

# Apollo Lessons Learned: Contamination Control for Samples

A photograph of the lunar surface, showing a dark, cratered terrain. In the background, a thin crescent of the Earth is visible against the blackness of space. The foreground is dominated by the dark, textured surface of the moon, which slopes upwards from the bottom right towards the top right.

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## ORGANIC

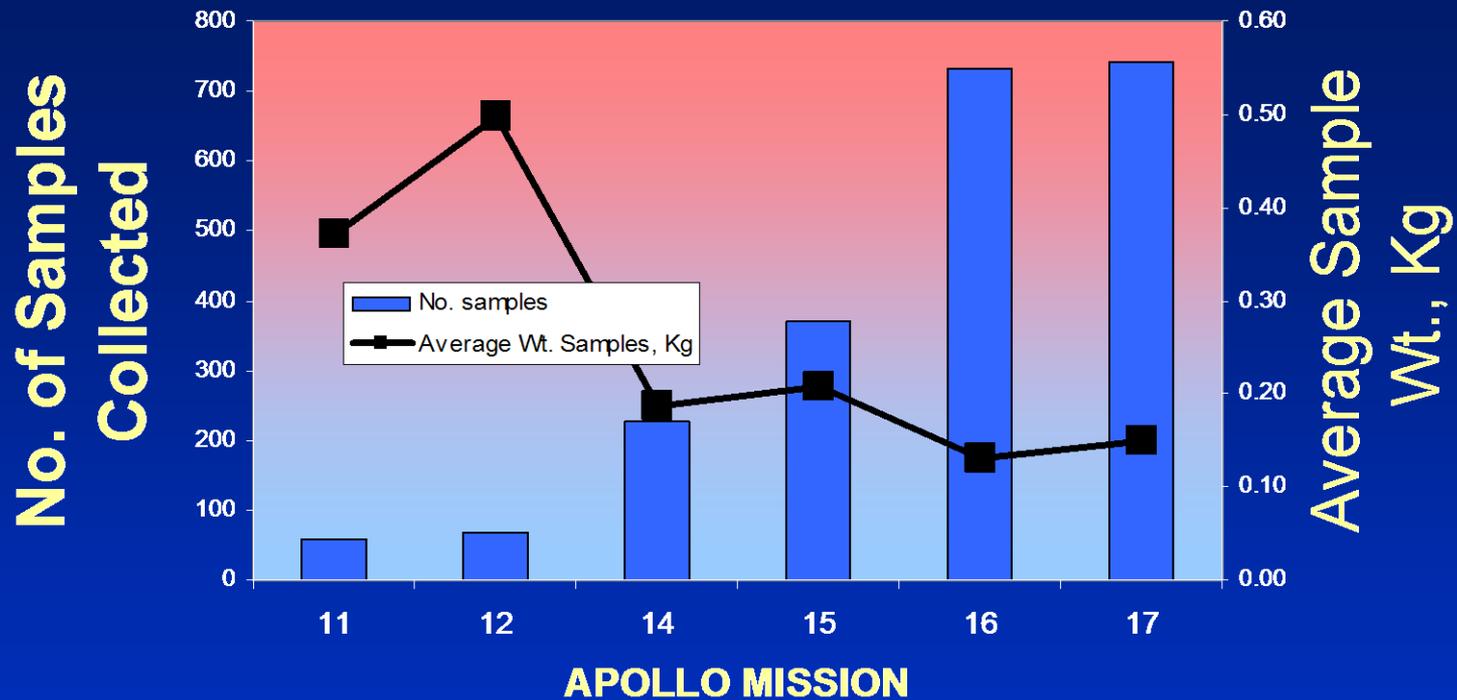
- Sources
- Monitoring
- Results of analyzed lunar samples

## INORGANIC

- Material restrictions
- Isolated environments
- Controls on fabrication

Hazard containment &  
sample preservation

6 Missions 1969-1972  
2196 samples, 382 Kg



Reference: J. H. Allton (1989) Catalog of Apollo Lunar Surface Geological Sampling Tools and Containers, JSC-23454

Link:

[http://www.lpi.usra.edu/lunar\\_resources/documents/LunarSampleToolCatalog.pdf](http://www.lpi.usra.edu/lunar_resources/documents/LunarSampleToolCatalog.pdf)

