

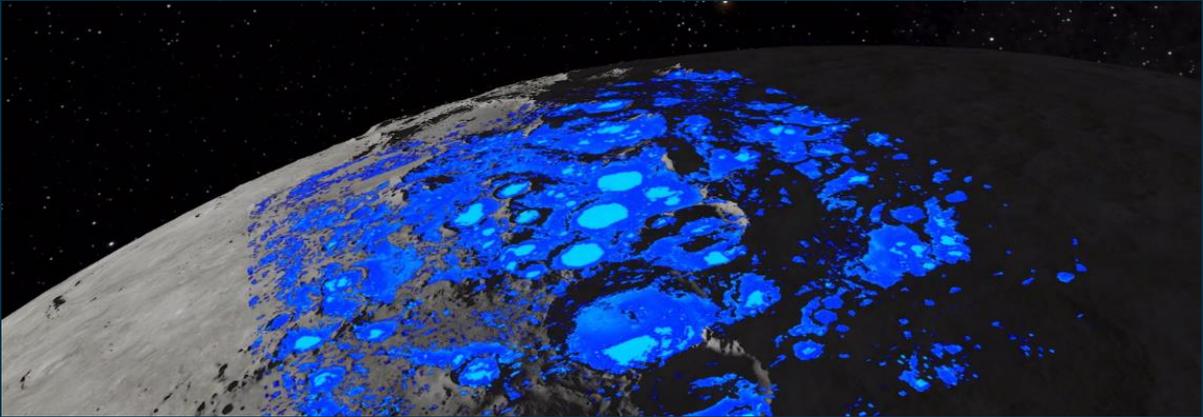


Lunar ISRU processing technology

Dr. Alexandre Meurisse, Research Fellow in Lunar ISRU
ESALAB@UCL - Off-World-Living Workshop

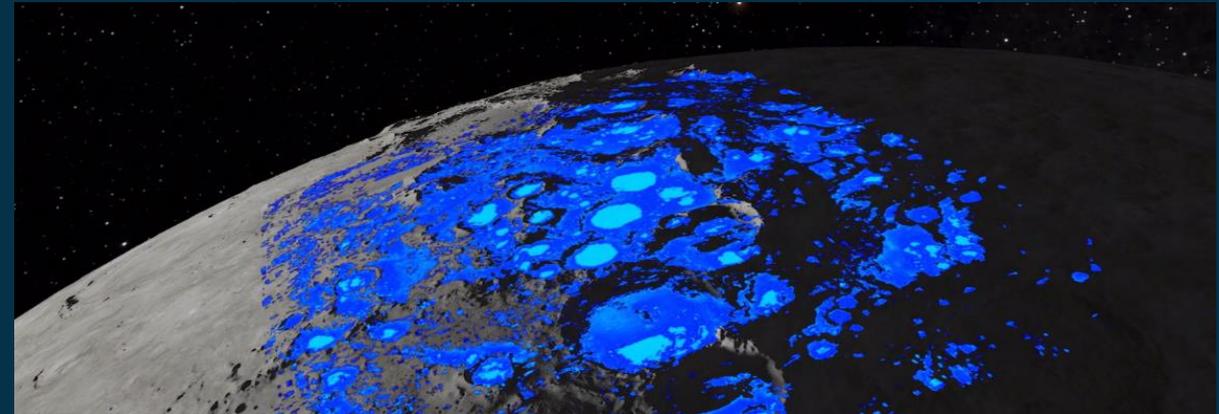
06/05/2021

Lunar resources





PROSPECT on board LUNA 27



Objective: Study soil and volatiles composition near the south poles

Instruments:

- Drill able to collect samples down to 1m
- Carousel with 25 ovens
- A mass spectrometer

Launch dates:

