RAPID SAMPLE ACQUISITION AND PROCESSING FOR *IN SITU* MISSIONS. G. H. Peters[1], L. W. Beegle[1], G. S. Mungas[1], R. C. Anderson[1], and G. H. Bearman[1], Jet Propulsion Laboratory, California Institute of Technology, M/S 306-333 4800 Oak Grove Drive, Pasadena, California 91109, Gregory.H.Peters@jpl.nasa.gov.

Introduction: In-situ instruments all rely on access to samples for analysis -whether it is imaged, heated or chemically treated— simply put the first step is preparing and distribution of a sample. Arm and mast mounted instruments require samples to be cleaned of the weathered outer layer and the exposure of inclusions and stratigraphy to maximize science return. In addition, by studying both weathered and unweathered layers we can begin to understand atmospheric and surface weathering effects. This can tell us about the processes involved and the survivability of chemical and biological signatures across the entire planet and define future search strategies. A vast majority of analytical instruments require that fines be created from larger rocks so that mineralogy, chemistry, and potential biological remnants can be analyzed. Herein we describe the Rapid Active Sampling Package (RASP), an enabling technology that tackles sample acquisition, preparation/processing and transport, and does so with minimal mass and power budgets. The system is suitable for use on rocks, ice and icy samples regardless of the water/soil ratio. Unlike other systems, it is very light in mass and power.

Description: A RASP tool is designed to rapidly process rock, permafrost or ice. The sample acquisition/processing time is on the order of seconds with less than 1 Watt hr/cc consumed while RASPing into >100Mpa basalt [1]. RASP systems can generate powders from the un-weathered interior of rocks and are able volumetric erasers that can be used to uncover unweathered interiors of rocks for analysis. Like a geologist's hammer RASP systems may be used to strike away the weathered layers of exposed outcroppings except RASP systems have the added ability to make and deliver the powdered rock samples to analytical instruments.

While RASP systems provide tremendous utility they are also mechanically simple. The RASP tool uses a rotary cutting bit (or two counter rotating bits) that spins at 8,000 to 30,000 RPM. When the spinning bit is made to contact the sample substrate at an oblique angle the substrate is cut away (Figure 1). The cuttings are processed into powder at the moment that the bit touches the rock. These powders are immediately ready for delivery to instruments. Through a series of arm maneuvers the RASP is systematically moved over and into the rock, the bit grinds the rock into powder. The catch container intercepts ballistic particles and keeps most of them from falling back onto the rock surface leaving the recently uncovered surface clean of debris and providing a convenient method of delivery of the processed cuttings.

The simplicity and utility of RASP systems are evidenced by its use on the Phoenix Mars Scout mission, which is to acquire permafrost samples on Mars. The original architecture centered on using an arm-mounted scoop to uncover a layer of permafrost. The scoop was equipped with sharp cutting tines that were to be used to scrape up a pile of permafrost. Once a pile of cuttings had been accumulated, the scoop was to pick up the pile. It was realized, only 2 years from launch, that the arm was not strong enough to produce a reasonable amount of sample.. In response to this problem RASP systems were conceived and prototyped at JPL's EMSiL. Within four months of its conception the RASP was selected for the Phoenix mission.

RASP technology is simple. It consists of a rotating bit and a catch container that resides on the end of a robotic arm. This bit can be used as a volumetric eraser that grinds away at rocks while automatically creating fines that are directly captured and are suitable for a variety of analytical instruments— XRD, XRF, thermal desporption, chemical extraction, organic molecule detectors and mass spectrometers. This technology is also enabling for arm and mast mounted imagers and spectrometers because it can expose the unweathered region in surface rocks, exposed bed rock and outcrops. For sedimentary deposited rocks formation it can expose stratigraphy, so that a history of the site can begin to be formulated. For analytical instruments it can process material into fines from any layer it exposes, so that analytical instruments can investigate mineralogy, chemistry and potential biology signatures, and do it in a systematic manor. The operation of RASP systems allows fines sampling from finite depths allowing gradual measurements within rocks, enabling depth analysis at millimeter resolution Fig 2.