# SOURCES OF ORGANIC CONTAMINATION

## Simoneit & Flory

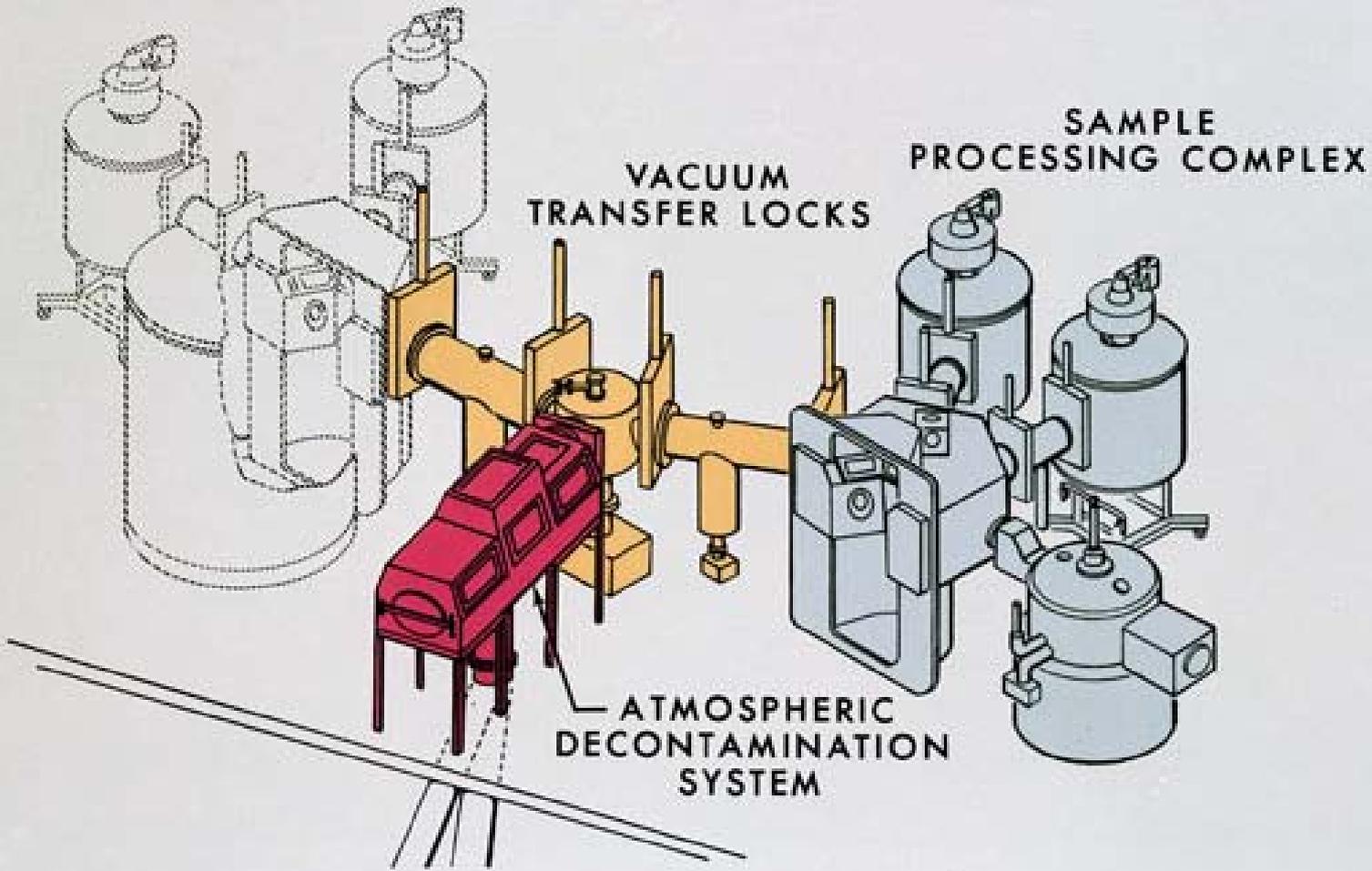
1. Surface contamination of lunar-bound rock box
2. Surface contamination of tools used to acquire samples
3. Exhaust products from descent engine and RCS
4. Lunar Module outgassing
5. Astronaut spacesuit leakage
6. Particulate material abraded from spacesuit, etc. during EVA
7. Venting of Lunar Module fuel and oxidizer tanks, cabin and waste systems
8. Venting of life support backpack
9. Exposure to LRL vacuum and nitrogen gloveboxes
10. Surface contamination of sample processing tools & containers
11. Surface contamination of containers sent to PIs

Reference: B. R. Simoneit and D. A. Flory (1970) Apollo 11, 12 and 13 Organic Contamination Monitoring History, UC Berkeley – also a similar document is available electronically, call Debra Baxter 281-483-7432 Johnson Space Center.

