SAMPLE ANALOGUE CURATION ACTIVITIES at ESA

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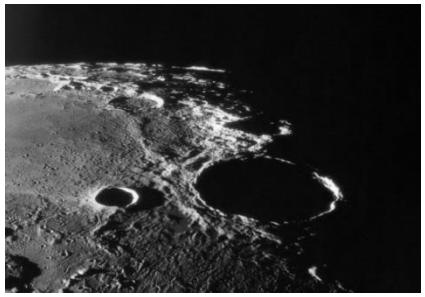
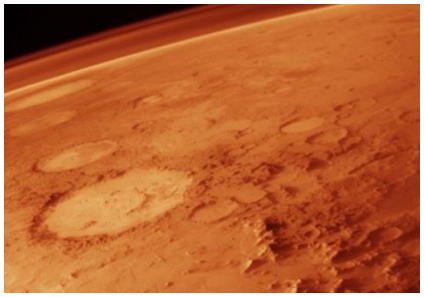
01/06/2016

PROGRAMMATIC FRAMEWORK

ISS/ Mission implementation and operations (Phase B2/C/D/E)



ISS PHASE 3

EXOMARS

Utilisation for the benefits of humanity and preparation of human exploration

ELIPS FOLLOW-ON

Technology & Mission Definition (Phase A/B1)

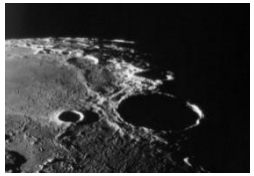
MREP FOLLOW-ON

STRATEGIC MISSION ROADMAP

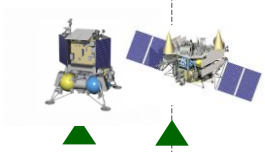
- Planned Robotic Missions
- Potential mid 2020's Robotic Exploration Missions

