INTEGRATED STUDIES OF PHOBOS AND DEIMOS – REMOTE, *IN SITU* AND LABORATORY INVESTIGATIONS. Andrew J. Ball[1], Ian A. Franchi[1] and John B. Murray[2], [1]Planetary and Space Sciences Research Institute, Centrre for Earth, Planetary, Space and Astronomical Research, The Open University, Walton Hall, Milton Keynes MK7 6AA. Email: A.J.Ball@open.ac.uk. [2]Department of Earth Sciences, Centrre for Earth, Planetary, Space and Astronomical Research, The Open University, Walton Hall, Milton Keynes MK7 6AA.

We present views from The Open University on complementary remote, *in situ* and laboratory investigations of the martian moons. Work done at the OU includes analysis of the Phobos grooves [1], geochemical sample analysis techniques, and work with academic and industrial partners on defining and proposing possible future mission architectures and payloads.

For ESA's Aurora programme, we recently proposed Deimos Sample Return (DSR). We had previously also examined a mission to send an orbiter to study each moon in turn, and a lander-carier to deploy a surface element to the surface of Deimos [2].

For sample return, 200 g of material would be highly desirable from either moon. Assuming the *Фобос-Грунт* (*Phobos-Grunt*) sample return is successful, we favour Deimos as a sample return target. Although Phobos exhibits at least two distinct surface units in the IR, Deimos remains essentially unexplored since *Viking*. DSR has previously been proposed, although in the end not selected, for the US Discovery programme (*Aladdin* and *Gulliver*).

Scientifically, sample return from a martian moon offers essentially the same science as from a primitive asteroid, PLUS information on its origin and history in Mars orbit, and the prospect of acquiring material originating from Mars itself. Having orbited Mars for some time, during which Mars has experienced a number of large meteorite impacts, the moons should have intercepted some of the resulting ejecta. Indeed, such collisions are strongly suspected to have caused the families of surface grooves on Phobos [1]. While we believe we have samples of Mars already here on Earth in the form of martian meteorites, they represent 2, or possibly 3 discrete localities on the surface of Mars. Their exposure ages all indicate ejection in the past 10-15 million years. All the meteorite samples are igneous rocks – once again, this suite of samples is strongly biased towards what can survive terrestrial atmospheric entry as recognisable material. Smaller fragments of martian sedimentary rocks – abundant from rover and high-resolution orbital imaging of the martian surface – should be present on the martian moons. Debris from a much wider range of impact events stretching back much further into the history of Mars might be present. The fraction of surface material originating from Mars has been estimated to be several percent.

Many technologies needed for Mars Sample Return (MSR) must (or can) be demonstrated in a highly representative environment throughout the whole functional chain: aseptic assembly; transfer to Mars; precision soft landing; sampling techniques; sample containment consistent with martian planetary protection regulations; biosealing of sample canister; return to Earth with high speed re-entry and recovery; sample curation and laboratory analyses. A martian moon sample return could be achieved without costs and risks incurred by entering the Martian atmosphere at high speed, descending to the surface into a deep gravitational well, collecting a sample during a lengthy deep drilling operation, and ascending back again from there and undertaking a rendezvous/capture manoeuvre.

The core science investigations for DSR need comprise only those necessary for successful sample acquisition and documentation (e.g. multispectral (Vis/NIR) imager, the sampling system itself and a stereo descent/ascent camera). The vast majority of the geochemical science is performed in terrestrial laboratories, as for MSR. This involves detailed, complex analyses, utilising high precision and high sensitivity instruments that are entirely unfeasible to contemplate flying as remote or *in situ* instruments for a considerable stretch into the future. A wide range of laboratory techniques is now available, and able to work with mg samples, analysing their constituents at the ppm and ppb levels, much more precisely than achievable *in situ*. Most recently, considerable improvement in the suite of techniques has been achieved through participation in the analysis of samples from *Stardust* and *Genesis*.

Also to be considered, if resources allow, are *in situ* measurements to provide ground-truth for remote sensing, and geophysical measurements. Such measurements might include: penetrating radar; libration measurements; radio science; spectrometers (near-IR, alpha-X-ray or X-ray fluorescence, gamma ray, etc.); magnetometry; *in situ* physical properties.

References: [1] Murray, J. B. et al. (2006), *LPS XXXVII,* 2195. [2] Ball, A. J. et al., Mars Phobos and Deimos Survey (M-PADS) - A Martian Moons Orbiter and Phobos Lander. *Adv. Space Sci.*, submitted.