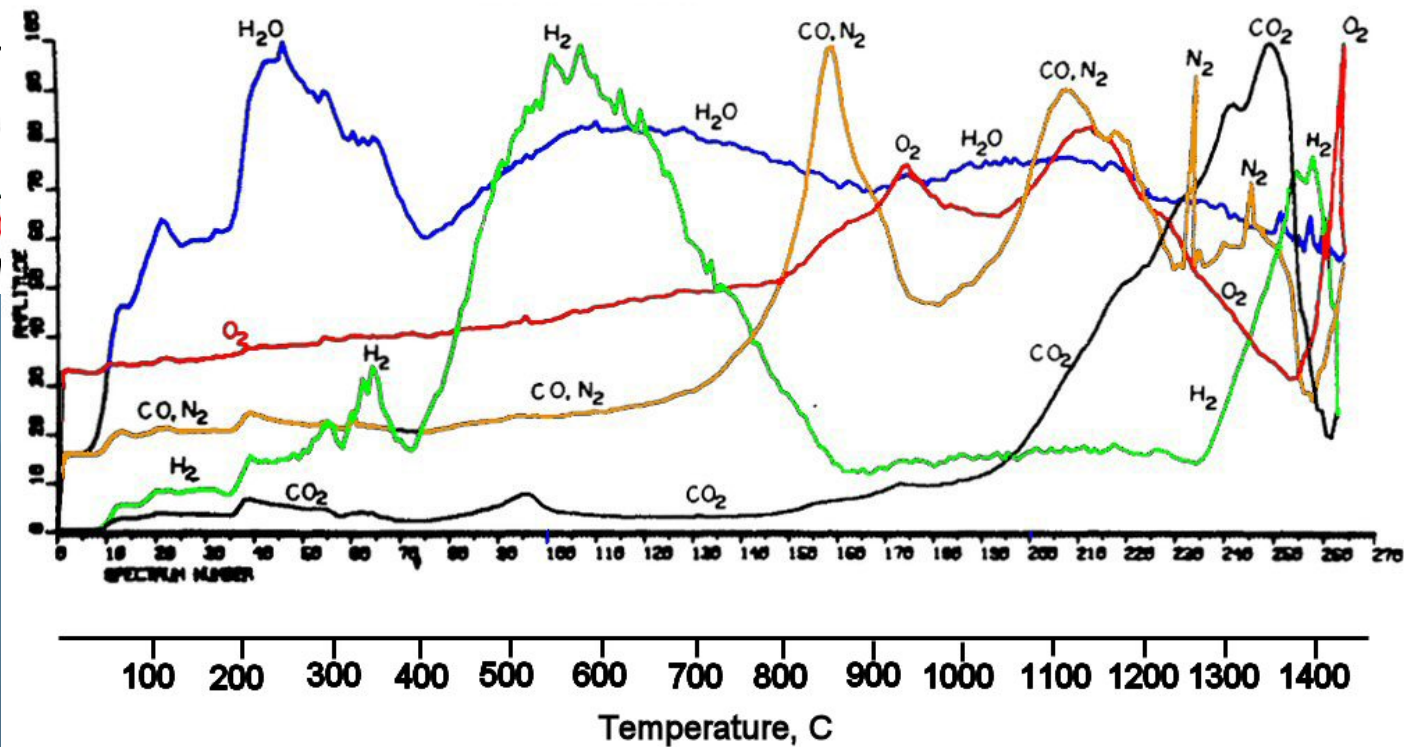
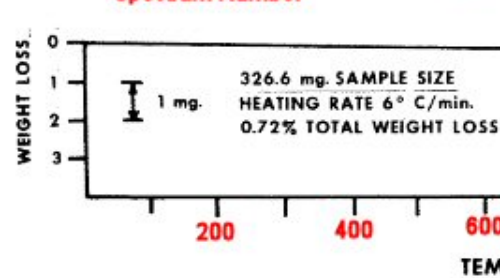
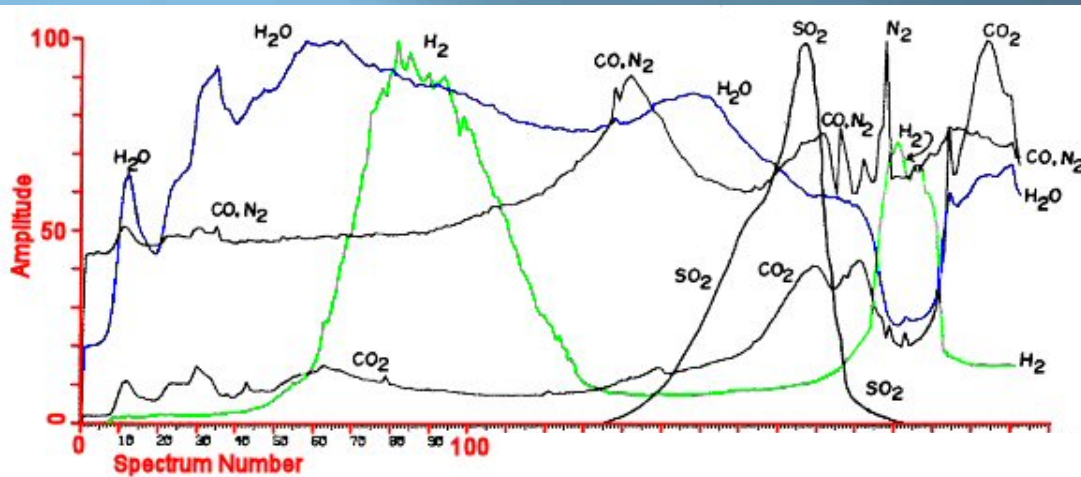