NASA-5-67-694

# PRIMARY VACUUM LABORATORY

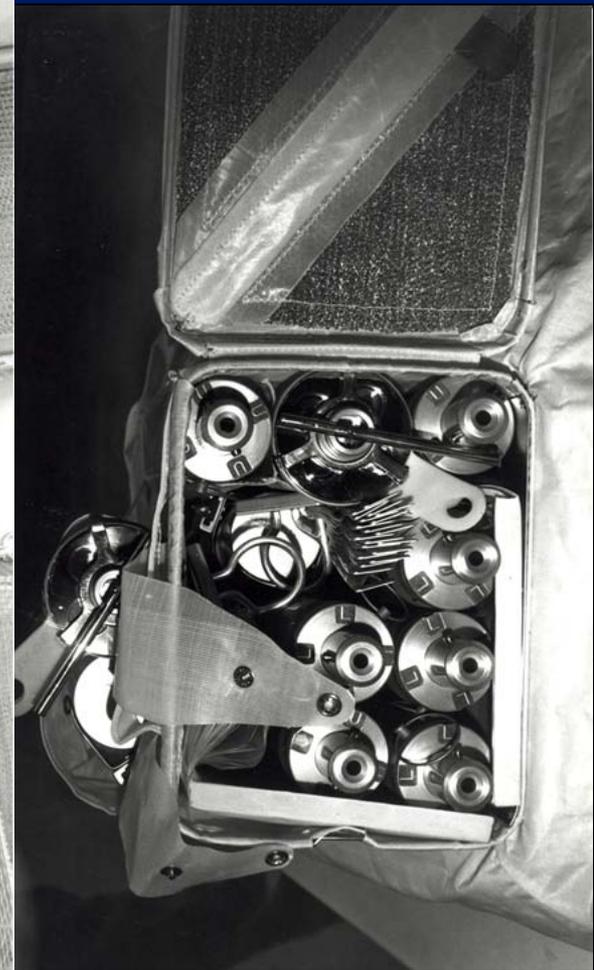
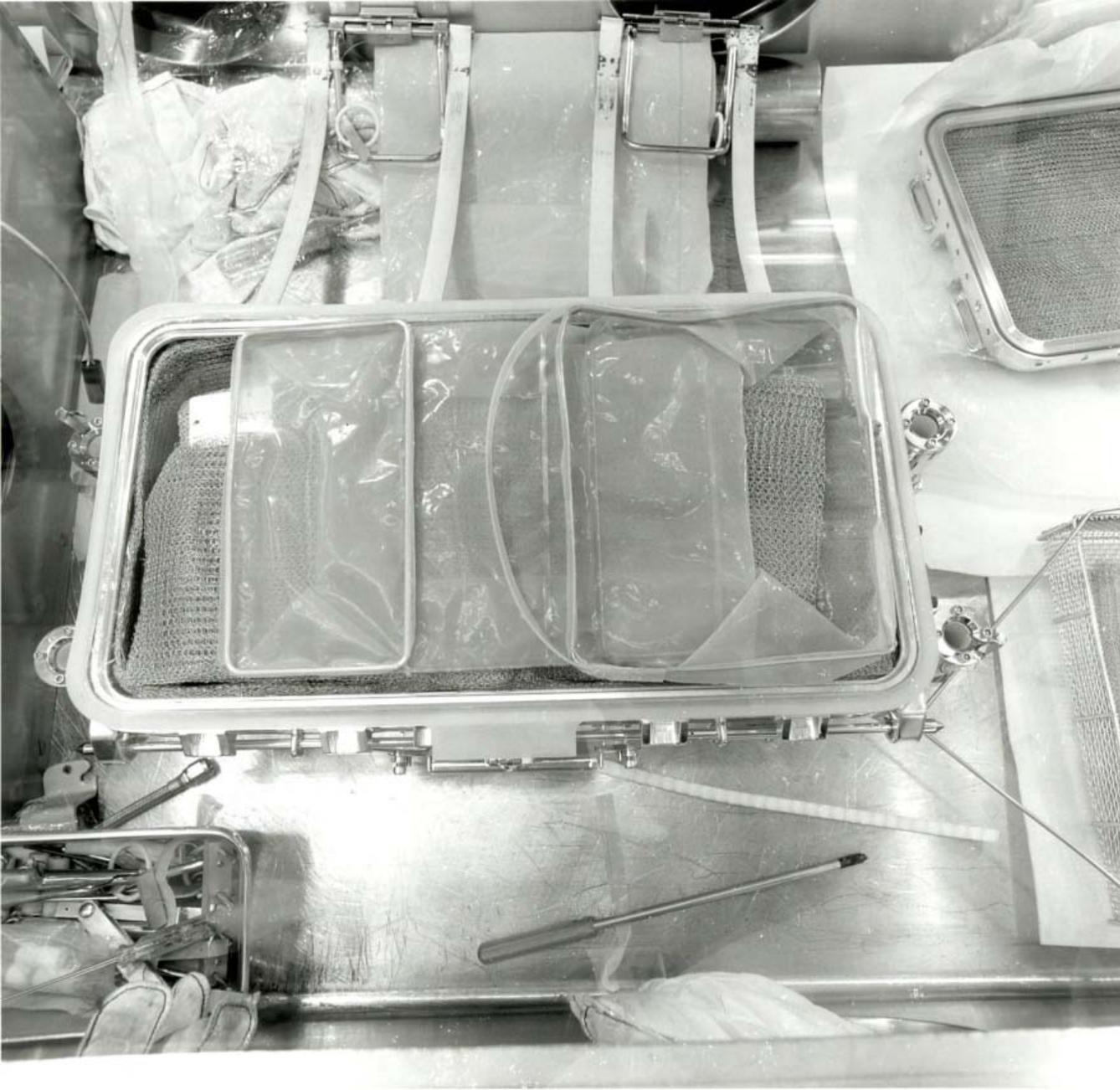
SAMPLE  
PROCESSING COMPLEX



