Astrobiology with a Groundbreaker Quick-Release Sample Return mission

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Groundbreaking MSR: Science Requirements and Cost Estimates for a first Mars Surface-Sample Return Mission. MacPherson et al. 2002.

MEPAG Study

Main finding:
"The first surface-sample return mission from Mars… should consist of a simple lander whose only tools are an extendable arm with very simple sampling devices…"

Simple First MSR

Scenarios that might motivate a simple MSR

- Technology test for human exploration
- Site certification for human exploration
- Low availability of science funds for MSR
- All of the above

⇒Science is likely to be just one of many motivations on the first MSR.

First MSR

Must solve significant new technology challenges

- launch from Mars
- in orbit rendezvous
- comply with planetary protection
  - break chain of contact with the surface
  - fail safe Earth re-entry
  - release plan

Planetary Protection

The first MSR will be of particular importance

- break chain of contact with the surface
  no flexibility here
- fail safe Earth re-entry
  no flexibility here
- release plan
  yes, flexibility here

Sample Handling Facility

A combined containment lab and clean room

- If required before the first MSR it is a significant cost and schedule problem.
- If designed before samples, could follow a worst case scenario.
- Building after the first MSR reduces schedule & cost and reduces design uncertainty.

$\Rightarrow$ Make first MSR independent of a facility.

Sterilize the first sample

Allows a nominal curation and release plan

- Recognize that back-contamination is a public policy issue and not a just science issue.
- Recognize that there will be considerable public attention on the first MSR.
- Recognize that the Earth re-entry will be perceived as high risk.

⇒Sterilization of the sample to medical standards could solve this issue.

Groundbreaker Quick Release Scenario

- Simple sample collection (no mobility)

- Sterilization, enroute, to medical standards
  - gamma radiation sterilization (20 Mrad) is a significant technology & launch issue
  - heating to ~150ºC for several days, monitoring T, CO_2, and H_2O: a DTA experiment

Astrobiology with a Groundbreaker Quick Release MSR

- Light element (C,N,O etc) geochemistry and isotopes (esp. nitrates, carbonates, etc).
- Chemical weathering that formed the soil
- Organics. The Viking limit (ppb) is suspect
  - GCMS limit is ppb but pyrolysis may be ppm
  - refractory organics (T>500ºC)
  - search for IDP
- Magnetic fraction. Possibly of biogenic origin
- Oxidant(s) and Fe redox state
- Toxicity

Comparison to the Basalt Mission (J. Jones this morning)

- Same approach: a simple first mission
- Don't try to solve the "life on Mars" question in a single mission. The Viking mistake.
- Soil collected probably adequate for most of the Astrobiology goals listed above
- Main difference: for Astrobiology it probably makes more sense to return to a MER or MSL site
  - connect soil to local rocks
  - connect to in situ measurements

Conclusions

- Continue developing optimal & baseline science scenarios for MSR for science-driven missions.
- Also have a well defined science floor for the first MSR or non science-driven missions.
- For Astrobiology a Groundbreaker Quick Release MSR is of value and forms a science floor.
  - no mobility, simple instruments
  - sterilized samples

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