CURATION FACILITY STUDY FOR MOON SAMPLE RETURN MISSION

John Robert Brucato
INAF – Astrophysical Observatory of Arcetri, Firenze, Italy
Sara Russell
The Natural History Museum, London, UK
Caroline Smith
The Natural History Museum, London, UK
Andrea Meneghin
INAF – Astrophysical Observatory of Arcetri, Firenze, Italy
Ludovic Ferrière
Natural History Museum, Vienna, Austria
Luigi Folco
University of Pisa, Dept. of Earth Science, Pisa, Italy
Ian Franchi
Planetary & Space Sciences, The Open University, Milton Keynes, UK
Aurore Hutzler
Natural History Museum, Vienna, Austria
Petra Rettberg
DLR – Institute of Aerospace Medicine, Cologne, Germany

Moon 2020-2030 Symposium

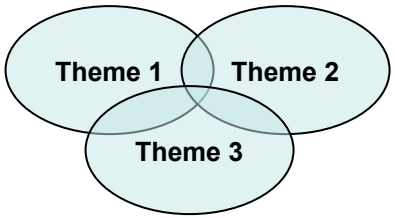
Almost all SR missions have to deal with following scientific themes:

Theme 1: ***What are the original conditions of the Solar Nebula;***

Theme 2: ***What are the evolutionary processes occurred during the Solar System lifetime;***

Theme 3: ***What is the role of extraterrestrial primitive materials in the origin of life on Earth and elsewhere.***

A challenging mission is motivated if answers to questions raised up by these three themes will be given simultaneously.



Sample Return mission opens new perspectives

Analyses of organic compounds that could be responsible for the origin of life on Earth;

Discovery primitive materials preserved during Solar System formation;

Understanding evolutionary processes occurred during the Solar System lifetime.

Development of Sample Return technologies suitable for future exploration: *Sampling mechanism, Earth return vehicle, re-entry capsule*.

Development of robotic systems able to make use of SR resources for human exploration.

Development of Curation Centers for analyses, delivery and storage of ET samples.

Educational Return

Public-Outreach

To build an European Sample Curation Facility is an essential asset to guarantee the scientific return of sample return missions and to maintain and develop an independent capability for planetary exploration in Europe.

EURO-CARES: A Roadmap for a European Sample Return Mission Curation Facility

COMPET-8-2014: sample curation facility and scientific exploitation of data from Mars missions

European Commission

Runs January 2015- December 2018

Mission: To roadmap a European Sample Return Curation Facility to receive and curate samples returned from Asteroids, the Moon and Mars

EURO-CARES
EURO-Curation of Astromaterials Returned from the Exploration of Space

is lead by NATURAL HISTORY MUSEUM London

naturhistorisches museum wien nhm

OSSERVATORIO ASTROFISICO DI ARCETRI
INAF ISTITUTO NAZIONALE DI ASTROFISICA

CBM
Centre de Biophysique Moléculaire

DLR

UNIVERSITY OF LEICESTER

MUSEUM NATIONAL D'HISTOIRE NATURELLE

ULB UNIVERSITÉ LIBRE DE BRUXELLES

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General activities of storage and curation facility

- To prevent mineralogical, chemical and physical alteration of samples;
- To protect samples from chemical (inorganic and organic) and particulate contamination;
- To catalogue and archive the samples;
- To document sample handling history;
- To perform and document the sample preliminary examinations;

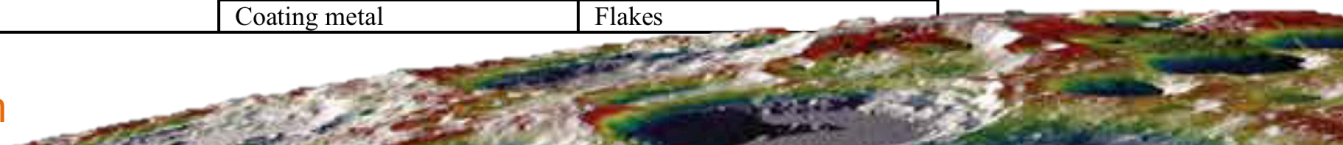
- To separate and prepare samples;
- To distribute samples to scientists around the world for detailed study;
- To preserve a portion of each sample collection for future study;
- To secure the samples;
- To spread information of scientific results to the public.