SAMPLE  
PROCESSING COMPLEX

VACUUM  
TRANSFER LOCKS

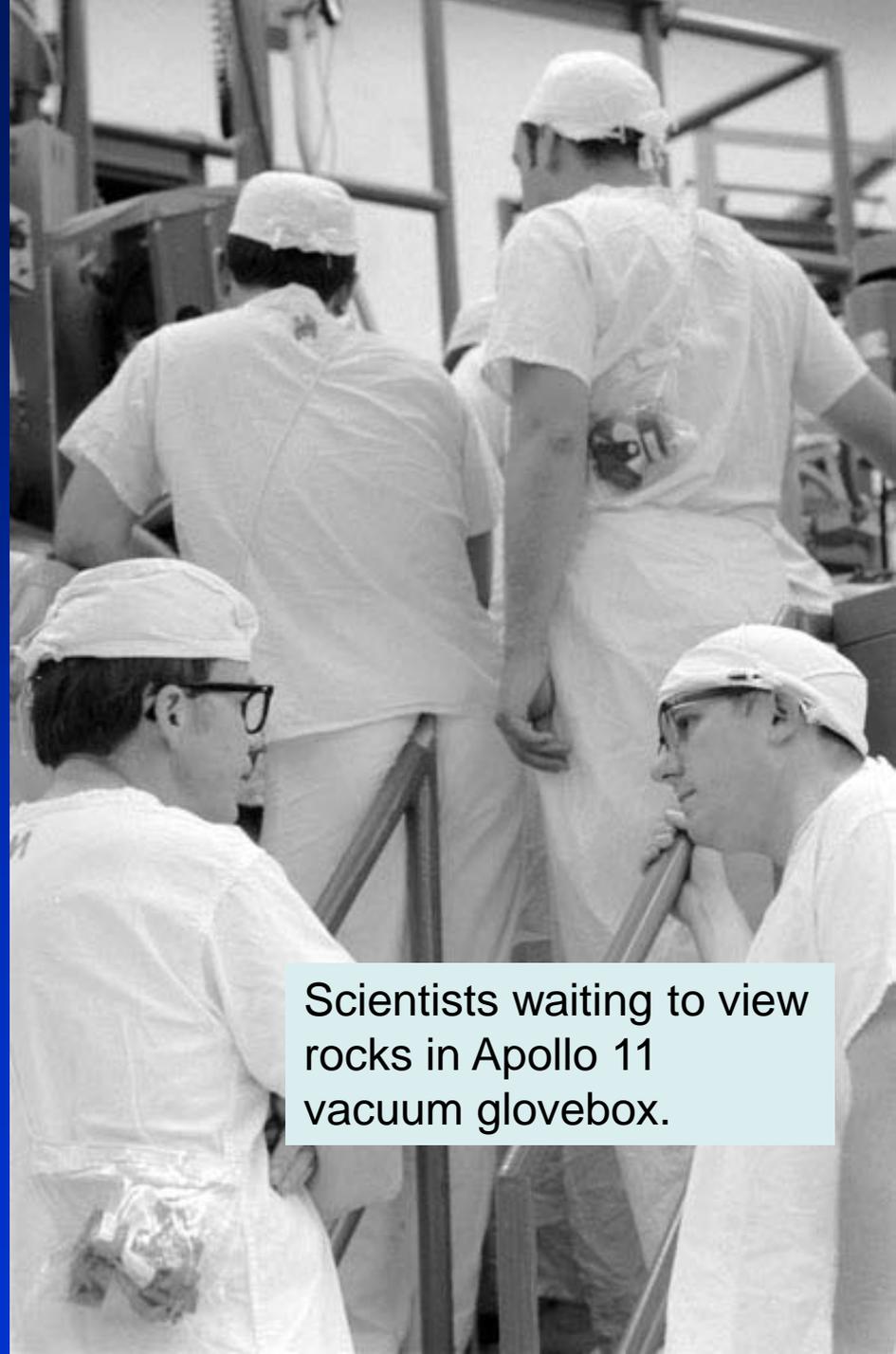
ATMOSPHERIC  
DECONTAMINATION  
SYSTEM



ROCK BOX PACKED  
FOR LAUNCH.  
Boxes closed in  
vacuum.