Potential for cooperation with NASA

MOON



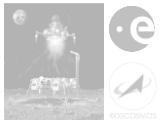
Luna 25 Luna 26



Luna 27

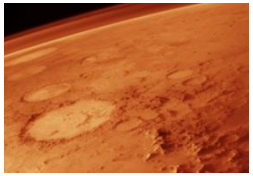
Lunar Volatile Prospector

Lunar Sample Return



TBD

MARS



ESA ExoMars Orbiter

ESA ExoMars Rover

NASA 2020 Rover

NASA Next Orbiter

Phobos Sample Return

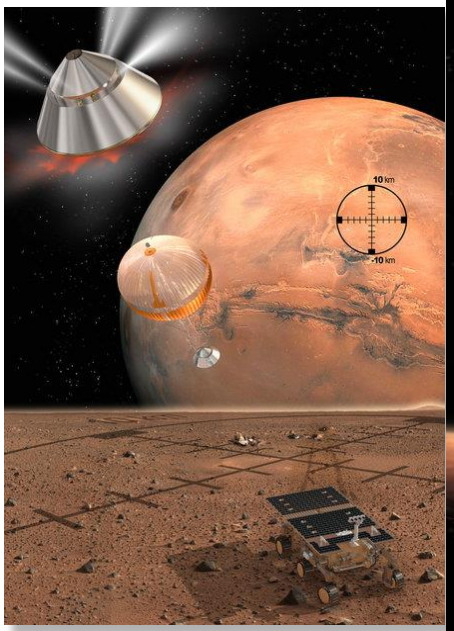
NASA Next Lander

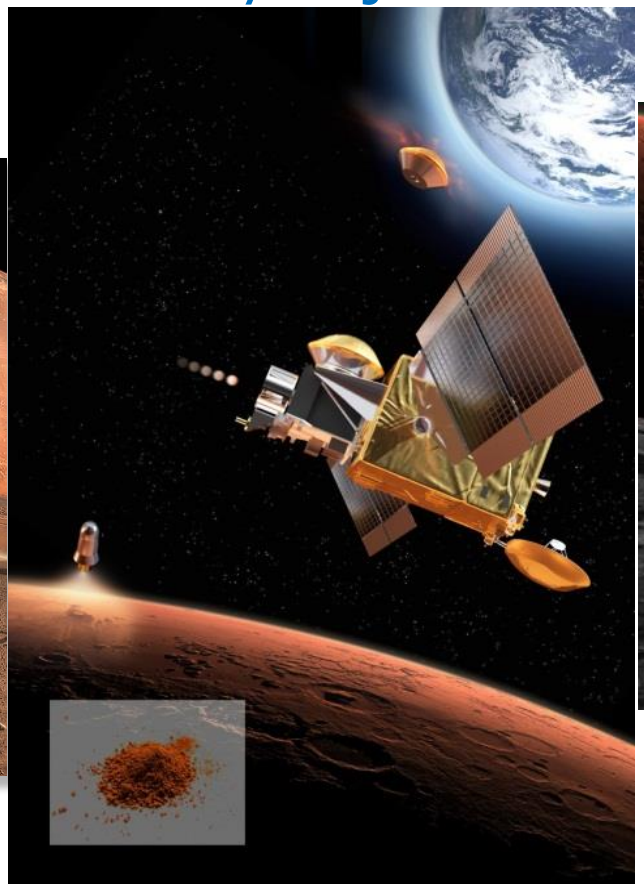
TBD

2016 2018 2020 2022 2024 2026 2028 2030

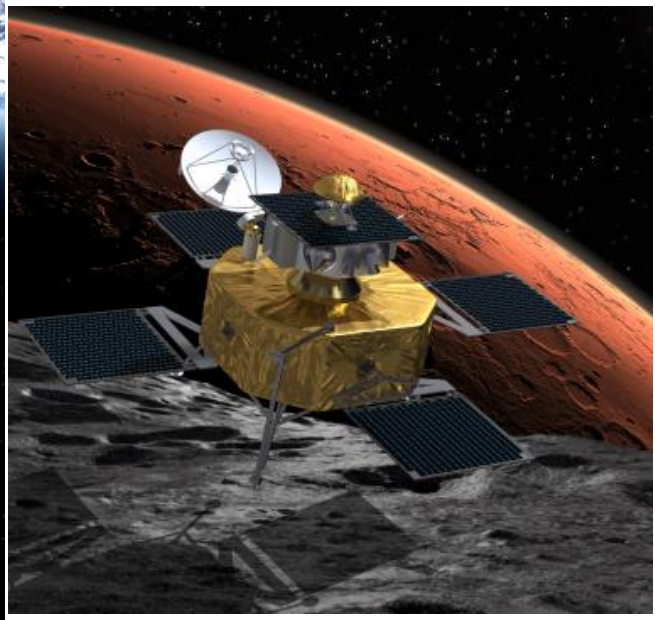
Sample Return Mission – key objective

MSR mission concept

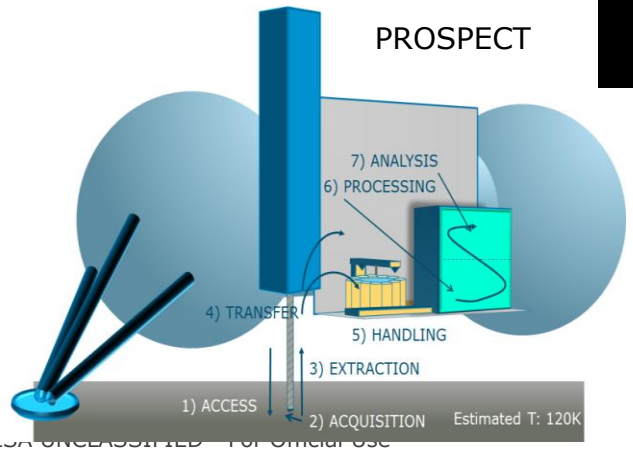




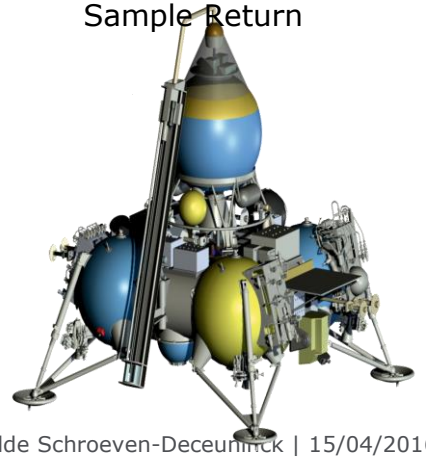
Phobos Sample Return



PROSPECT



Lunar Polar Sample Return



Robotic Exploration Programmes at ESA

Re-organisation to reflect the long term strategy of 3 mission targets

Reinforce Europe's position in Robotic Exploration, prepare for future missions to Mars, its moons and our Moon, following ExoMars

