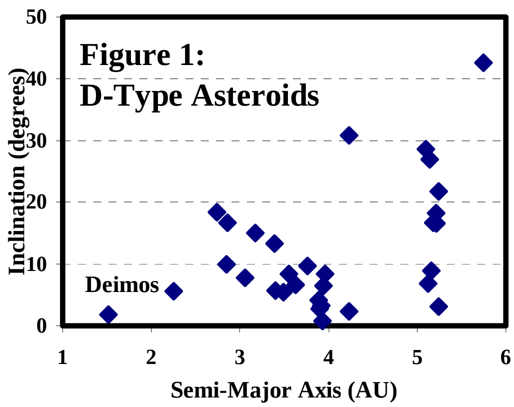
THE GULLIVER MISSION: SAMPLE RETURN FROM THE MARTIAN MOON DEIMOS. D. T. Britt[1] and the Gulliver Team, [1]University of Tennessee (Department of Geological Sciences, Knoxville, TN 37996, dbritt@utk.edu).

Introduction: The Martian moon Deimos presents a unique opportunity for a sample return mission. Deimos is spectrally analogous to type D asteroids, which are thought to be composed of highly primitive carbonaceous material that originated in the outer asteroid belt. It also is in orbit around Mars and has been accumulating material ejected from the Martian surface ever since the earliest periods of Martian history, over 4.4 Gyrs ago [1].



Deimos's position in the Martian gravity well makes it more likely to accumulate and retain material. Much of the ejecta from Deimos will not have the velocity to escape the Martian system and will eventually reaccrete to the moon [2]. Deimos is also probably a low-density rubble-pile and that structure strongly dissipates impact energy, further limiting ejection velocities and mateial escape [3]. Because of stochastic processes of regolith mixing over 4.4 Gyrs, the rock fragments, grains, and pebble-sized materials will likely sample the diversity of the Martian ancient surface and as well as thoroughly mixing the original primative material of Deimos .

Analysis of Martian ejecta, material accumulation, capture cross-section, regolith overturn, and Deimos's albedo suggest that Mars material may make up as much as 10% of Deimos's regolith. The Martian material on Deimos would be dominated by ejecta from the ancient crust of Mars, delivered during the Noachian Period of basin-forming impacts and heavy bombardment. Deimos is essentially a repository for two kinds of extremely significant and scientifically exciting acient samples:

- Primative spectral D-type material that may have accreted in the outer asteroid belt and Trojan swarm. This material samples the composition of solar neubla well outside the zone of terrestrial planets and provides a direct sample of primative material so common past 3 AU but so uncommon in the meteorite collection.
- Ancient Mars, which would include the full range of Martian crustal and upper mantle material from the early differentiation and crustal-forming epoch as well as samples from the era of high volatile flux, thick atmosphere,

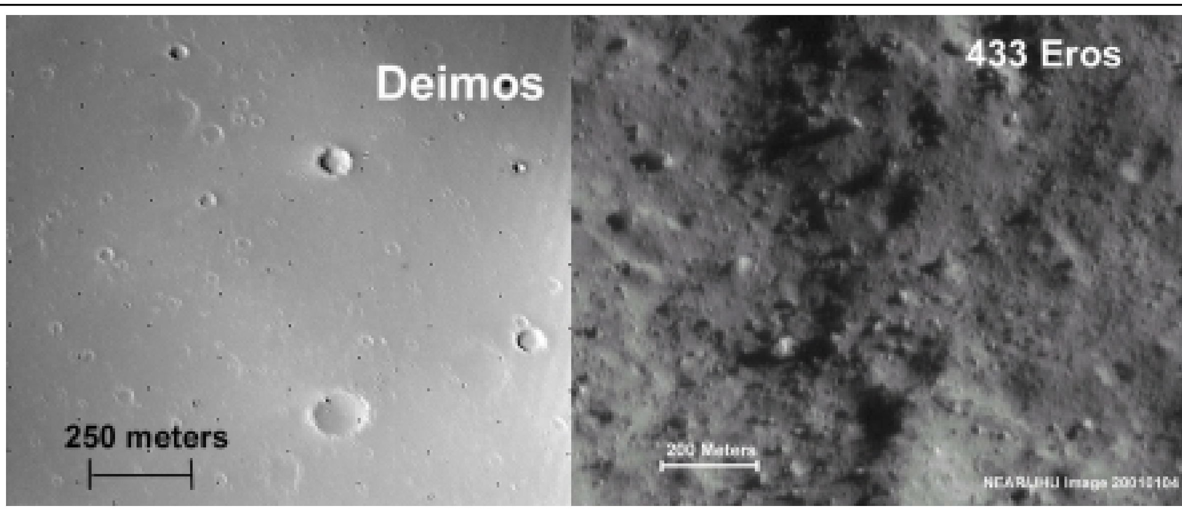


Figure 1: Comparison of the surface roughness on Deimos and 433 Eros

and possible surface water.

Compared to other primative D-type asteroids, Deimos is by far the most accessable. Shown in Figure 1 are the orbital parameters of D-type asteroids. Deimos's orbit is less inclined and far closer than any other D asteroid. In essence, Gulliver represents two shortcuts, to the outer asteroid belt and to Mars sample return.

Mission: The Gulliver Mission proposes to directly collect up to 10 kilograms of Deimos regolith and return it to Earth. This sample will contain up to 9 kilograms of primative material and up to 1000 grams of Martian material. The spacecraft instrument suite is tightly focused to the requirements of finding a safe and scientifically interesting sampling location, collecting a sample, and returning to Earth safely. They include a high-resolution imaging camera for navigation and sampling site selection, a radar altimeter for closed-loop approach maneuvering, and a wide-angle descent imager to record the sampling site and the actual sampling process.

Deimos is also by far the safest small body for sample return yet imaged. Shown in Figure 2 is a comparison of the surfaces of Deimos and 433 Eros. The NEAR-Shoemaker mission succeeded in landing on Eros with a spacecraft not designed for landing and proximity maneuvering. As can be seen in Figure 2, Deimos is significantly less rough at 5-10 meter scales than Eros.

The inherent robustness of Earth-based cosmochemical laboratory analysis, along with the diversity of the sample, allows the mission scientific goals to be both ambitious and comprehensive: (1) Determine the geochemistry of the accretion zones for the primative D-type asteroids found in the outer asteroid belt and near Juipter. (2) Study pre-boitic materials in primative asteroids for their implications on the chemistry and astrobiology of outer solar system objects. (3) Search for isotopic biomarkers in the early crust of Mars. (4) Determine the composition, diversity, and crystallization history of the Martian crust. (5) Date and characterize the era of Martian heavy bombardment After initial processing these samples will be made available as soon as possible to the international cosmochemistry community for detailed analysis. The mission management team includes Lockheed Martin Astronautics (flight system, I&T) and JPL (payload, mission ops, and mission management).

References: [1] Burns J. A. (1992) *Mars* (Kieffer H. H. et al., eds), 1283-1302. [2] Hamilton D. P. (1996) *Icarus* **119**, 153-172. [3] Housen, K.R. et al.. (1999) *Nature*, **402**, 155-157.