

Key “Big Picture” Questions I’ve Heard:

- ***Are there reservoirs of “primitive, endmember” ices (CO, H₂O) on >5AU small bodies?***
 - land to get isotopic composition of ices and silicates to understand early fractionation, W:R processes
- ***Did populations of Trojans and KBOs have a common origin?***
 - surface methanol (other ices) as tracers → fly-bys of multiple Trojans (and KBOs?), land-on one?
- ***How long did 10- to 100-km scale objects take to form? Metamorphic/Igneous bodies vs. “sedimentary” accumulation?***
 - landers(?) to assess mineralogy in-situ; isotopes needed to establish timeline?

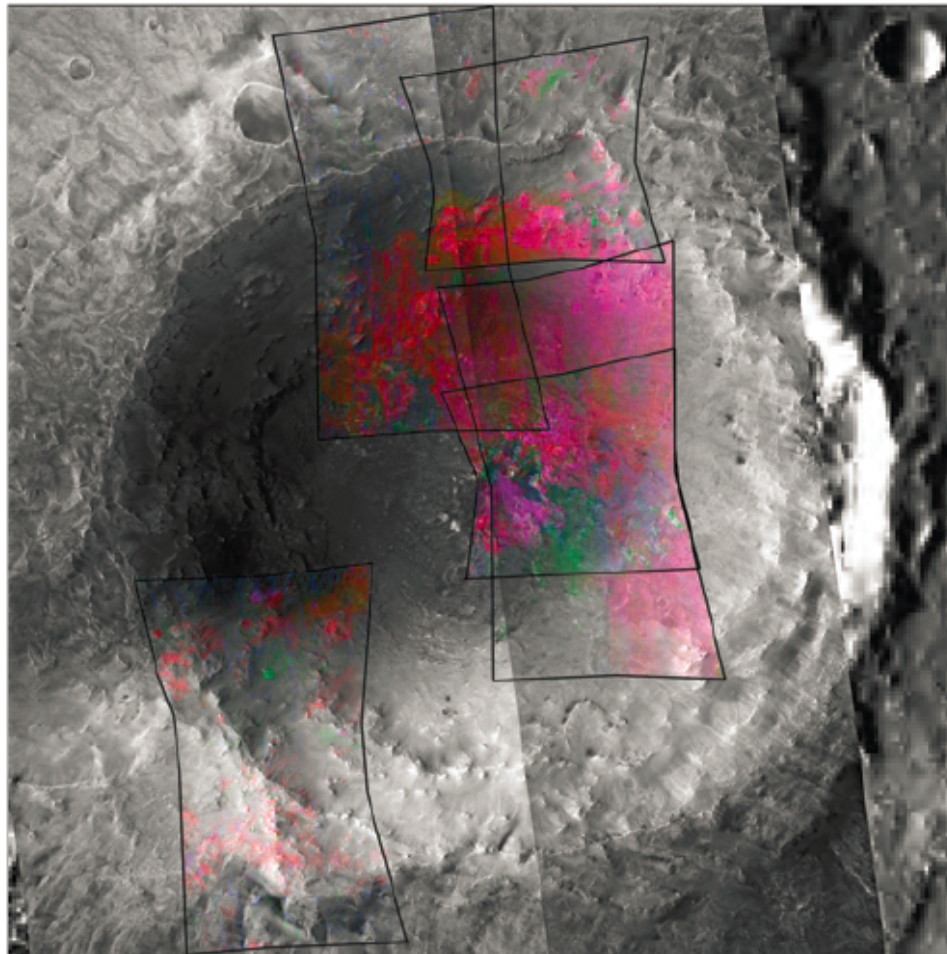
- Concepts: *Several fly-bys vs. single (or 2?) in-situ vs. sample return*
- *Fundamentally a cost-benefit problem, **given the best questions***
- *Instrument suites & Power systems (solar, SEP, nuclear)*

| | Fly-by | Orbiter | Lander |
|---------------------------------|---|--------------------------|---|
| COMPOSITION | | | |
| Bulk chemistry | no? | GRS, neutron | APXS, XRF, wet chem |
| Mineralogy | IR | IR | IR, Raman, MB, XRD |
| Organics/volatiles | IR, sub-mm | IR, UV, sub-mm | UV, IR, Raman, TLS, MS |
| Stable Isotopes | no? | no? | TLS, MS |
| <i>Subsurface access</i> | <i>collision of carried mass; otherwise, none</i> | | <i>µm: landing syt. cm-m: scoop/drill</i> |
| PHYS. PROP | | | |
| Density | orbit path | | µm- to cm-scale |
| Structure/Porosity | radar for macro? | radar for macro? | µm- to cm-scale |
| Thermal Inertia | TIR | TIR | TIR |
| Surface age/processing/roughnes | imaging | Imaging, laser altimetry | space environment effects on RS |

Key Issues/Thoughts

- ***Multiple ($n > \sim 3$) surface visits and multiple ($n > 6$) fly-bys unlikely given present budgetary realities, so we should capitalize on synergies with***
 - Upcoming missions (Hayabusa 2, Rosetta, New Horizons, Dawn, OSIRIS-REX, etc.)
 - New telescopic capabilities (e.g. JWST)
- ***Suggested approach: Identify key “big picture” questions and which concept(s) allow answering one or more***
- ***Key advances enabled by a fly-by/orbiter***
 - From single point composition, mass, shape to surface compositional heterogeneity (increased spatial res \rightarrow increased mineral/ices ID?), gravity field, surface age
- ***Key advances enabled by in-situ science***
 - From structure, surface age, semi-quantitative composition \rightarrow isotopic composition, definitive phase ID, petrologic textures of relationships between phases
- Sample return enables still more analysis than in situ, but complicated to preserve volatiles in their in situ state
- Tradeoff between multiple fly-bys, small # sites for an in-situ visit,
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- How severe do we think space weathering/surface alteration will be?
- What do we gain at the km- to cm-scale? (between telescopes and petrology)

Example: km- to 10s m-scale mineral IDs on Mars → insight on metamorphism (e.g. T 200-400C)
 Is this scale important/likely to be fruitful for small bodies?



■ silica
■ Fe Mg smectite
■ chlorite, prehnite
 5 km