Sample Return mission as long-term goal

EXPERT
Develop key technologies
Validate through intermediate missions

Sample Analogues

Sample Analogues shall contribute to a successful development of almost all key aspects of a SRF as well as Sample Return Mission

sourceable representative characterized equivalents

Various sizes - pebble size down to fine dust

Various types – soil/regolith, rock, but also frozen and volatile

Physical/geotechnical properties - characterized

Chemical / mineralogical properties - characterized

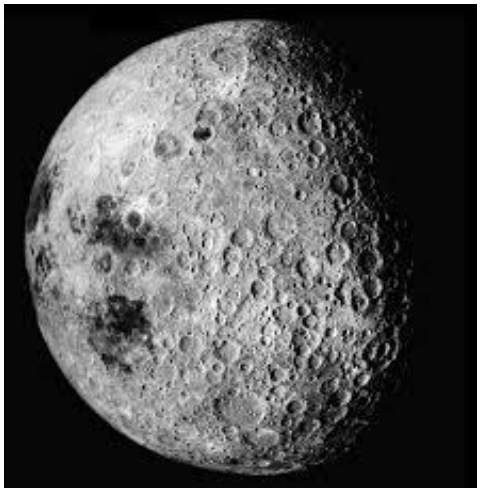
Sustainable in longer term

Relatively easy sourcing

Curated

Sample Analogue Collection

Mars, Phobos, Deimos , Asteroids & Moon
=
future operational regions

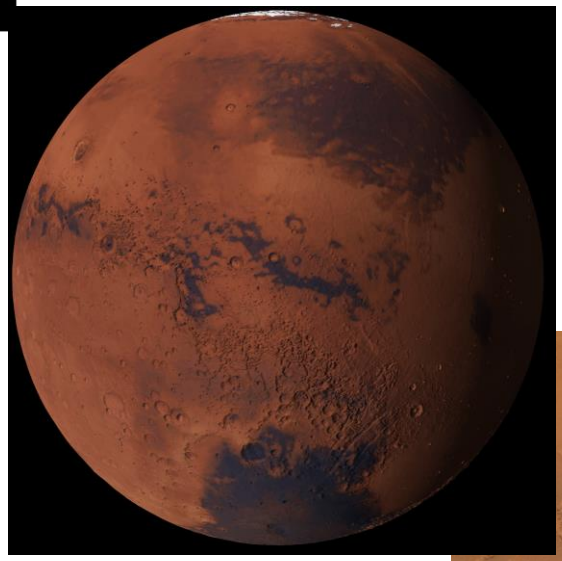


Analogues are needed

Space Technologies

SRF Technologies

SRF protocols



Activity started under MREP-2 in 2 phases Directly with Natural History Museum in London (UK)

Phase 1 – 10 months – completed June 2015

- Define catalogue of geological characteristics for selected and/or intended operational regions for future RE missions, using mission architecture concepts recently under study
- Define requirements for sample analogue materials to be representative for each target body
- Identify suitable set of specimen
- Identify equipment and facilities needed for validation of proposed analogue sample materials

Sample Analogue Collection – outcome Phase 1

- The initial number of specimen to be quite limited, aiming to define "stock materials" approach with possibility of mixing them to create different, more specific analogues depending on technology/target body combination.

- 4 types identified
  - Basalt (N Ireland quarry and fresh from Iceland)
  - Bentonite clay, iron-rich (UK supplier from own Cyprus mine)
  - Anorthosites as Moon analogues (Norwegian quarry tbc – back up Canada?)
  - Single minerals as ref for e.g. calibration or addition to regolith mixtures of asteroid-like target bodies

- Driving requirements in selection of the specimen is not only geochemical and geotechnical equivalence to target material, but as well sustainable sourcing (cost, logistics, abundance)

Sample Analogue Collection for RE

Phase 2 – 18 months – started July 2015

- Acquire starting collection for sample analogues, in order of priority for Phobos/Deimos, Mars, Asteroids and Moon
    - All acquired except for fresh basalt from Iceland (Aug/Sep16) and anorthosites (logistics)
- Geochemical and mineral characterisation of the various specimen ongoing
- Geotechnical characterisation to be started imminently
- Curatorial database (MS Access) in development for all sample analogues and their associated information

Selection of initial Sample Analogue Collection

Basalts
50-100kg of each

3mm and down quarry dust
6mm aggregate
10mm aggregate
20mm aggregate
150-200mm gabion stones (large piece of basalt rock)
Fresh Icelandic basalt – amount tbd

Bentonite/Clays
50-75kg of each

Bentonite granules
KM2 Bentonite powder
KMA Bentonite powder
KMSR Bentonite Powder
Bentonite Pellets
Attapulgite granules
Sepiolite granules

