

Preparing for the Next Generation of Lunar Sample Return.

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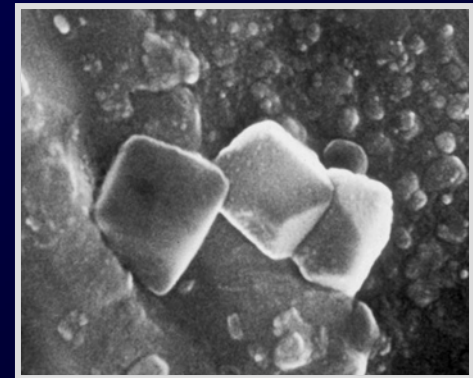
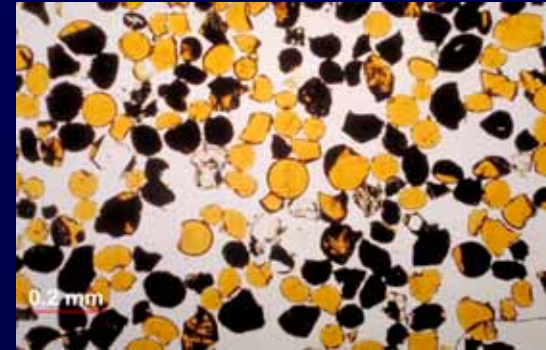
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Why Sample Return?

- Return of lunar samples provide a unique perspective – the opportunity to study the returned material in well equipped Earth labs.
- This unique perspective is based on scale (down to angstroms), precision, sample manipulation capability, and the ability to modify analytical experiments as logic and technology evolves.
- Sample analyses have led to many of our fundamental concepts of the origin and evolution of the Moon, Earth-Moon system, and rocky planets.



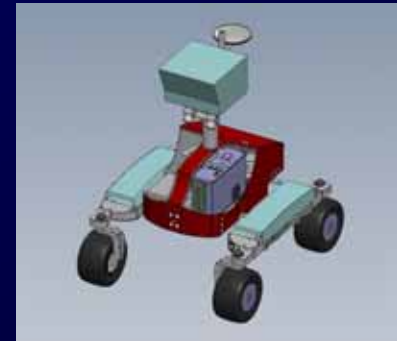
Outline



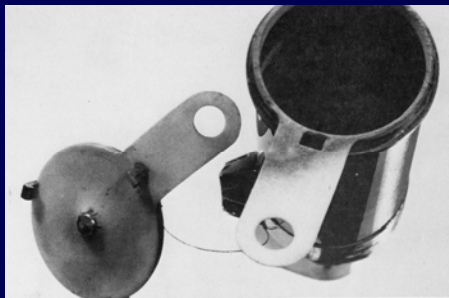
Linkages between lunar sample acquisition –curation and lunar exploration.



Sample mass and volume.



Sample analysis on the lunar surface.



Sample acquisition, contamination and preservation.