The contamination prevention must be regularly satisfied during all the following operational tasks inside the Curation:

- Earyh Re-entry Capsule (ERC) handling;
- Sample handling;
- ERC storage;
- Sample storage;
- Sample characterization;
- Sample delivery to external laboratories and retrieving;
- Maintenance of Curation facility.

Contamination control

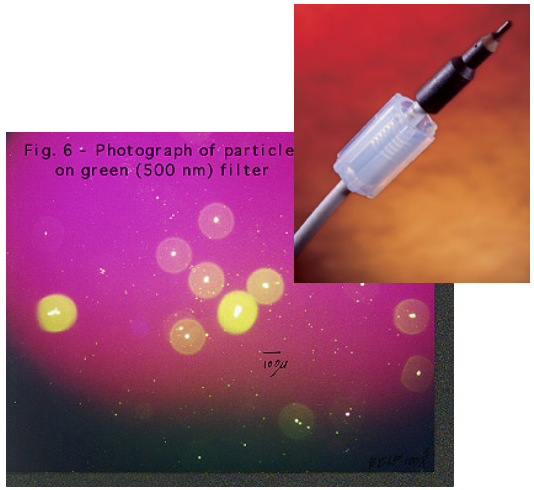
Source	Contaminant	Type
Facility	Surface coatings: walls, floors and roofs	Particulate & liquids
	Surface desorbed water	Liquids
	Building materials	Particulate
	Air conditioning	Particulate, liquidss
	Room air	Particulate, molecular
	Spills and leaks	Liquid, molecular
	Air filters	Particulate
	Packing	Plasticizers and liquidss
	Containers	Particulate, flakes
People	Skin	Biological (cells), flakes
	Skin fat	Liquids
	Cosmetics	Molecular, particulate
	Spittle	Liquids
	Clothing fibers	Particulate
	Particles in hair or clothes	Particulate
	Hair	Biological thread
	Bacteria, fungi and viruses	Biological
	Water	Molecular, liquids
	Organics	Molecular
	Secondary microorganism products	Molecular, biofilm
Tools	Friction and wear	Particulate
	Lubricants and emissions	Molecular, liquids
	Vibrations	Particulate, thread
	Brooms and mops	Solids
	Spatters	Liquids, solid film
	Cleaning chemicals	Molecular, liquids
	Plasticizers	Molecular (outgases)
	Adhesive plates	Molecular
	Machine oils	Liquids
Product generated	Teflon	Flakes, molecular
	Quartz	Flakes
	Aluminium	Particulate, molecular
	Gold	Particulate, molecular
	Stainless steel	Particulate, molecular
	Coating metal	Flakes



Contamination control

Contamination control sequences will cover the following aspects:

- Trace chemical analysis;
- Trace metal analysis;
- Trace elemental analysis;
- Organic contaminant identification;
- Inorganic contaminant identification;
- Particulate contaminant identification.
- Biological contaminant identification.



Contamination control will be performed on:

- Sample containers;
- Clean room environment;
- Processing cabinet;
- Witness plates flown (e.g. spacecraft fuel, lubrificants, etc.);
- Flight hardware
- Testing samples.

Environmental Monitoring

A control plan needs to be prepared according to ESA or state guidelines

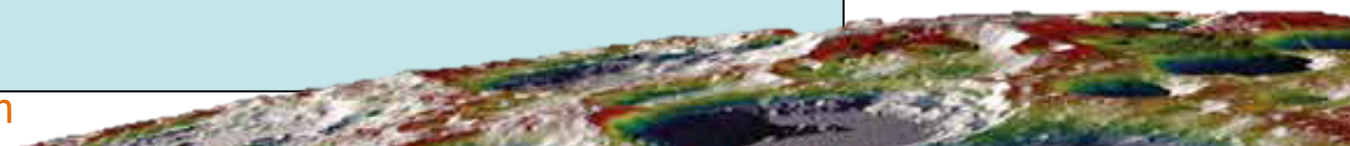
Obtain Representative Samples

Use Appropriate Sampling Method

Use Appropriate Analytical Method

Ensure Adequate Records of Chain of Operations

Develop a Sound DataBase



Avoid Sample Alterations

The best solution is to keep the samples at conditions mimicking those they have experienced at their collection site

High temperature can change sample properties and induce desorption of volatiles.