- CLPS launch date: ≈2023
- Luna 27 launch date: ≈2025

PROSPECT Payload



≤0.1 g sample

25 experiments

Potentially including hydrogen demonstration

High-end space mass spectrometer



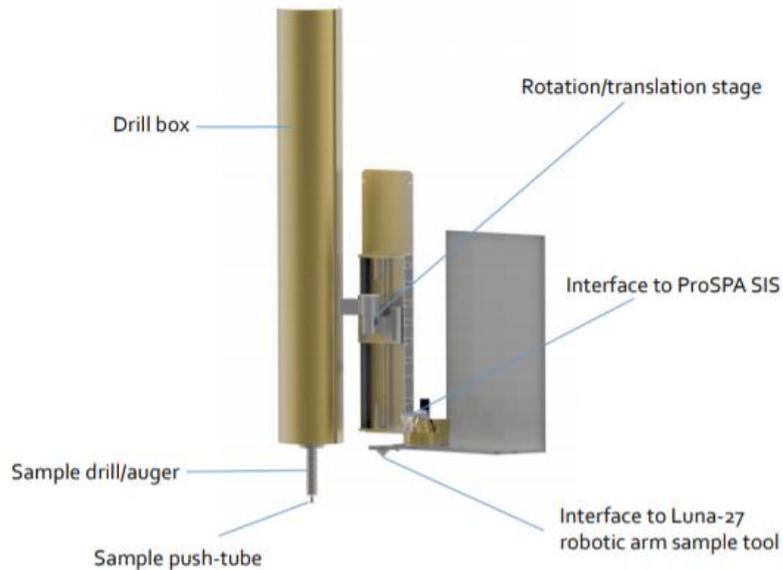
Russian sample



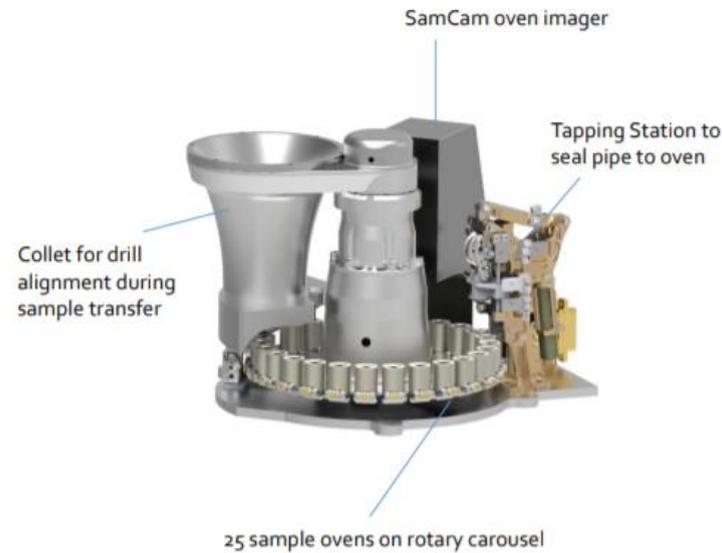
ESA sample



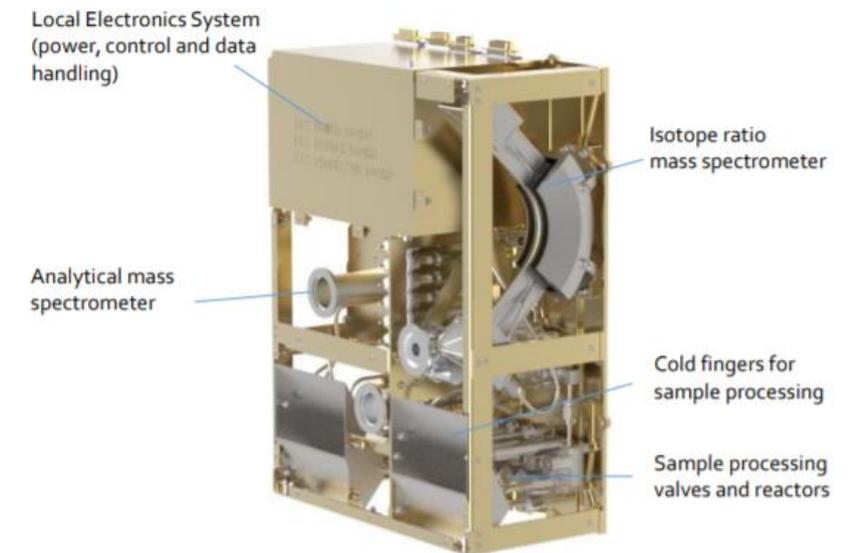
ProSEED Drill: Sample Extraction & Delivery