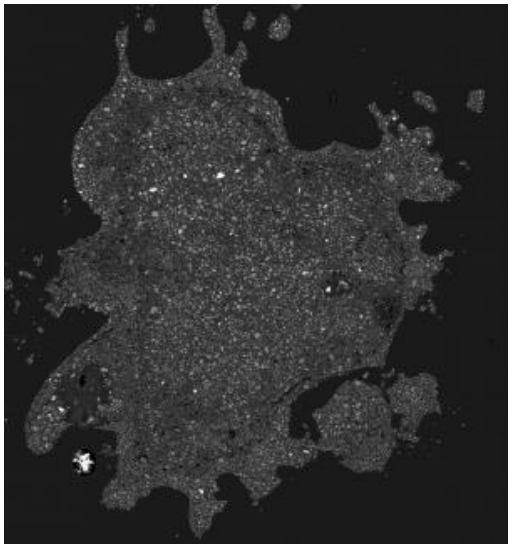
Analogue Minerals

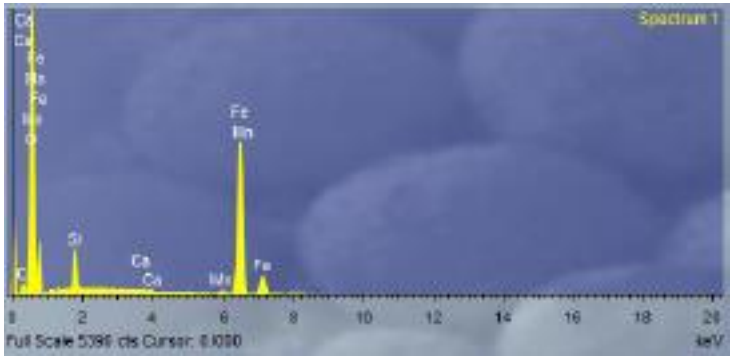
Olivine
Magnetite

Anorthisites

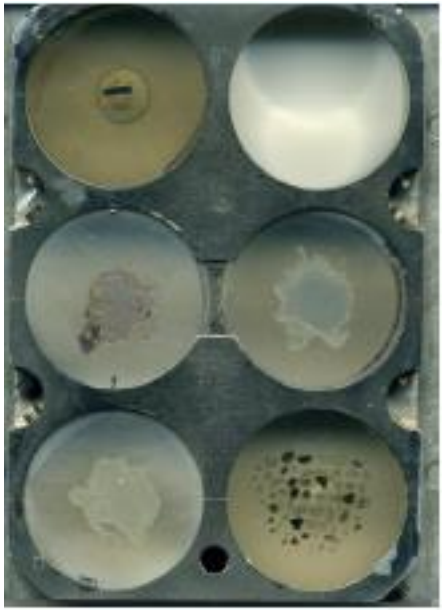
All materials sub-sampled (500g) and sub-sub sampled for SEM, XRD analysis
Geotechnical tests to be done

