Report:
Mars Returned Sample Quality Workshop

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MEPAG meeting
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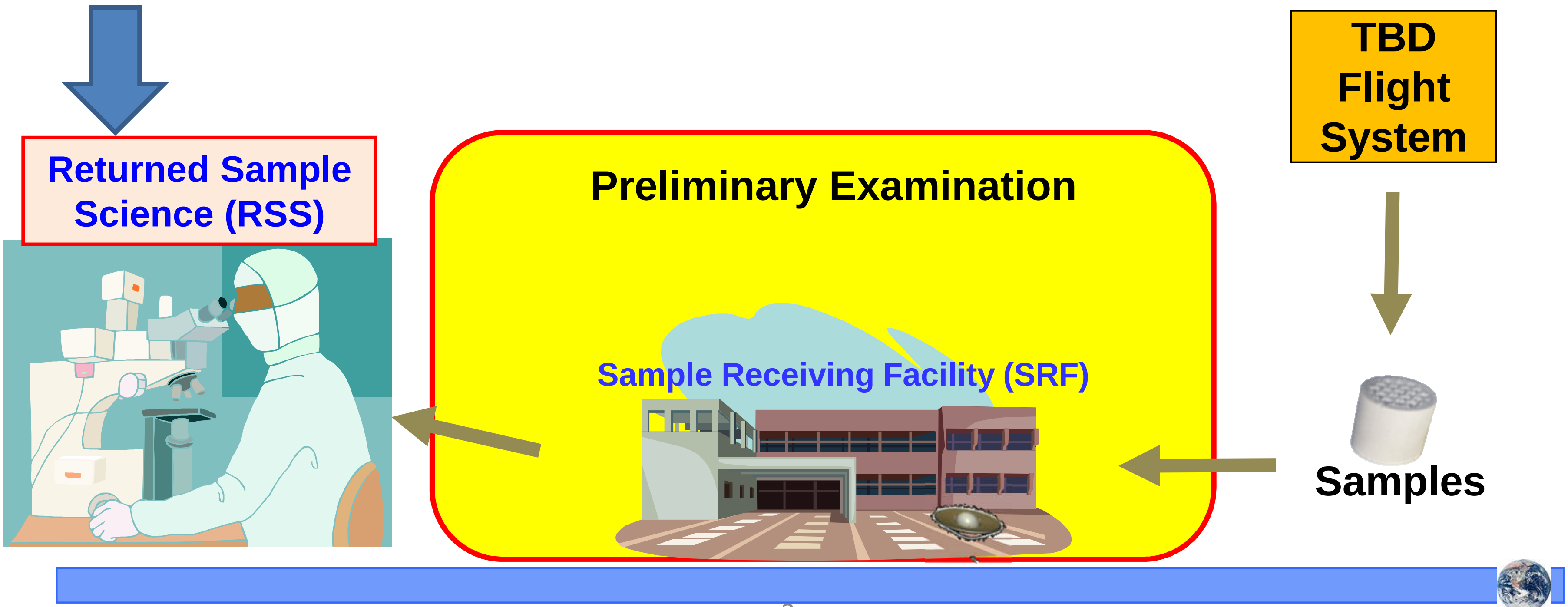
How Important is Sample Quality?

<u>HYPOTHETICAL:</u>

IF MARS SAMPLES WERE RETURNED TO EARTH, WHAT STATE WOULD THEY NEED TO BE IN TO BE SCIENTIFICALLY USEFUL?



Part 1.