Apollo 11 first box opened in vacuum



Scientists waiting to view rocks in Apollo 11 vacuum glovebox.



Curator Elbert King discussing the sample inside of vacuum glovebox.



Nitrogen-filled  
Gloveboxes with samples  
and sieving tools.

Apollo 15 astronauts Dave  
Scott and Jim Irwin discuss  
geology with planetary  
scientists.





Organic monitors:

- Ottawa sand in cabinet
- York mesh in Moon-bound box

1  $\mu\text{g}/\text{cm}^2$  inside rock boxes from York mesh for Apollo 11 – IMPROVED for Apollo 12 and later: 10 to 100  $\text{ng}/\text{cm}^2$

Most frequently measured contamination from tool & cabinet rinsings hydrocarbons, fatty acids, plasticizer for polyethylene bags.

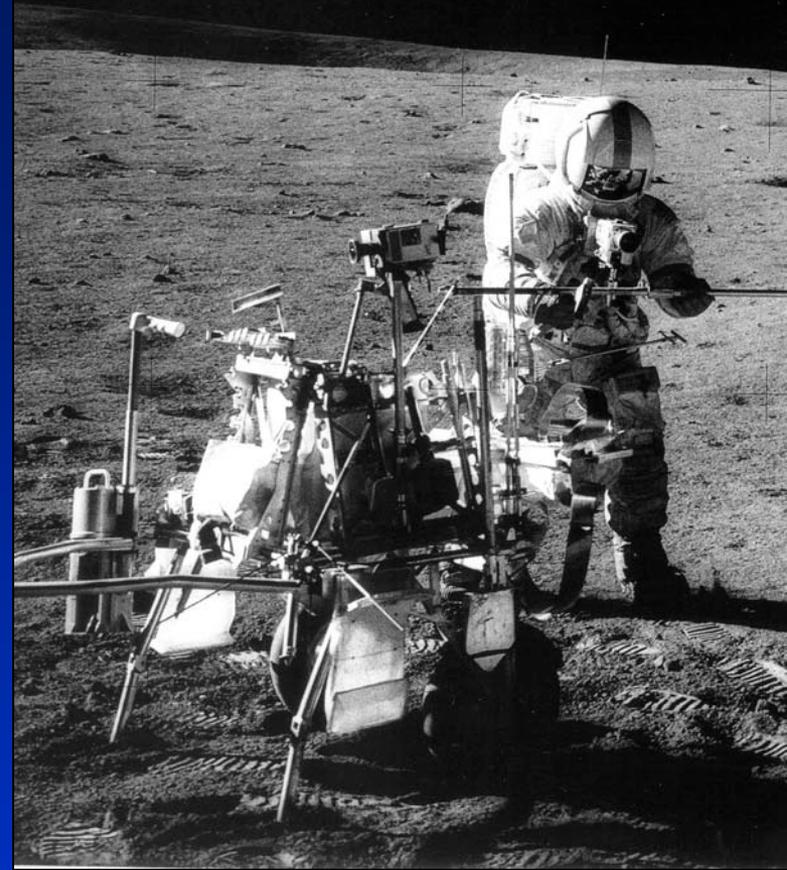
Reference: B. R. Simoneit and D. A. Flory (1970) Apollo 11, 12 and 13 Organic Contamination Monitoring History, UC Berkeley – also a similar document is available electronically, call Debra Baxter 281-483-7432 Johnson Space Center.

## Measured Contamination on Lunar Samples

- Apollo 11 samples 1ng/g organics
- Apollo 12 samples 0.1 ng/g
- Range of contamination reported by investigators
- Porphyrin-like entities: trace ng to pg (possible rocket exhaust) **1970**
- Amino acids: 50 ng/g **1970**
- Indigenous lunar carbon about 100 ppm