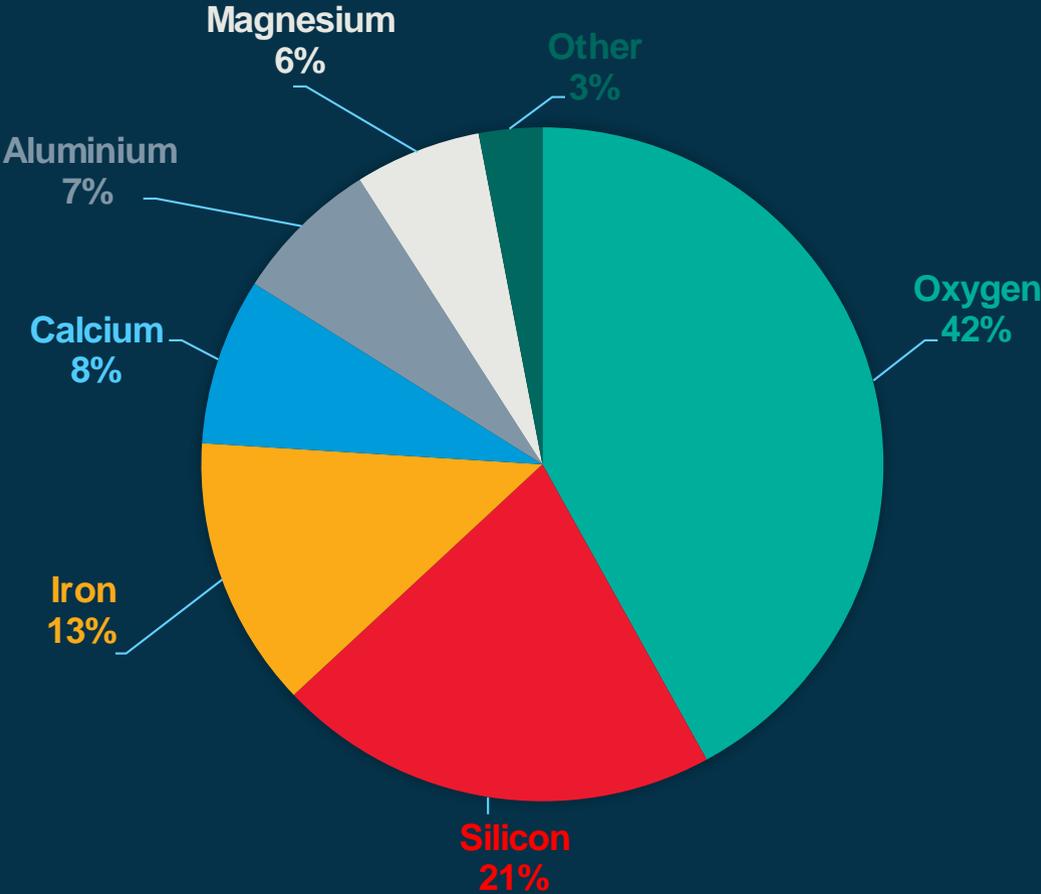
ProSPA SIS: Solids Inlet System



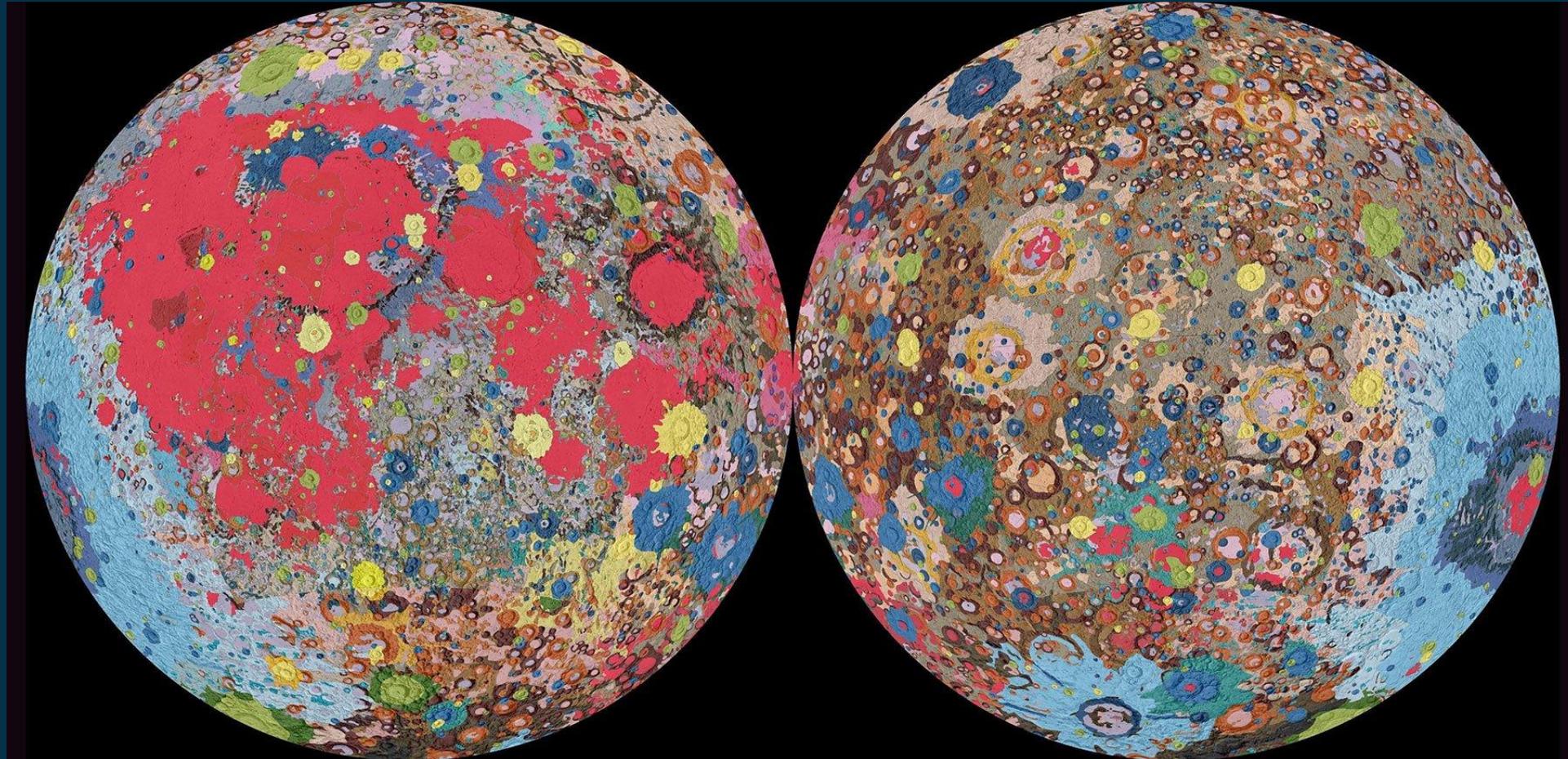
ProSPA Science Laboratory



Lunar regolith composition



Lunar regolith composition



US Geologic Survey

https://astropedia.astrogeology.usgs.gov/download/Moon/Geology/Unified_Geologic_Map_of_the_Moon_GIS_v2.zip