Interaction with gasses might cause sample chemical alteration.

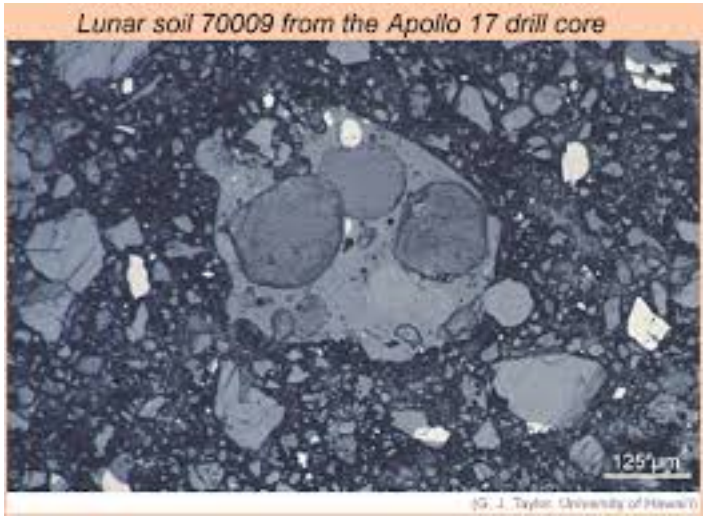
Illumination could alter chemical characteristics of returned samples through photochemical processes.

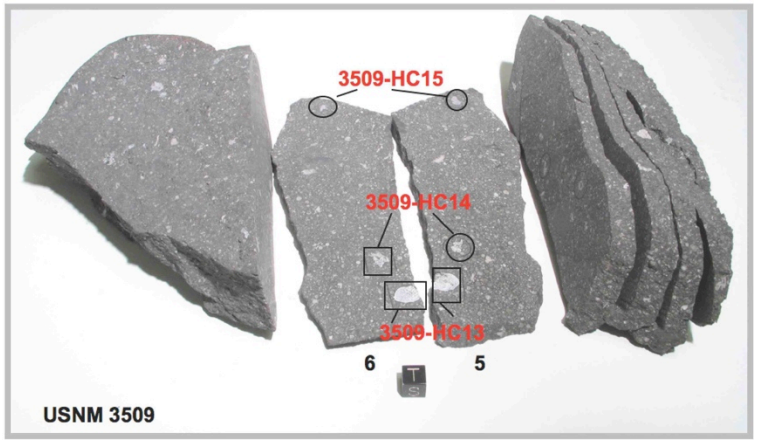
Exposure to magnetic sources may alter the original samples magnetic properties.

The presence of naturally occurring radionuclide in soil, rocks, water, and air along with cosmic radiation results in continuous and largely unavoidable radiation exposure.

Sample Preparation

- Separation of pebbles and dust;
- Sample preliminary examination;
- Sample classification;
- Polished sections of pebbles and dust;
- Separation of samples to be delivered to laboratory for studies and those stored indefinitely in the facility;
- Sample allocation in special holders for delivering to worldwide laboratories.