RASP systems "hog-out" the sample hole. Getting stuck in a rock is highly unlikely, so the practice of designing bit release mechanisms is negated. RASP systems have many advantages over and incorporates the functions of many sample acquisirtion, processing and delivery tools. The RASP has been called the "Swiss Army Knife" of *in situ* missions. A single small arm mounted RASP system can be used to acquire samples from consolidated materials including rock, "**Like a drill",** process samples into powders for delivery to instruments "**Like a rock crusher",** reveal Shallow Sub-surfaces "**Like a RAT Tool",** expose rock stratigraphy "**Like a Corer".** RASP systems also provide

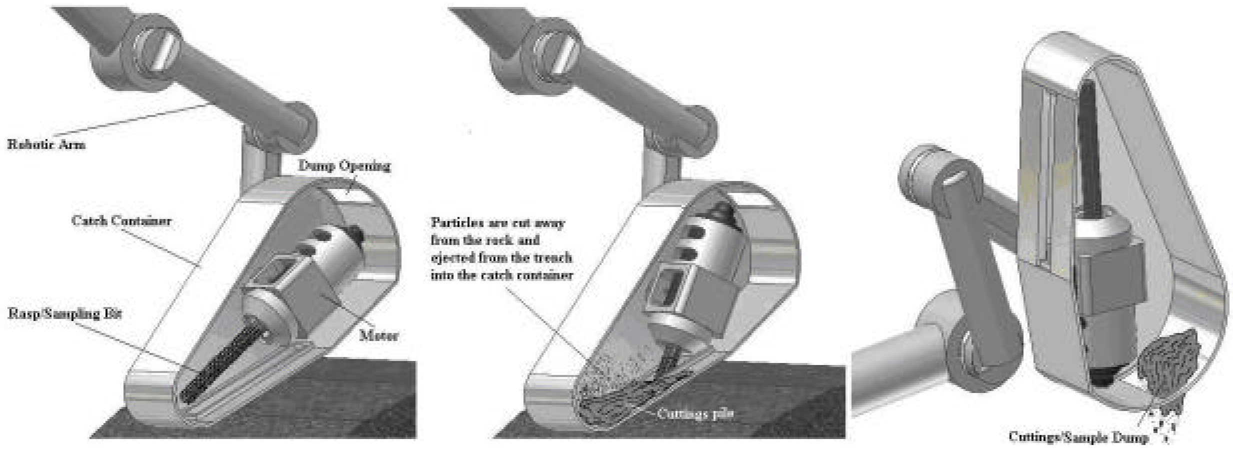

Figure 1. Rendering of the RASP system architecture for processing and distribution of samples on a robotic arm. The entire end to end collection, processing and distribution would take less than 1 minute, and require less than 1 Whr/cc specific energy per unit volume of basaltic rock removal.

the ability to go back and obtain samples from newly exposed strata of interest like no other tool conceived. In keeping with the Swiss Army Knife analogy, RASP systems are also "Pocket Sized" . Estimates are ~2kg for a fully redundant flight system for sampling rock (The RASP system on Phoenix added <200grams to the payload).

References: [1] Peters G. H et al. (2008) Planet. Space Sci. doi:10.1016/j.pss.2007.10.001.

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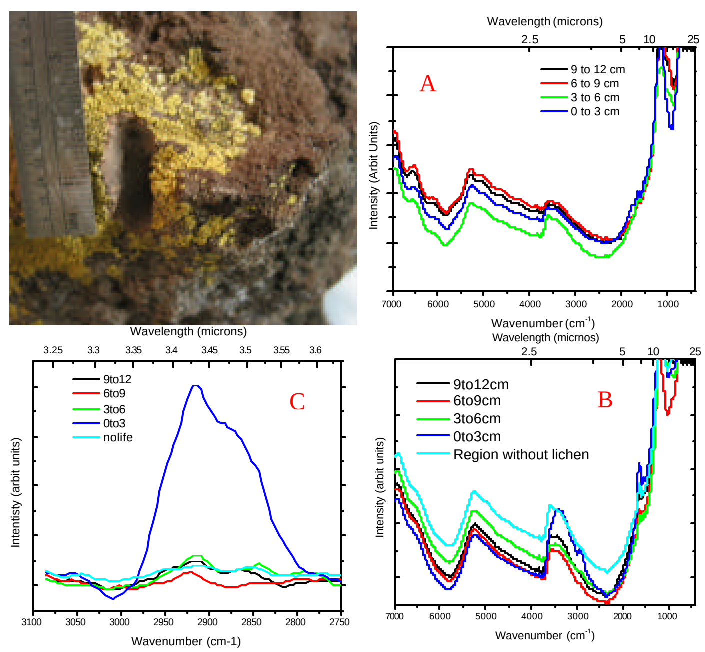

Fig 2. RASP investigation of a Basaltic rock from a recent flow collected Cima Ca with epilithic lichen growing on its outer surface. We used a simple hand held RASP to expose an initial notch in the outer part of the rock ~1 cm down (photo). Then we collect material every 3 mm from the surface down to 12 mm by extending the notch. Spectra A is from a section of the rock without the lichen. Spectra B is from the lichen dominate region, with Spectra C the blown up 3.4 micron C-H Stretch feature indicative of life. Notice there is no evidence of cross layered talk in Spectra C.