NASA SBIR 2010 Phase I Solicitation

S5.03 Surface and Subsurface Robotic Exploration

Lead Center: JPL
 Participating Center(s): ARC, GSFC, JSC, LaRC

Technologies are needed to enable access, mobility, and sample acquisition at surface and subsurface sampling sites of scientific interest on Mars, Venus, small planetary bodies, and the moons of the Earth, Mars, Jovian and Saturnian systems. Many scientifically valuable sites are accessible only via terrain that is too difficult for state-of-the-art planetary rovers to traverse in terms of ground slope, rock obstacle size, plateaus, and non-cohesive soils types. Sites include crater walls, canyons, gullies, sand dunes, and high rock density regions. Tethered systems, non-wheeled systems, and marsupial systems are examples of mobility technologies that are of interest. These technologies could enable new approaches for deployment, retrieval, access, and mobility.

A variety of mobility system architectures can be considered. Single vehicle systems might utilize a 200 kg class rover and dual vehicle systems might utilize a 500 - 800 kg primary vehicle that provides long traverse to the vicinity of a challenging site and then deployment of a smaller 20 - 50 kg vehicle with steep mobility capability for access and sampling at the site.

For surface and subsurface sampling, advanced manipulation technologies are needed to deploy instruments and tools from landers and rovers. Technologies to enable acquisition of subsurface samples are also needed. For Mars and Venus, technologies are needed to acquire core samples in the shallow subsurface to about 10cm and to enable subsurface sampling in multiple holes at least 1 - 3 meters deep through rock, regolith, or ice compositions. Shallow subsurface sampling systems need to be low mass and deeper subsurface sampling solutions need to be integratable onto 500 - 800 kg stationary landers and mobile platforms. For Europa, penetrators and tools to allow deep drilling are needed to sample and bore the outer water-ice layer and through 10 to 30km to a potential liquid ocean below

Consideration should be given for potential failure scenarios, such as platform slip and borehole misalignment for integrated systems, and the challenges of dry drilling into mixed media including icy mixtures of rock and regolith. Systems should ensure minimal contamination of samples from Earth-source contaminants and cross-contamination from samples at different locations or depths.

Innovative component technologies for low mass, low power, and modular systems tolerant to the in-situ environment are of particular interest. For Europa, the radiation environment is estimated at 2.9 Mrad total ionizing dose (TID) behind 100 mil thick aluminum. Technical feasibility should be demonstrated during Phase I and a full capability unit of at least TRL level 4 should be delivered in Phase II. Specific areas of interest include the
following:

- Tether play-out and retrieval systems including tension and length sensing;
- Low-mass tether cables with power and communication;
- Steep terrain adherence for vertical and horizontal mobility;
- Modular actuators with 1000:1 scale gear ratios;
- Electro-mechanical couplers to enable change out of instruments on an arm end-effector;
- Drill, core, penetrator, and boring systems for subsurface sampling to 10cm, 1 m, 3 m, and deep subsurface;
- Shared intelligence allowing systems to collaborate and adapt exploration scenarios to new conditions.

Proposals should show an understanding of relevant science needs and present a feasible plan to fully develop a technology and infuse it into a NASA program.