Preliminary Characterization

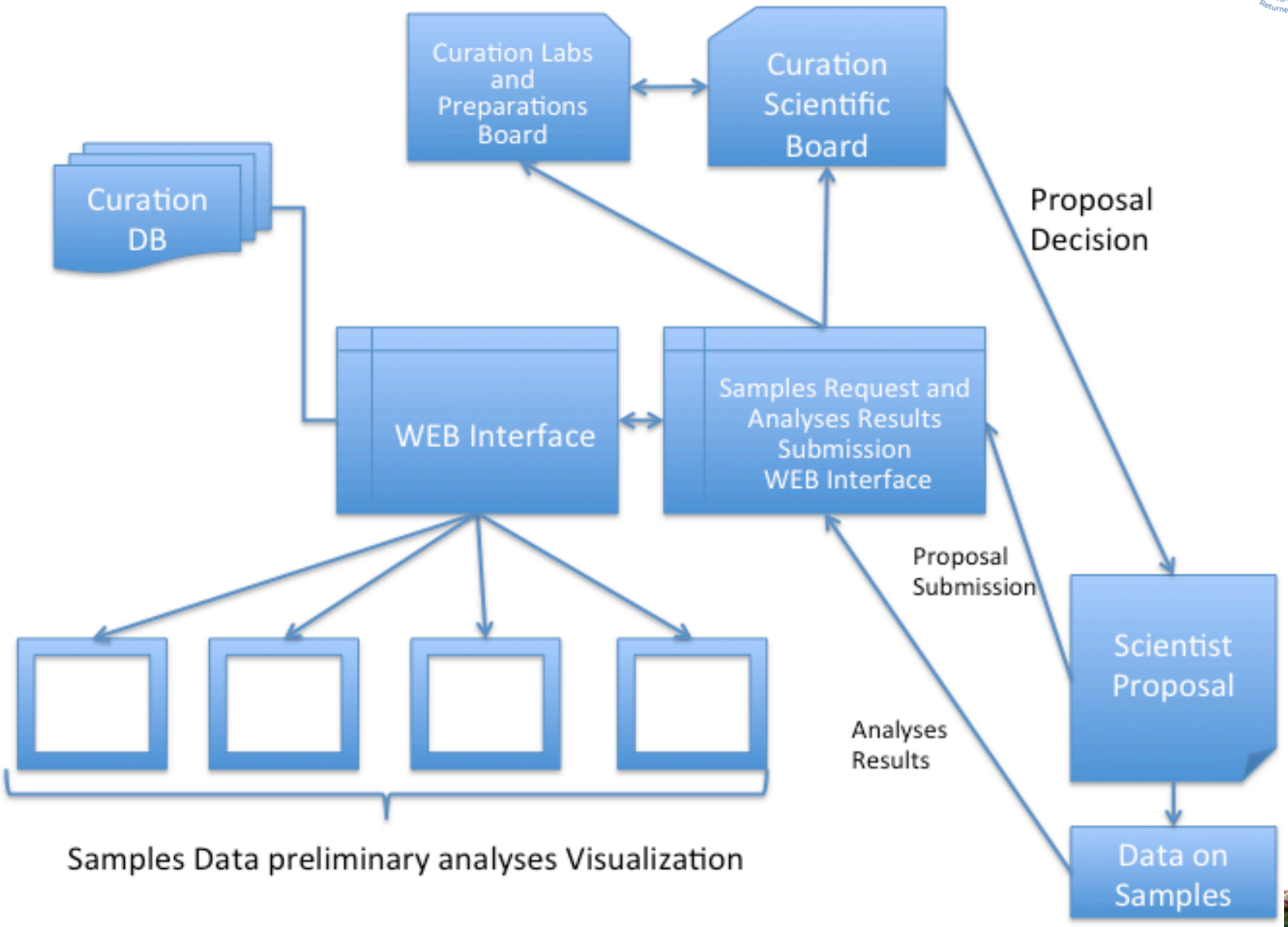
Imaging	Optical microscopy Scanning Electron Microscopy (SEM) X-ray CT
Mineralogy	X-ray Diffraction (XRD) Visible-Infrared spectroscopy Microanalysis scanning Electron Microscopy (SEM-EDX) High precision balance
Organic analyses	Visible-Infrared micro spectroscopy Micro Raman spectroscopy
Fluid Inclusion	Micro-Raman Spectroscopy Optical petrography

Curation Database

Samples will be catalogued in order to set up a series of self-consistent describing elements according to:

- Specimen description: name, physical properties, preliminary investigation data set, classification.
- Sample description: name, type (e.g. rock, pebbles, dust), form (e.g., single chip, cube, plate, fragments, many grains, powder, etc.).
- Sampling site (e.g., outer part, inner part, central, etc.).
- Sample allocation.