Hydrogen reduction plant

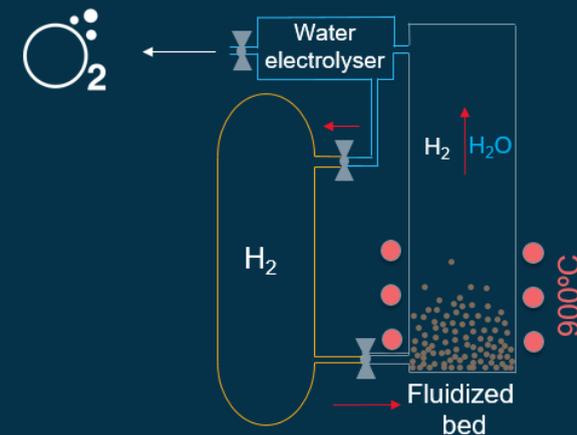
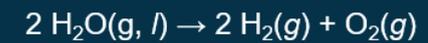
As part of the research activities at ESRIC



Hydrogen reduction plant

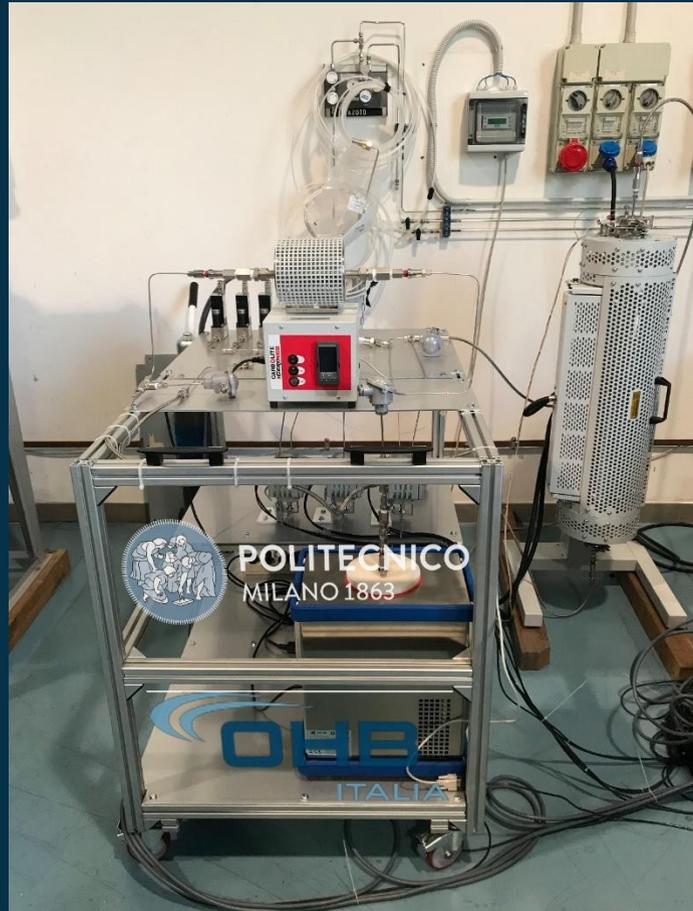
Research topics:

- Better understand fluidized bed processes and potential for space application
- Understand the reduction potential of H₂ with various materials
- Possibility to enhance the plant to do plasma reduction



Carbothermal reduction plants

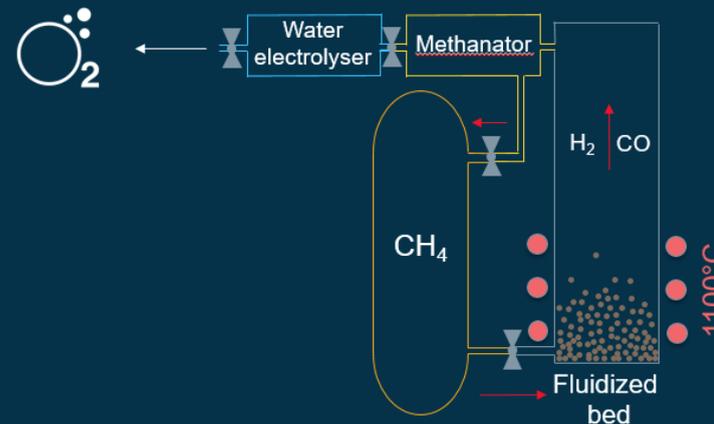
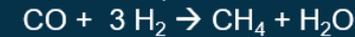
As part of the research activities at ESRIC