Rock Samples

Approach

Focus Group: Carlton Allen, Lars Borg, Dave Des Marais, Chris Herd, Scott McLennan

Pre-Workshop

- Define science investigations for each potential RSS objective
- Draft assessment of sample quality factors that might impact RSS science investigations
- Define draft requirements (w.r.t. RSS) for quality factors
- Formulate draft requirements for sample quality

LPSC Workshop March 16th, 2014

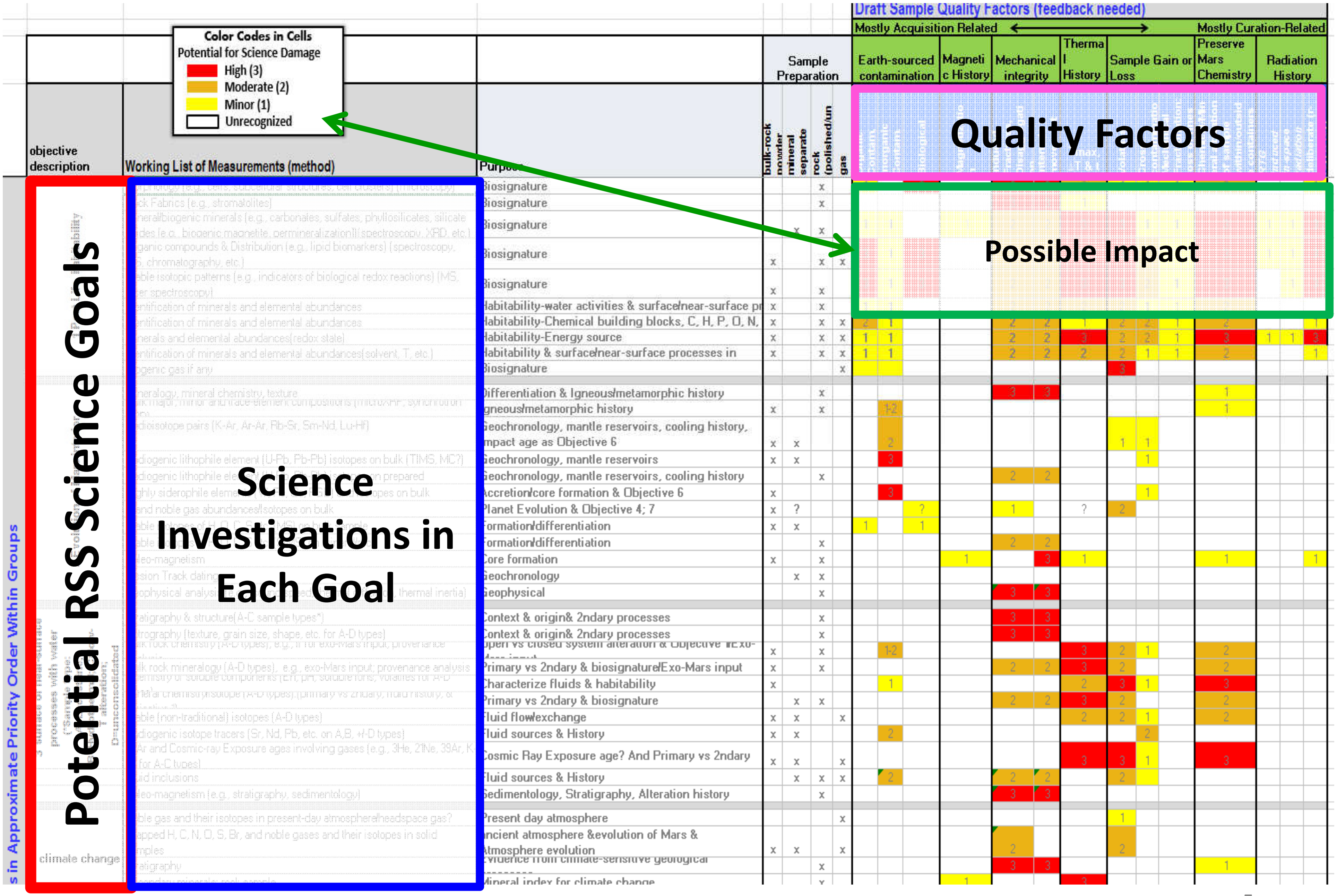
- Participants: 30+ sample scientists from universities and NASA centers
- Review and edit the starting materials above
- Input on quantifying potential sample quality requirements
- Prioritize the quality factors

Post-Workshop

- Close out open issues identified at workshop
- Derive sample quality requirements for M-2020