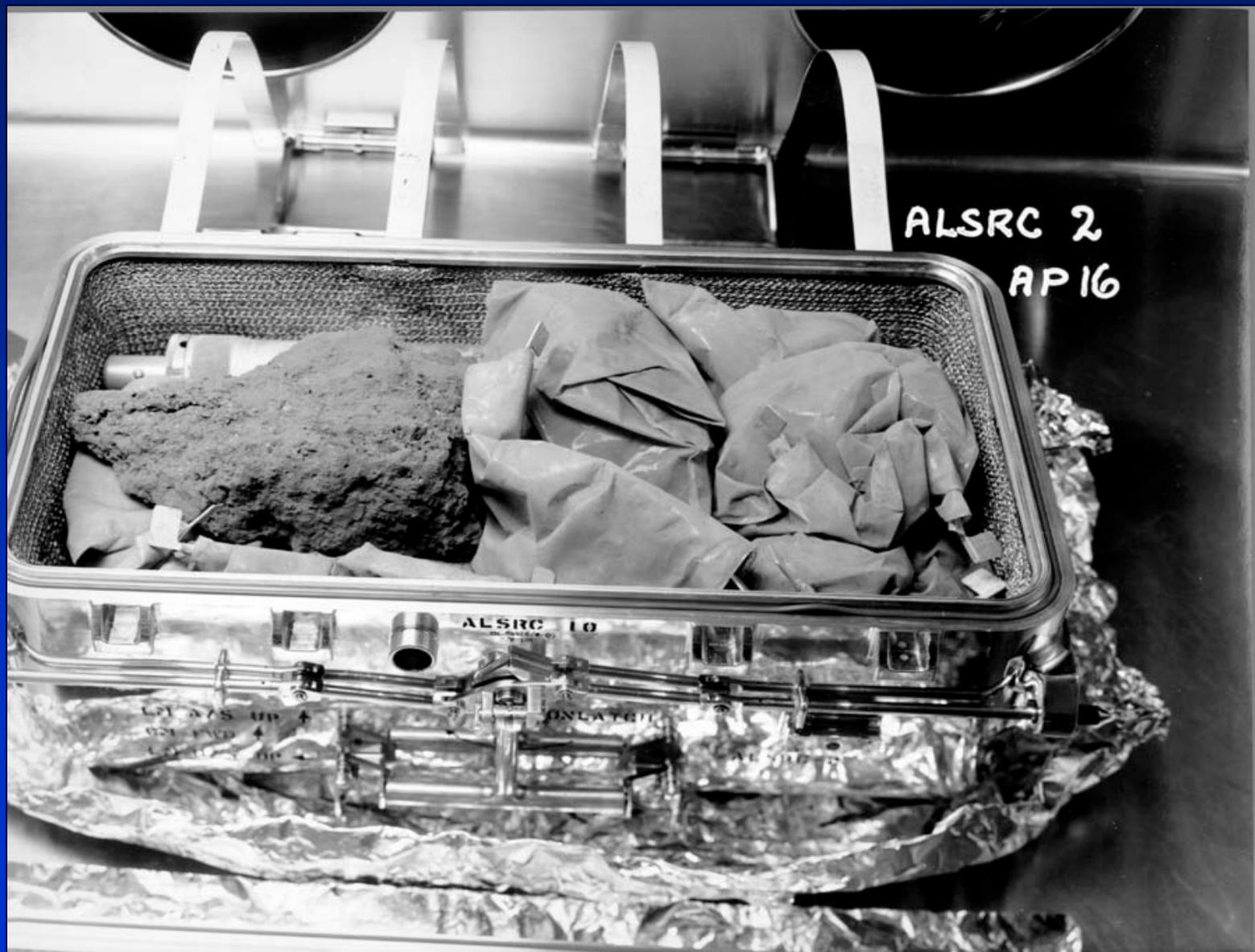
J. H. Allton (1998) A Brief History of Organic Contamination Monitoring of Lunar Sample Handling, Lunar and Planetary Science XXIX, abstract #1857.

Link: <http://www.lpi.usra.edu/meetings/LPSC98/pdf/1857.pdf>



Spacesuit leakage & shedding

# Vacuum bakeout of rock box added organics



## Special Organically Clean Lab at Berkeley

- Two glove boxes in tandem, preceded by vacuum entry chamber, all located in Class 100 room (ISO 5)
- For repackaging for PI allocations, along with Ottawa sand
- Access to low level analytical instruments



## ORIGINAL MATERIAL RESTRICTIONS

- Organics – fluorocarbon-based materials for elastomer gaskets, lubricants, sample bags
- Inorganics – sensitive elements prohibited, interfere with science analyses
  - EXAMPLES: Pb, Sr, U, Th, Li, Be, K, Rb
- Nitrogen acceptable cover gas – no noble gases
- Select alloys for tools and containers (7075, 6061 – 316L)

## SUBSEQUENT ISSUES

- Pb from surface treatment of core tubes
- Indium from container seals
- Moly sulfide from lubricants
- Xylan – not pure teflon