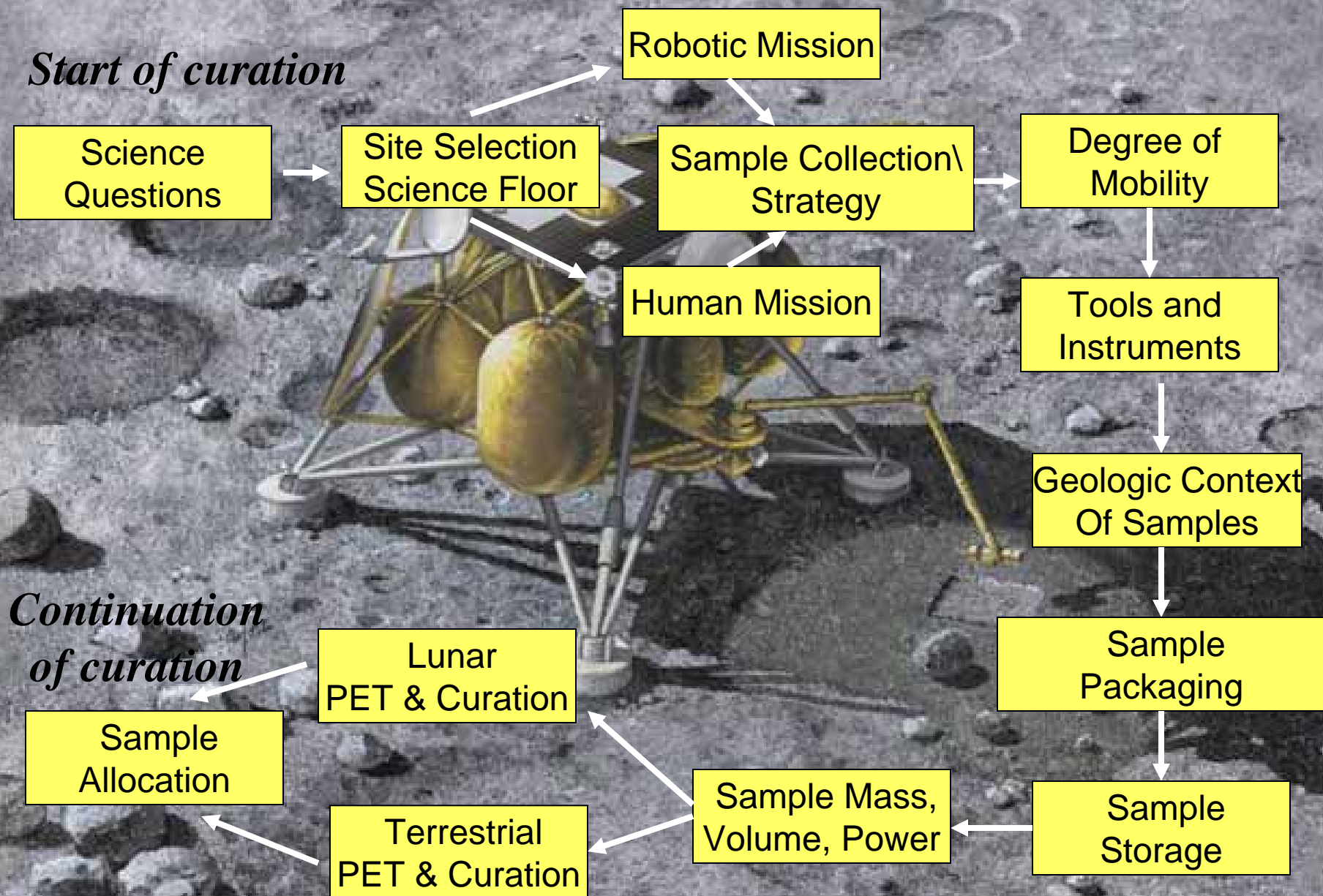


Curation facility and infrastructure needs.



Moving forward.

Flow chart for lunar sample return



CAPTEM Analysis of Sample Mass and Volume

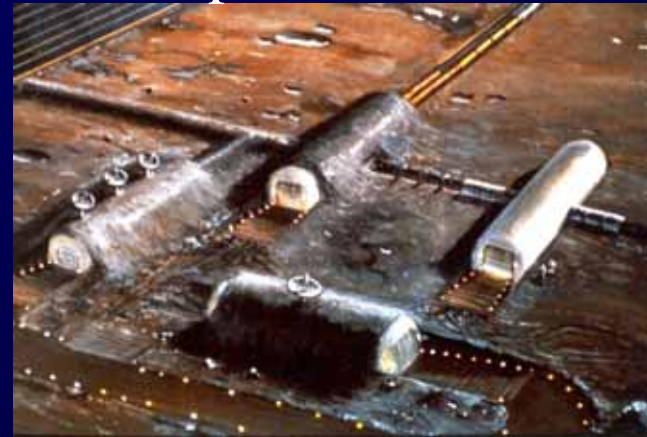
- The lunar exploration architecture should accommodate 150 kg of traditional geological samples for return to Earth.
 - This geological sample mass exceeds that of the Apollo 17 mission by only 35%. Yet, it is substantially less than a mission could potential collect.
 - Container mass needed to accommodate 150 kg of lunar samples is approximately 30 kg. Equal to 3 Apollo Lunar Sample Return Containers, 4800 cm³ of volume.
- To accommodate the preservation of volatile-bearing samples, an additional 36 kg of samples and containers need to be included in the architecture capability.
- On the basis of our analysis, a total mass capability of 250 to 300 kg is appropriate to accommodate all materials (biological, geological, engineering) and associated containers from the lunar surface.