Bentonite results

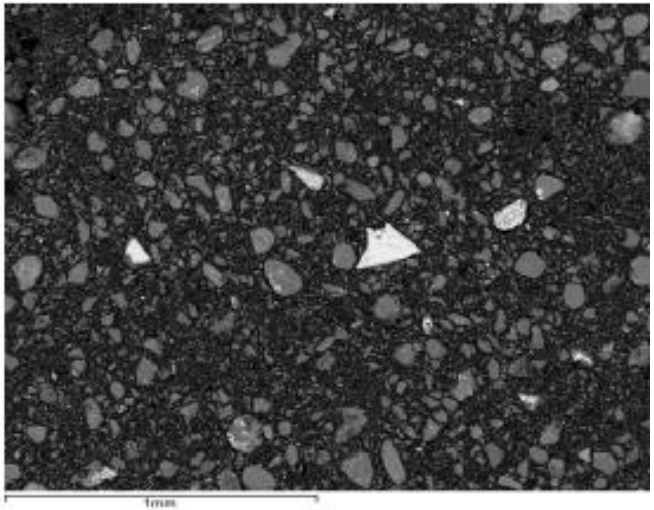




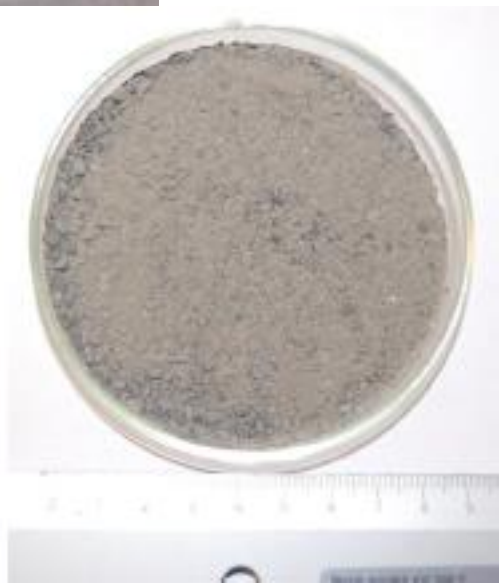
KMA sample; BSE image; X-Ray spectrum



Polished blocks



Basaltic Rocks



MC 2014 - Further needs acknowledged

Materials need to be housed…. Curated

Materials need to be used ….. Promote awareness

More different materials need to be acquired …. Scout, network and acquire

Portions of Materials used/developed through other activities need to be requested, characterised and incorporated in collection if appropriate

➔Start Analogue Curation Facility
➔Build Central Knowledge & Expertise
➔Enhance Central Collection aiming at achieving reference Standards

Starting Sample Analogue Curation Facility for RE

Starting Sample Curation Facility – 18 months – procurement initiated……..

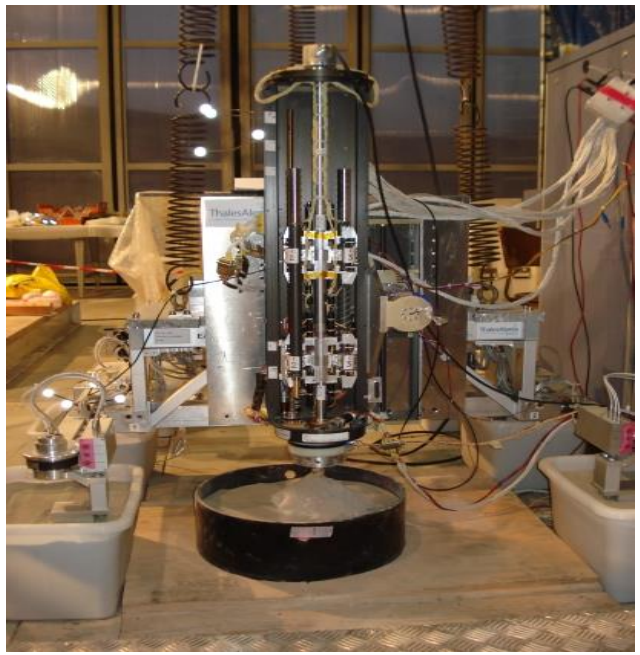
- Enhance the initial collection with further specimen procured/developed during ESA supported technology developments, from field trials, potentially other collections
- Define a set of standard characterisation protocols for new incoming specimen
- Validate them through application on new specimen
- Define a set of protocols for sub sample preparation
- Validate them for various sub sample types
- Acquire lab equipment to perform basic sample characterisation, sub sample preparation and inspection
- Keep curatorial database up-to-date, wrt new specimen, sub samples and

Main objective = increase available sample analogue specimen and increase central knowledge database on the various specimen from and for all activities related to European Robotic Exploration

Exploitation of Sample Analogue Curation Facility

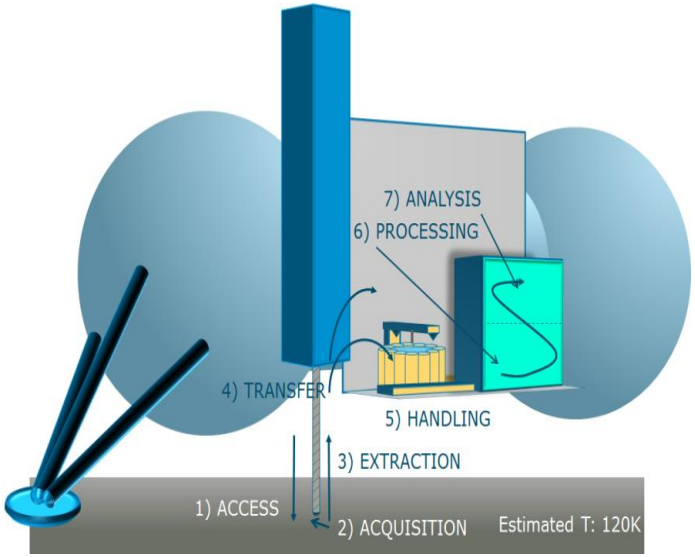
- Define first collaborations with Moon activities linked to analogues, specific for Lunar Polar Sample Return and Prospect (others may come)
- Scout for materials developed/procured/used/tested in other MREP activities; characterisation if deemed useful (to be assessed on case-by case), e.g. sampling tool activities, sterilisation limit activities, thruster contamination activities
- Supply new exploration E3P/EXPERT activities in need of analogue materials, e.g. sample handling technos for SRF, wheel-soil characterisation activities, etc
- Initial discussions on collaborations for human exploration under the E3P umbrella where astronaut/analogue interaction is needed
- …….