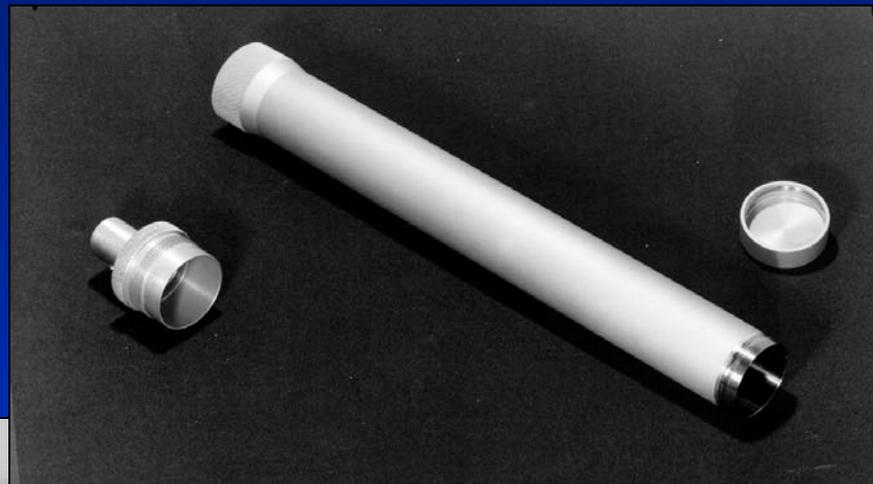


ALSRC 1009



## CORE TUBE SURFACE TREATMENT

Tube body titanium alloy Al-4V, threaded joints treated via electrochemical process called Canadizing which impregnated TFE



Soil sample within were contaminated with trace amounts of lead (Pb) which interfered with age dating analyses.