Sample analysis on the lunar surface.

Sortie scenario



Outpost scenario



- The training of astronauts to perform as scientists and geologists on the surface of the Moon.
- An important augmentation to human observations is the development of simple analytical tools that assist the astronaut in sample selection. Clearly, these tools need to be miniaturized, user friendly, safe, and provide rapid results. KISS.

Sample analysis on the lunar surface.

Sortie scenario



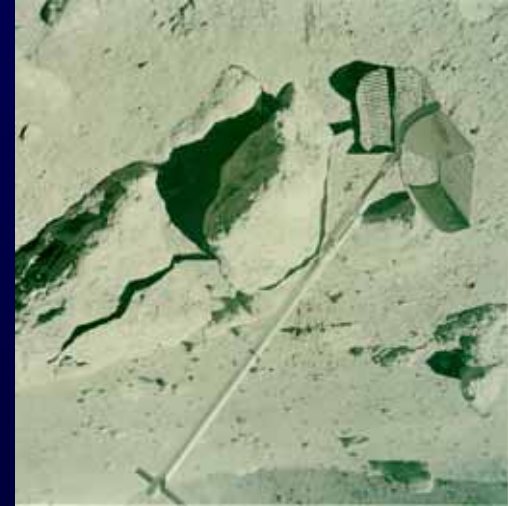
Outpost scenario



- For the outpost scenario, science and sample strategies must be defined carefully before the identification of instrumentation, outpost power requirements, and consumables for sample preparation.
- The sample handling strategies in the outpost scenario must always include considerations of contamination.

Sample acquisition, contamination and preservation.

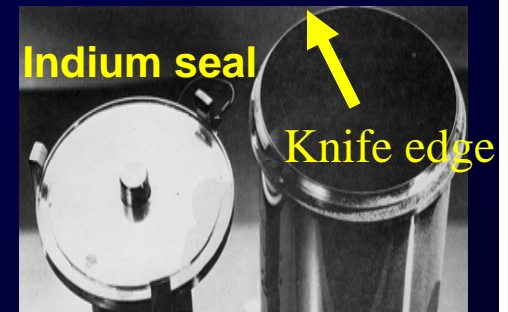
The Apollo Program was extremely successful in reducing contamination levels during sample collection. There were, however, some mistakes.



Sample acquisition, contamination and preservation.

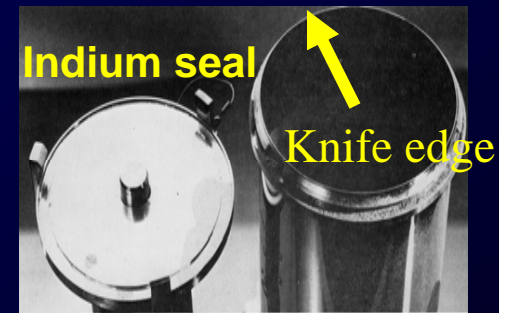
EXAMPLES:

- Indium (10%Ag) Seals, Rock Boxes, etc.
- A15 drill core, Ti alloy, threads canadized in Pb bath.
- Core bit with WC cutters brazed to drill stem; W, Ni, Pb?
- Band saw blade diamonds adhered in electroplated Ni.



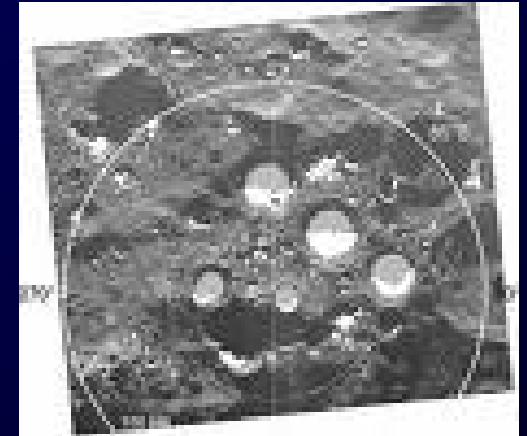
Sample acquisition, contamination and preservation.

