Sample Return Questions (from Mark, Hal and Mike)

1) How do we identify small body targets for sample return missions?

Most people in the decadal feedback liked comet surface sample return and volatile-rich asteroid sample return.

Expense is always a major issue and the target orbit is a big cost driver. If our desired targets span a range of orbits, then to what extent have we identified the targets of interest in the most accessible orbits? This feeds into the need for population studies.

The easiest targets to access are those moving in prograde, low inclination orbits that pass relatively close to Earth's orbit. If an object that doesn't meet those criteria is identified as "particularly interesting" from remote observations, we have to decide whether the scientific objectives justify the greater expense of getting to that target.

2) How does the nature of our potential targets affect planning for sample return?

If small asteroids and comets were pretty homogeneous, then we could just go to one place and grab something. How heterogeneous do asteroids and comets appear to be ?

For asteroids, some have to be heterogeneous based on meteorite studies (of xenoliths, and brecciated meteorites), but is this true for the "vast majority"?

Are comets heterogeneous beyond local existence of volatiles? Would a macroscopic refractory sample be different in its bulk composition depending on where you pick it up?

If the Spitzer observations of phyllosilicates and carbonates on Temple 1 are correct, then there could be great differences in refractories from place to place. i.e. some places would have been wet in the past, and others not.

How do we balance the need to investigate populations broadly vs. single objects in depth?

Multiple samples from a surface is another cost driver. If we want to grab multiple samples from one body, or samples from both members of binary systems, what technology requirements and operational capabilities does this drive?

3) How do we sample a surface?

What are the different technologies for doing this, both untested, attempted or successful?

What is the effect of the sampling on the material sampled? To what extent can stratigraphy be preserved? What are sample technique trade offs?

What are the options and challenges for volatile-rich samples?

What are the relative values of a merely frozen sample (sub 0°C) vs. a truly cryogenic sample (much colder still). What are the challenges to recover, return, curate and study frozen or cryogenic samples?

If there is no frozen storage, then when warmed chemistry will occur that would make interpretation of the sample difficult.

4) Planetary protection concerns. Is it worth sampling a P or D asteroid, for example, if we have to cauterize it before Earth return?

5) Once we get a sample back to Earth (assume not a crygenic sample), then what happens to it? How is it handled? How is it stored?

Are there manpower issues regarding maintaining and expanding curatorial capabilities? Do we have the facilities we need?

To what extent is information about curated samples accessible to the broader community? When a sample is analyzed, is there some capture of information from that analysis that goes into a central database? This currently varies from mission to mission. For the Stardust Mission it is a condition of sample allocations that the PIs fill out sample results summary sheets to be posted on the Curation website.

6) Are there community capability issues (i.e., skills that are being lost with retirings)?

Perhaps I could get one of the industry folks to talk about the technical challenges of sample return (any suggestions from anyone?).