# GAS-TIGHT CAN

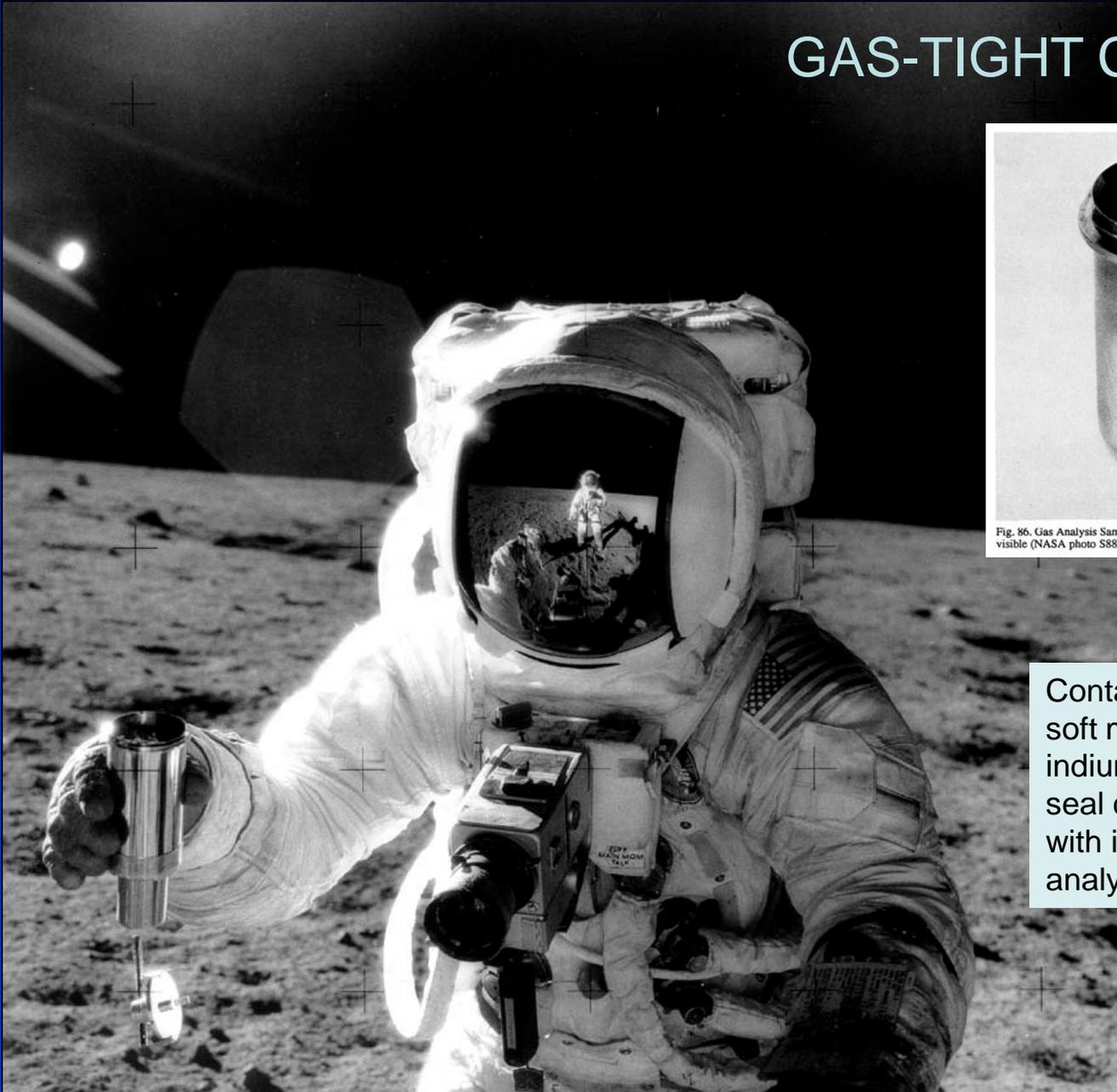
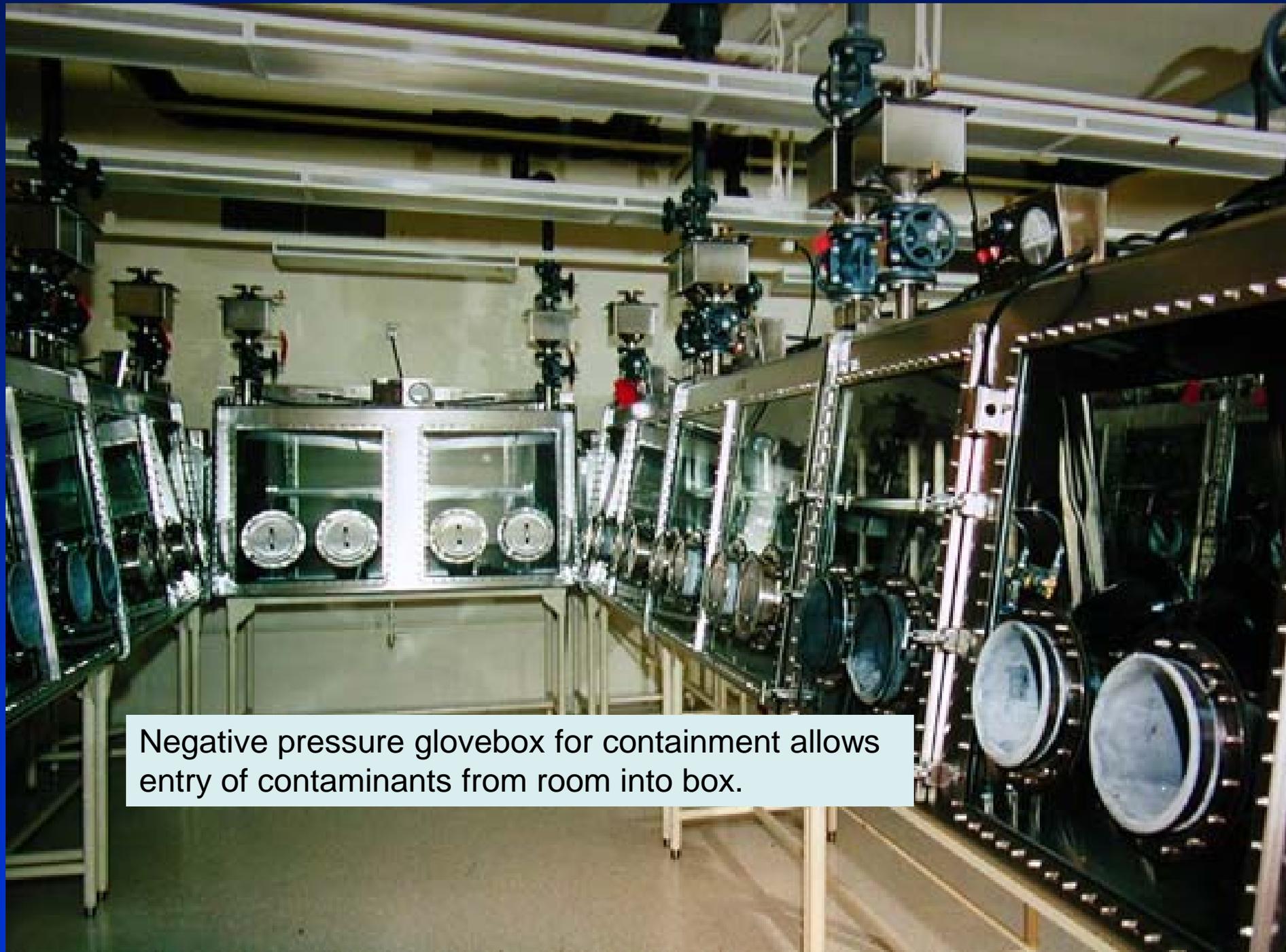


Fig. 86. Gas Analysis Sample Container (GASC). The knife-edge on the can and indium alloy sealing surface on the lid are visible (NASA photo S88-52660 taken from Union Carbide photo no. 121372).

Container used knife edge into soft metal seal. Seal was 90% indium with 10% silver. The metal seal carried trace contaminants with interfered with scientific analyses.



Negative pressure glovebox for containment allows entry of contaminants from room into box.

Biohazard testing resulted in many sources of organic contaminants not found in cleanrooms: animals, sterilants.





Current Lunar Sample Curation: Samples are handled in positive pressure nitrogen-filled gloveboxes.

## Contamination Control from the start:

- Mission sampling requirements
- Materials specification
- Sample facility oversight

Sample tools & containers cleanliness –  
PAY ATTENTION TO DETAILS, especially  
fabrication techniques and surface finishes