INSTITUTE FOR SPACE STUDIES

Mission Concepts for Accessing and Sampling High-Risk Terrains on Planetary Surfaces

March 9, 2009

Section A: Science Presentations

If you (an astrobiologist, geologist or planetary scientist) were conducting a science investigation on a planetary surface, what capabilities and tools would enable you to most effectively carry out your investigation? Do not constrain your thinking to state-of-the-art robotic mobility and sampling; assume that the technology is available to you to access and sample extreme terrains (e.g. steep craters, promontories, vertical strata, slippery terrain). Given that:

- What science investigation(s), in your assessment, would most benefit from having access to and collecting samples from such terrain?
- What potential target sites would be desirable for such an investigation (Lunar, Martian, etc)? Which geological features (e.g., craters, valles, chasmata) would be most desirable for the investigation?
- What measurements would be necessary to enable such an investigation?
- Does this investigation require remote measurement? In situ measurement? and/or sample collection? If the latter, in what form (e.g. core, powder, direct measurement on rock face)? What sample size must be acquired for analysis?
- Would your investigation cover a relatively small surface area (accessible over a few weeks/months by a single vehicle), or would your investigation require multiple distributed assets? If the latter, what are the key requirements for site exploration, accessing, sensing and sampling?
- What is the technology readiness level of the instrument(s) that is/are necessary to conduct such an investigation?
- What are the key technologies that must be developed in order to bring us closer to conducting such an investigation? Is your answer is affected by assumptions on the size of the delivery vehicle (e.g., assume that these instruments must be integrated onto a 40 – 60 kg robot)?
- What would you project the energy requirements to be to conduct the experiment (excluding requirements for accessing and collecting the sample if applicable).

- And most importantly, what new scientific questions would this investigation enable us to answer?

Section B: Mission Concept Presentations

- What are the driving constraints for precision landing of a payload on the Moon, Mars, and other potential target planets for accessing high-risk terrain? Where are the knees in the curve in terms of mass, landing ellipsoid (if applicable), landing mechanisms, etc.

- What are energy constraints for both solar and nuclear powered platforms (e.g. ASRG)? In particular, mobility mechanisms in extreme terrain may require short bursts of energy to overcome obstacles or to drill for samples. What power system technologies are compatible with this characteristic?

- What are potential constraints with regards to using tethered platforms (both powered and unpowered) that would be unique to planetary surfaces (in addition to tether mass, power loss, management and entanglement)? E.g., constraints on material and conductors, length of tether, etc.

- What are communication constraints for landing and operating in extreme terrains? E.g., what are some of the problems that arise when an explorer in a steep crater communicates with landers or rovers on the surrounding plateau or with a planetary orbiter?

Section C: Mobility and Sampling

- What is the state-of-the art in automated sampling systems including drilling, coring, sample transfer and handling. How much material is typically acquired and handled for spectroscopic analysis? What are the constraints on the handling and cross-contamination of samples?

- In terms of large prior science expeditions: e.g. Dante II at Mt. Spurr and AMASE at Svalbard, Norway:
  - What investigations were carried out that required access to and sampling from extreme terrain?
  - What measurements were collected?
  - What mission constraints did they operate under?
  - What were the limitations for terrain access, sampling collection, and analysis?
  - What were the key lessons learned from these expeditions?