Research topics:

- Better understand fix bed processes and potential for space application
- Understand the reduction potential of CH₄ and H₂ with various materials

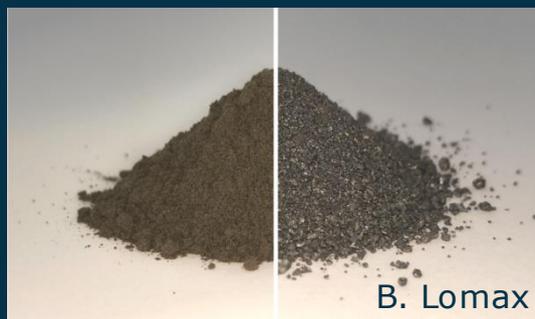
Methanation (Sabatier reaction)



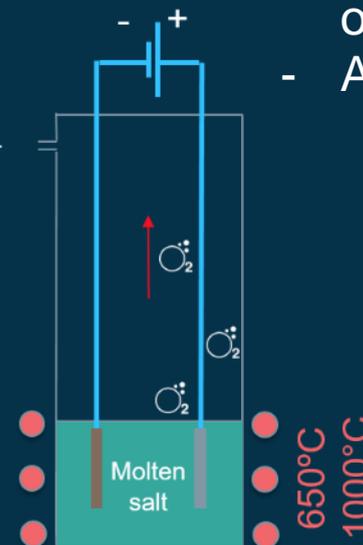
Molten salt electrolysis process



Regolith



Metal Powder



Research topics:

- Low temperature eutectic salt mixtures
 $CaCl_2-NaCl$, $CaCl_2-KCl$, $CaCl_2-LiCl$
- Salt to regolith ratio
- Inert anodes
- Bubble formation under partial gravity

- Understanding of the reduction mechanisms of lunar minerals
- Application of the metal powder
 - Metal fuels
 - Additive manufacturing

Ionic liquids and plasma reduction



ESA-S.Rohde, blog.esa.int

Research topics:

- Understanding the reduction potential of ionic liquids
- Develop new ionic liquids regeneration approaches
- Understand the reduction potential of various plasmas different from hydrogen
- Develop new recycling techniques for reactive gases
- Energy modelling