Web Interface to External Laboratories



Sample Manipulation Cabinet

- De-integration of Earth Re-entry Capsule (ERC)
- Extraction of sampling mechanism from the canister
- Extraction of samples
- Cataloguing and characterization of samples
- Samples allocation on special holders for storange and delivey
- Check of retrieved samples

Sample Manipulation Cabinet

- Characteristics-

Controlled Environment

- Single or double level of containment
- Ultra high purity environment

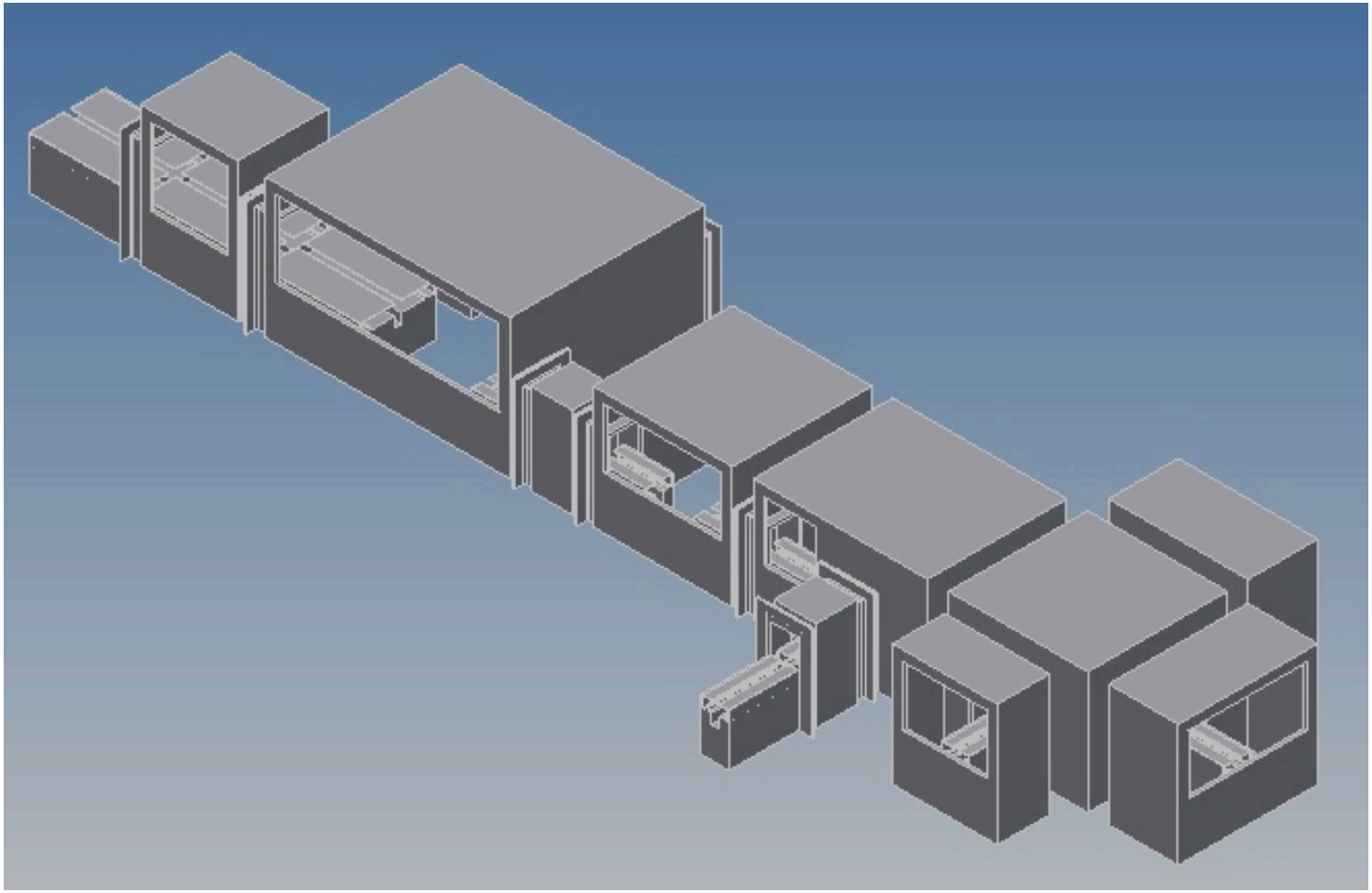
Interfaces

- Unified control systems and instruments
- Remotely controlled robotic manipulators
- Manual access

