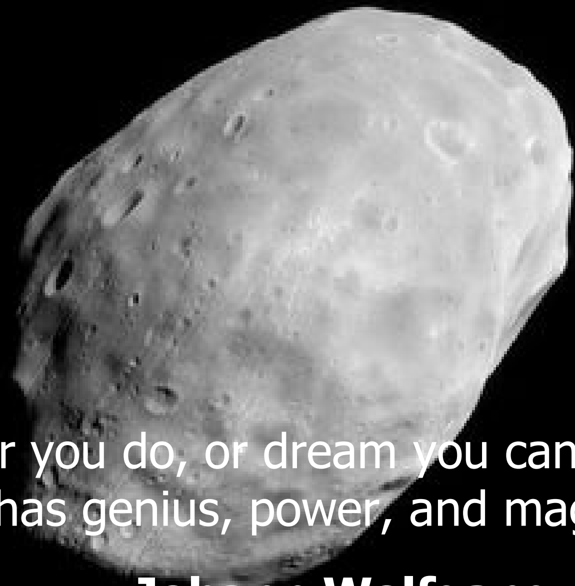


Power and Propulsion –
Small propulsion cell, computer system, battery cell encased in the lower cone.

The mission is ambitious and may be confronted with unforeseen difficulties…

Hayabusa

…but the benefits of a successful mission would far out weigh the element of risk and provide us with an unparalleled glimpse into the solar systems past and the future of Mars exploration



“Whatever you do, or dream you can, begin it,
boldness has genius, power, and magic in it”

Johann Wolfgang von Goethe

The mission would require 46 months for completion, including two months at Phobos and Deimos and the return of the surface sample. But data would be received at Earth 22-24 months into mission.