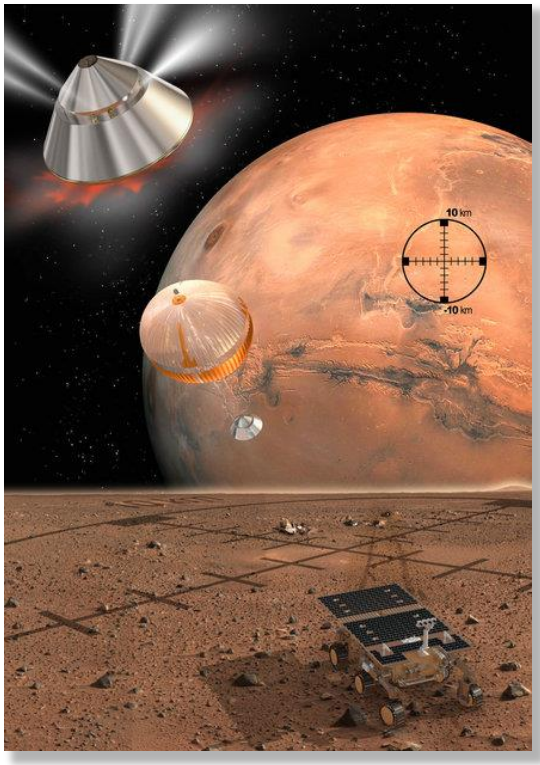
Figure 5-7 : Robot manipulator in the semi-conductor industry (Fanuc)



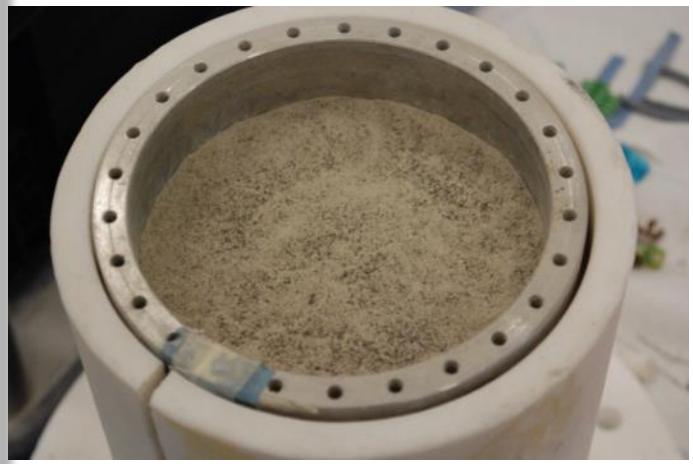
ExoMars drill BB being tested


Nikon


7) ANALYSIS
6) PROCESSING
4) TRANSFER
5) HANDLING
3) EXTRACTION
1) ACCESS
2) ACQUISITION
Estimated T: 120K


10 km
-10 km

Thank you!



Other relevant activities

E915-008FI Breadboard of a sample securing system for a Phobos Sample return Mission

E906-011FP ERC RF recovery beacon breadboard

E918-010MP Phootprint thruster plume and surface interaction testing facility development and thruster characterization

E914-003QI Testing of sterilisation limits for sample return planetary protection measures

E914-001MM MSR biocontainment system sealing and monitoring technologies - development and validation

CK50 Definition of Functional Requirements for a MSR Biological Containment Facility

E915-007FT Evaluation of sealing systems for a Phobos Sample Return Mission

E915-008FI Breadboard of a sample securing system for a Phobos Sample return Mission

E914-004QI Biosealing and Monitoring Technologies for a Sample Containment System - Sealing tests and EM design

E914-005MM MSR Double walled isolators - breadboard

E913-010MM Manipulation systems for sample handling in a Sample Receiving Facility

E926-001FM Starting a sample analogue collection for exploration missions

E926-002FM Starting a Sample Analogue Collection for future Exploration missions - Phase 2