Continuous involvement of scientists (community, M-2020, program) and engineers (project, program)

Rock Samples: Sample Quality Matrix



Example

Investigations Related to E2E-iSAG #1: Past Life, Habitability

Working List of Measurements (method)	Purpose	Sample Preparation			
		Powder	Minerals	Rock	Gas
Morphology (e.g., cells, subcellular structures, cell clusters) (microscopy)	Biosignature				
Rock Fabrics (e.g., stromatolites)	Biosignature			x	
Mineral/biogenic minerals (e.g., carbonates, sulfates, phyllosilicates, silicate oxides [e.g., biogenic magnetite, permineralization])(spectroscopy, XRD, etc.)	Biosignature		x	x	
Organic compounds & Distribution (e.g., lipid biomarkers) (spectroscopy, MS, chromatography, etc.)	Biosignature	x		x	x
Stable isotopic patterns (e.g., indicators of biological redox reactions) (MS, laser spectroscopy)	Biosignature	x		x	
Identification of minerals and elemental abundances	Habitability-water activities & surface /near-surface processes	x		x	
Identification of minerals and elemental abundances	Habitability-Chemical building blocks, C, H, P, O, N, S	x		x	x
Minerals and elemental abundances(redox state)	Habitability-Energy source	x		x	x
Identification of minerals and elemental abundances(solvent, T, etc)	Habitability & surface /near-surface processes involving water	x		x	x
Biogenic gas if any	Biosignature				x

Part II: Sample Quality Factors & Requirement

Mostly Acquisition Related

- Earth Sourced Contamination
  - Organic/Biological (input from Organic Contamination Panel)
  - Inorganic
- Magnetic History
- Mechanical Properties
  - Fracturing
  - Movement of fragments
- Thermal History
- Radiation History
- Sample Gain/Loss
  - Volatiles
  - Cross-Contamination
  - Loss of drilled samples
- Preserve Mars Chemistry: Chemical/Mineral alteration of sample within/outside containers

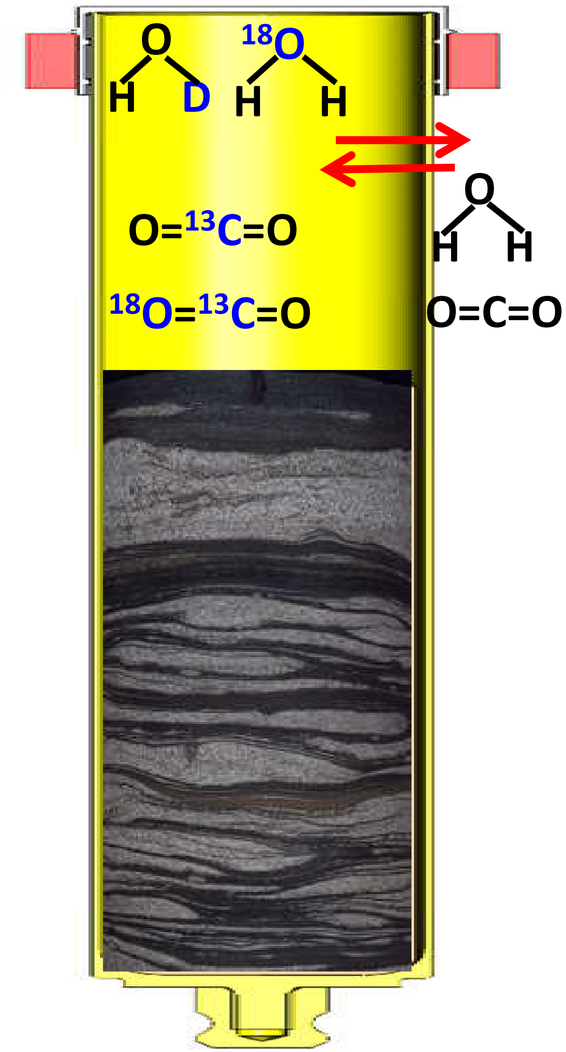
Mostly Curation Related

Organic Contamination Panel

See example next chart

Example

Gain/loss of Volatiles



Draft Requirement

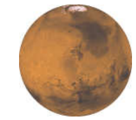
Samples should be acquired, transported, and made available to scientific research in a manner that shall have a greater than 80% confidence that seals for individual samples have a leak rate <TBD cc_{Mars} of He/second.