- Such mistakes point to the need for close cooperation between the science and engineering communities during the design and manufacture of hardware.
- Preserving sample pristinity must take precedence over standard engineering materials that might make acquiring samples relatively easy, but in doing so contaminate the sample.



Sample acquisition, contamination and preservation.

- Collection of volatile-rich material within permanently shadowed lunar polar regions is a near-term high priority objective.
- Retaining volatiles that occur on grain surfaces in the lunar regolith and minimizing modification to minerals susceptible to phase changes or chemical alteration (i.e. oxyhydration of lawrencite, modification of hydrites) in a non-lunar environment is also critical.
- Eliminating the loss of finest fraction of regolith.



Sample acquisition, contamination and preservation.

- Strategy and investments:
 - Design light weight containers that fit into both exploration architecture and preserve the integrity of samples.
 - The design of new containers for the return of samples that contain volatiles is a top priority.
 - Technologies for cold/cryogenic and organic-contamination-free collection-storage are necessary to enable the sampling of these types of samples.
 - Pressure, humidity, and temperature management are necessary to maintain sample integrity and minimize sample phase changes.



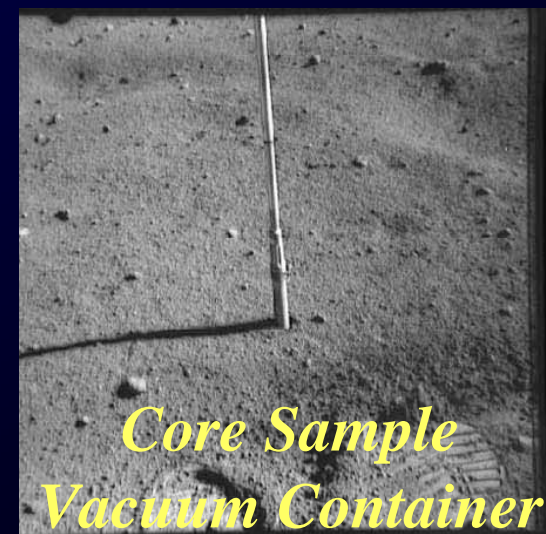
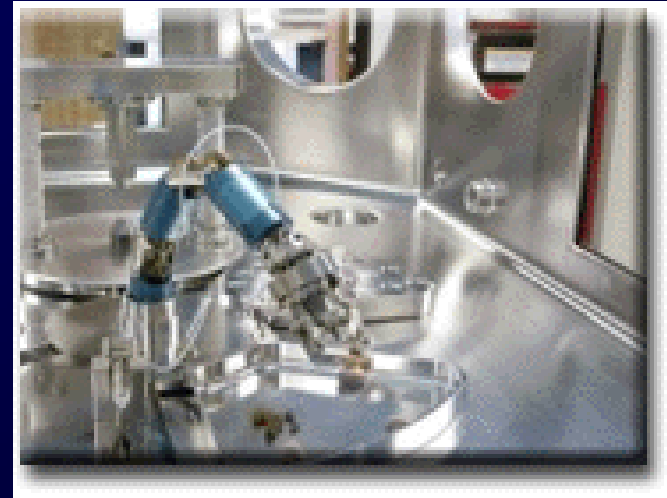
Curation facility and infrastructure needs.

- It is important to examine the current capacity and infrastructure available at the Lunar Sample Facility at the Johnson Space Center and the White Sands Test Facility.
- Devise strategy for lunar surface “curation” .



Advanced curation of fragile or environmentally sensitive samples.

- Icy regolith, volatile-rich materials, and reactive-samples present new technological challenges for curation.
- New curation techniques must be developed for preliminary examination, preservation, contamination, and allocation.
- Perhaps the first step is to examine some of the uniquely collected and stored sample returned during the Apollo program.



*Core Sample
Vacuum Container*

Moving Forward

Optimizing Science and Exploration Working Group (OSEWGW).

A joint CAPTEM-LEAG Response to NRC and NAC recommendations through the Lunar Sample Acquisition and Curation Team (LSACT).