www.esa.int/About_Us/EAC/Spaceship_EAC

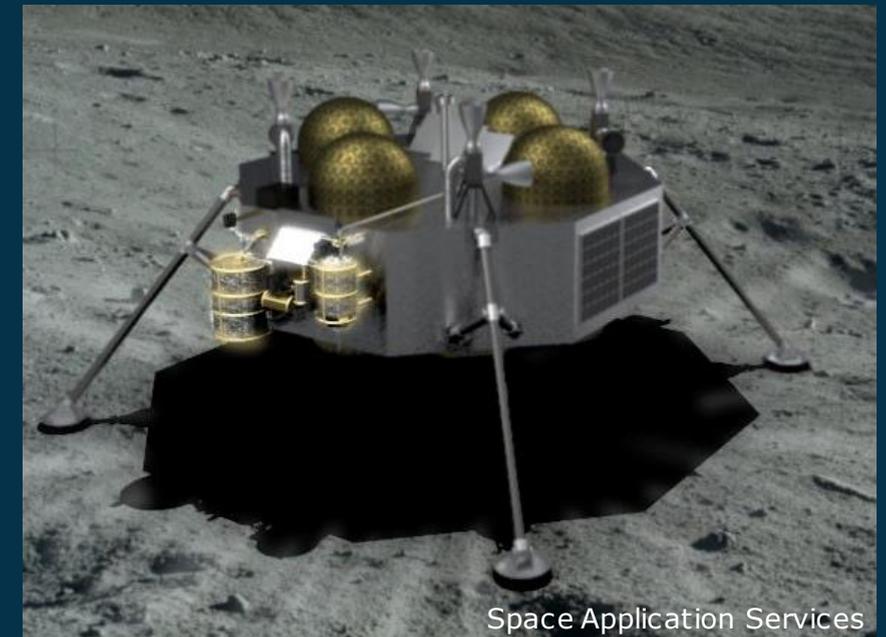
ISRU Demonstration Mission

Currently in Phase B – phase 1

Launch 2027 - 2030 on-board commercial lander or the European Large Logistic Lander (EL3)

Objectives

- Demonstration of the production of 90g of O₂ from lunar regolith
- Develop key technology in preparation of a pilot plant*
- Answer science questions relevant for advancing the knowledge and European expertise on ISRU

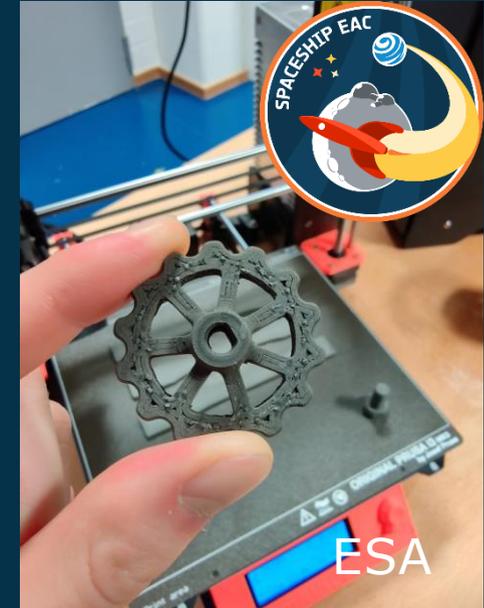


*: as part of the discussions at the ISECG (International Space Exploration Coordination Group)

Manufacturing processes



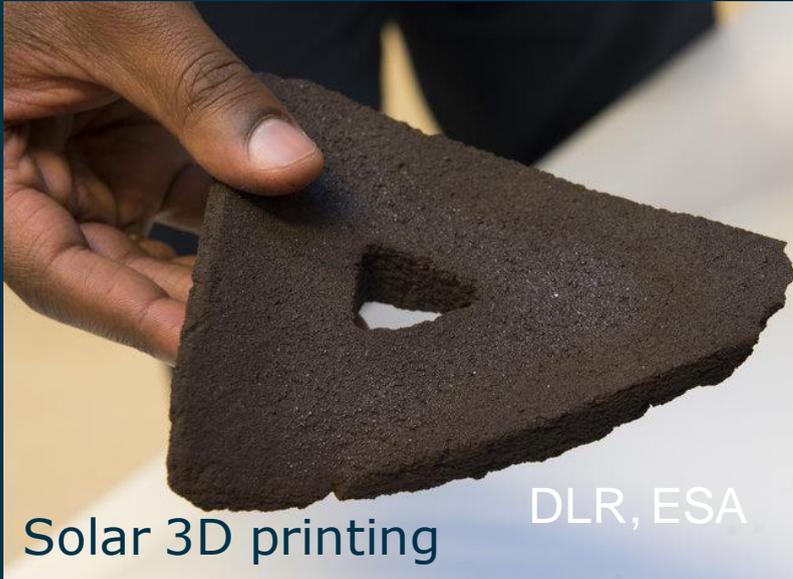
Manufacturing with regolith and binders



Manufacturing processes



Manufacturing with regolith



Solar 3D printing

DLR, ESA

Fiber manufacturing



ACT, ESA

Microwave sintering



ESA



Brick sintering

ESA, DLR

+ 3D printing of reduced regolith

Thank you for your attention



esa



SOM

