SAMPLE COLLECTION, PLACEMENT, AND STORAGE FOR SAMPLE RETURN. K. M. Nebergall, 3137 St Michel Lane, St Charles, IL, 60175, knebergall@gmail.com

Introduction: Objective (18) reads: "Concepts for systems to manipulate rock and regolith for acquisition, transfer/handling, and storage/preservation of surface, near-surface, or subsurface material. System capabilities could range in scale from samples for in situ analysis and caching (from ~half-dozen to ~a couple dozen preserved samples) to quantities required for resource extraction."

Based on my work on an earlier Mars Sample Return concept, this paper would discuss the following solutions:

Universal Sample Collector: This sample collection hand can grab, chip, or scoop material of nearly any applicable density, bring it to the sample bin in a sealed form, then release, drop, or scrape it into the sample collector regardless of viscosity. This is very scalable, and may be part of a replaceable cartridge or remote subvehicle such as a cliff climber or mini-rover. A large version could be used for mining. The easiest way to picture this is to imagine a top and bottom element. The top element is like a scraper, and the bottom element is like a rectangular measuring scoop. The back of the scraper has a negative image of the sample scoop. There are side walls to prevent samples from slipping out of the sides. The scraper is on a system that can let it vibrate to chip rock, open, close, move forward and back to expose the sample scoop. It can also use the negative image of the scoop to push high viscosity samples out the end, then scrape any remainder off the bottom of the scraper. The sample collection scoop on the receiving end would also have a scraper edge. This arrangement may have dealt with the Phoenix lander sampling problem, where days were lost trying to get high-adhesion samples into the collection equipment.

Sample Drill-Grip: This second design is a combination drill/hand that can grab samples or drill them out of solid rock. Basically, this is an open core drill bit that can be split in half like a pincer to grab or release samples, including core samples.

Sample Classification/Collection Tape: A sample collection "tape" allows samples gathered to be identified, isolated from other samples, sealed, and packed very efficiently in small pockets for return. Each sample location would be known and encoded to the sample tape location. A tape reel can isolate 20-50 sample pockets, and the sample return capsule could contain two or three tape reels. Several tapes are filled and returned to the sample return vehicle. Breaking the sample collection into several sorties helps ensure contingency samples are available should the rover fail or become stuck.

Large Sample Collection Multi-Pocket Bag: A 10-pocket draw-string bag can be made for larger samples that cannot fit on the tape collection pockets. When the string is drawn, it closes to a thick disc of the same proportions and shape as the sample collection tapes above. The tapes and rock collection draw-string bag would be stacked around a core sampler cylinder.

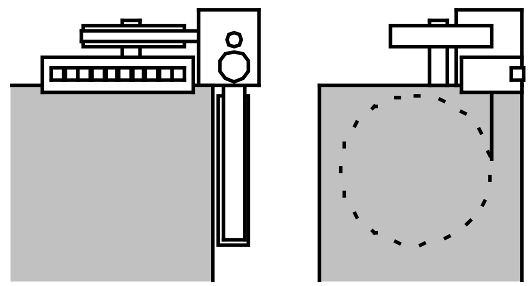

Figure 1: Top view (left) and side view (right) of sample collection tape mechanism with 10-cell bag mechanism.

Mulit-Core Sampler: The Multi-Core Sampler would be a conventional design. However, should the sampler hit a rock or other obstruction that prevented it from gathering a full sample, the lander would then pound in a thin foam cup-shaped disc, then go for a second or third sample in the same cylinder. The disc would keep each sample in place, separate the samples, and minimize the lost space should the sampler encounter an obstacle. This minimizes the loss of science payload if the core sampler hits a rock and gathers 1 cm of soil in a 6 cm tube. The first sample effort is simply isolated and the process repeated until the core sampler tube is filled.

Rover Deployment: If one starts with the MER design as a platform, little modification is required to make a sample return rover. The Mossbauer Spectrometer would be removed, which also takes up a very large part of the internal bay. The four instruments on the hand would be replaced with two sample collectors and two in-situ instruments. A Wi-Fi equivalent technology would allow the rover to communicate with the lander over short distances to arrange and coordinate sample transfers. The lander may also, if equipped to do so, clear dust from the rover solar panels or replace sampling instruments.

Sample Collection Bay: This bay on the lander would grab the samples from the rover and lander core sampler collectors, do initial examinations, package them into the sample return capsule, and seal the capsule. This would consist of two small robotic arms on a mobile platform, a basic set of instrumentation to do initial analysis for amino acid handedness or other biological flags, and a frame on which to assemble the core, rock collection bag, and one or more sample collection tapes. The system would then seal the sample collection cylinder and insert it into the return vehicle. Since all these items are designed together, locks and grip latches on each mechanism would interlock to simplify assembly and movement. Most elements of movement would be scripted with fail safes as any other industrial robotic assembly operation.

Note: This concept dovetails with the Sample Return Capsule abstract that is also being submitted for this workshop.