Input from 03-16-14 Workshop

- Strategy and requirement agreed to limit loss of volatiles to <1% of original water.
- Additionally, agreement on a non-sealing failure rate (e.g., like 20% of samples can fail to seal).

See complete list in handout table

Draft Priority of Sample Quality Factors
from 2014 LPSC Workshop



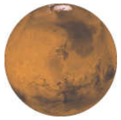
Potential Magnitude of Impact	L	M	H
H		*Inorganic Contamination*	• *Organic Contamination* • *Fracturing* • *Movement of Fragment* • *Loss of Drilled Samples* • *Volatile Loss or Gain* • *Thermal History*
M		*Chemical/Mineral Alteration of Samples within and outside of Containers*	*Biological Contamination*
L	*Radiation History*	• *Cross Contamination* • *Magnetic History*	

Priority of Science Investigations Affected

Part 2.

Soil Samples

Scientific Significance of Martian Soils

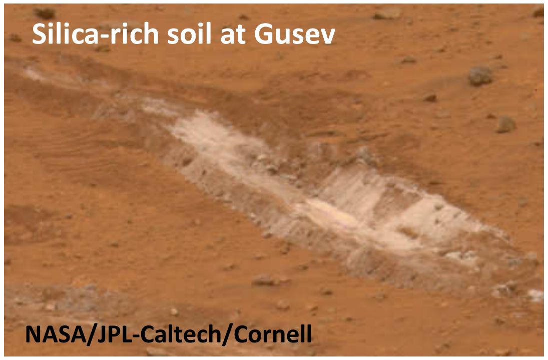


Focus Group: Mike Mellon, Doug Ming, Dick Morris, Sarah Noble, Rob Sullivan, Larry Taylor,

Physical, structural, chemical, mineralogical properties of soils and their lithic components are important for:

- **Climate-soil interactions**
- **Differentiation and evolution of Martian crust and mantle**
- **Surface/near-surface processes with or without water**
- **Habitability**
- **Future human exploration (hazards, resource, etc.)**

Present Knowledge of Martian Soils



- **Previous missions analyzed soils to <10-20 cm depth.**
- **From the surface to shallow depth, dust-rich and dark soils are typically present (exceptions exist), and chemical variations with depth are observed occasionally.**
- **Global, Regional, and Local Input. Broadly basaltic with diversity in soils, e.g., sulfur- or silica-rich soils at Gusev**
- **Chemistry suggestive of fluid activity**
- **Unconsolidated materials display a wide size range from 10's of µm to a few mm.**

Soil-related Recommendations

Questions	Recommendation	Rationale
Need to preserve stratigraphy?	Important to sample coarse-scale stratigraphy, but accept that fine stratigraphy can't be maintained in sample tube	Hypotheses related to atm-regolith interactions, or changes with surface/sub-surface conditions
Number of samples?	Minimum 1-2 soil samples, with the capability for more if peculiar soils are encountered	Depend on landing site One for the very top surface; and the other (mature, no dust); if peculiar soils (e.g., sulfur-rich, silica-rich) or stratigraphy are encountered
Collect rock fragments?	Yes as long as they fit in the sampling holder	Soil may contain rock types not sampled by rovers or meteorites

Sample quality requirement for rocks can be applied to soils

The final sampling strategy is landing-site dependent, and would consist of numerous *ad hoc* decisions until we have a chance to interrogate the Mars-2020 site on the surface

Summary

- Understanding the relationship between the condition of the samples as received by a potential future analyst, and the science that could be achieved, is central to understanding the cost/benefit relationships of Mars Sample Return.
- Feedback from all sectors of the community on this draft analysis is encouraged.

- Please send comments to:
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