PRIME (Phobos Reconnaissance and International Mars Exploration): A Phobos Lander Mission to Explore the Origin of Mars's Inner Moon. Robert Richards[1], Pascal Lee[2], Alan Hildebrand[3], and the PRIME Team. [1]Optech Inc., 300 Interchange Way, Vaughan, Ontario, L4K 5Z8, Canada, robertr@optech.ca. [2]Mars Institute, [3]University of Calgary.

Introduction: The PRIME Lander mission is a concept for a Canadian-led international robotic mission to land on Phobos and investigate the origin of this martian moon. The concept was proposed by Optech Inc. in collaboration with the Mars Institute and MDA Space Systems and was selected and supported in early 2007 as a Mars mission concept study by the Canadian Space Agency.

Background: The single most important science objective in the exploration of Phobos is to determine *the origin of Phobos.* Resolving this issue addresses not only the origin of Phobos itself; it helps answer fundamental questions about Phobos's evolution through time and the current state of this martian moon. It also addresses the relationship between Phobos and Mars, Deimos, and other small bodies of the Solar System.
Competing hypotheses concerning Phobos's origin include: 1) Phobos is a circum-Mars formed body or the collisional remnant of a once larger one; 2) Phobos is a captured small body (asteroid or comet) or the collisional remnant of a once larger object. In each of these cases, Deimos could be genetically related to Phobos, but this is not necessarily the case.
The PRIME Lander Mars mission concept was developed with the central scientific goal of determining (or constraining to the extent possible) the nature and origin of Phobos. Important but secondary scientific goals are to understand (or constrain better) Phobos's evolution through time and the current state of the object**.**

Mission Objectives: The primary objectives of the proposed PRIME Lander mission are to substantially:
- Advance our understanding of the nature and origin of Phobos.
- Advance our understanding of the evolution of Phobos through time.
- Advance our understanding of the current state of Phobos.

The single most reliable measurement that can be made to answer the question of Phobos's origin is to determine the martian moon's bulk composition. While remote sensing studies may help constrain the bulk composition of Phobos, they characterize strictly only the composition of Phobos's surface regolith, which might not be representative of Phobos's bulk. Determining the bulk composition of Phobos can be done unambiguously only by determining the composition of a representative sample of Phobos's bedrock. This is most easily done via in situ petrographic and mineralogic examination of a representative piece of Phobos's bedrock and by analysis of its elemental composition.

PRIME Lander: The PRIME Lander is a fixed Lander that will first characterize potential landing sites from orbit - actually pseudo-orbits about Phobos, soft land on Phobos using a short-range lidar (CAMELOT-2), then examine its surroundings using a body-mounted gamma-ray spectrometer/neutron detector (GRS/NDL) and two arm-mounted instruments, a combination panoramic/microscopic color imager (CHAMP) and an alpha particle x-ray spectrometer (APXS). Additional baseline instruments include a surface scanning lidar (PASCAL) and a magnetic susceptibility measurement experiment (MAG), the latter also an arm-mounted instrument. The Lander would also be equipped with an ultrastable oscillator capable of supporting Radio Science during the initial pre-landing orbital phase.

Rock Dock Maneuver: The PRIME Lander's CAMELOT-2 lidar, designed by Optech, will allow a precision soft touchdown of the spacecraft within an arm's reach (< 0.5 m) of a selected block exposed on Phobos's surface. This "rock dock" capability is unique to the PRIME Lander mission and represents the key enabling technology that promises to allow resolution of the mystery of Phobos's origin. A PRIME Lander in situ analysis mission incorporating the "rock dock" capability, while inherently more complex than a strictly orbital mission, will more likely allow definitive resolution of the question of Phobos's bulk composition and therefore its origin. The capability of the proposed mission will be illustrated using the Phobos "monolith" – a 90 m wide boulder – as a candidate landing site target.

PRIME Lander to Mars Sample Return: In addition to providing an opportunity to resolve the question of Phobos's origin, the PRIME Lander mission involves mastery of key technologies and strategies likely needed for an eventual Mars Sample Return mission, namely orbital rendez-vous in Mars orbit, landing hazard avoidance, and high precision landing (rock dock maneuver).

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