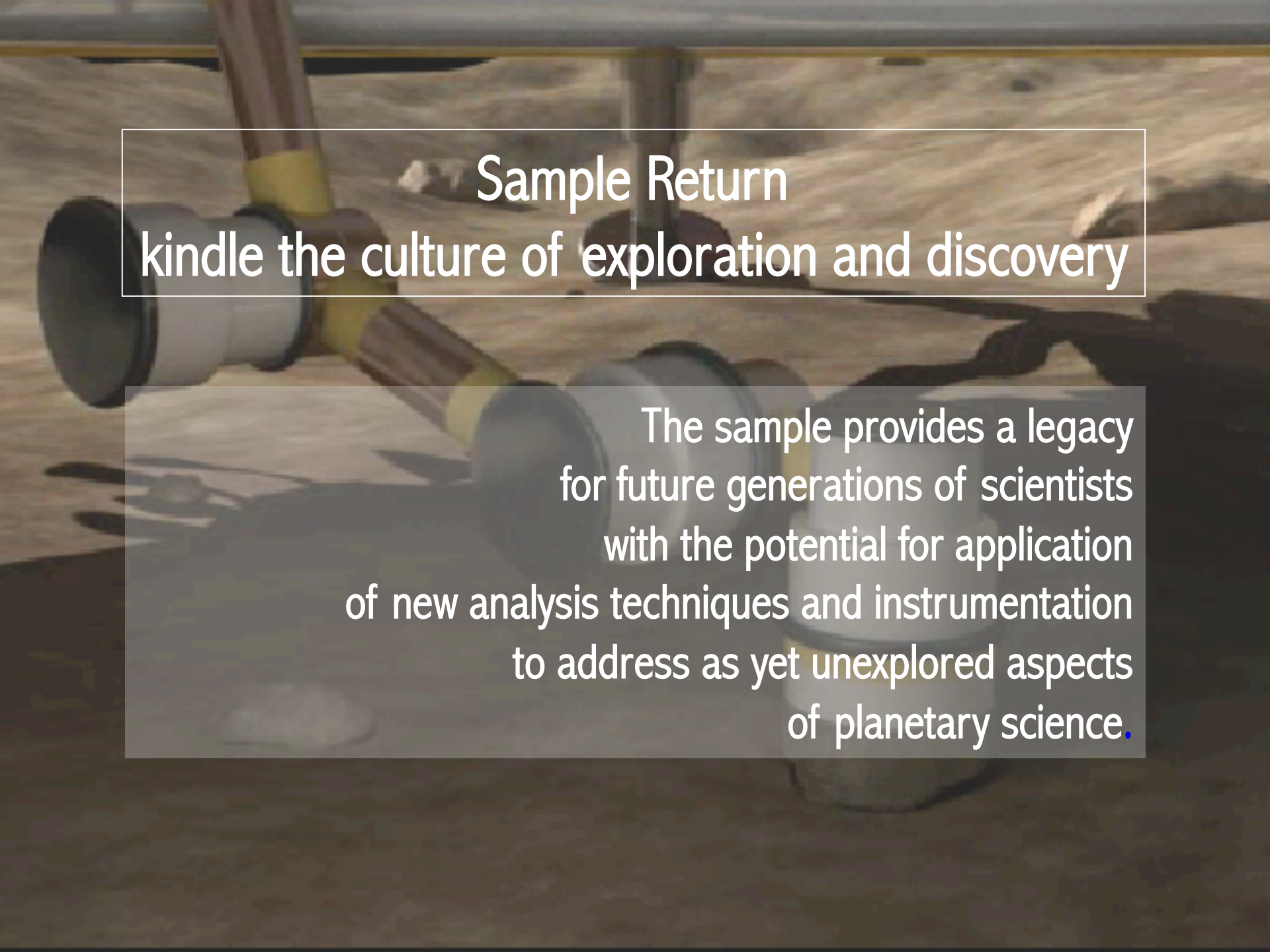
Modularity

- Versatility

Sample Manipulation Cabinet



(From Sample Curation Facility for MarcoPolo-R ESA M3 study mission)


Sample Return
kindle the culture of exploration and discovery
The sample provides a legacy
for future generations of scientists
with the potential for application
of new analysis techniques and instrumentation
to address as yet unexplored aspects
of planetary science.