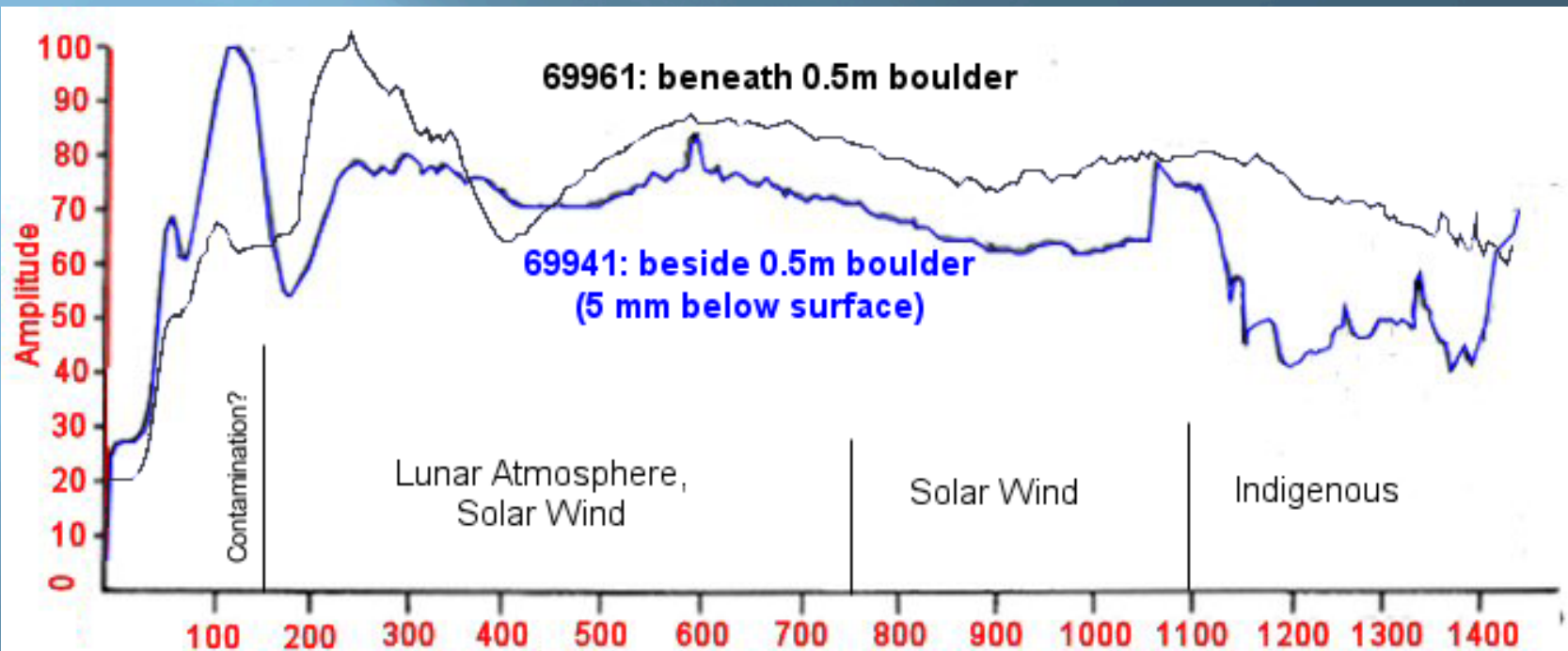
Extracting Solar-Wind Volatiles *Efficiently* Requires Pneumatic Size Separation And Transport

B. L. Cooper, K. Zacny, and D. S. McKay

Vacuum Heating



Solar-Wind and Other Volatiles

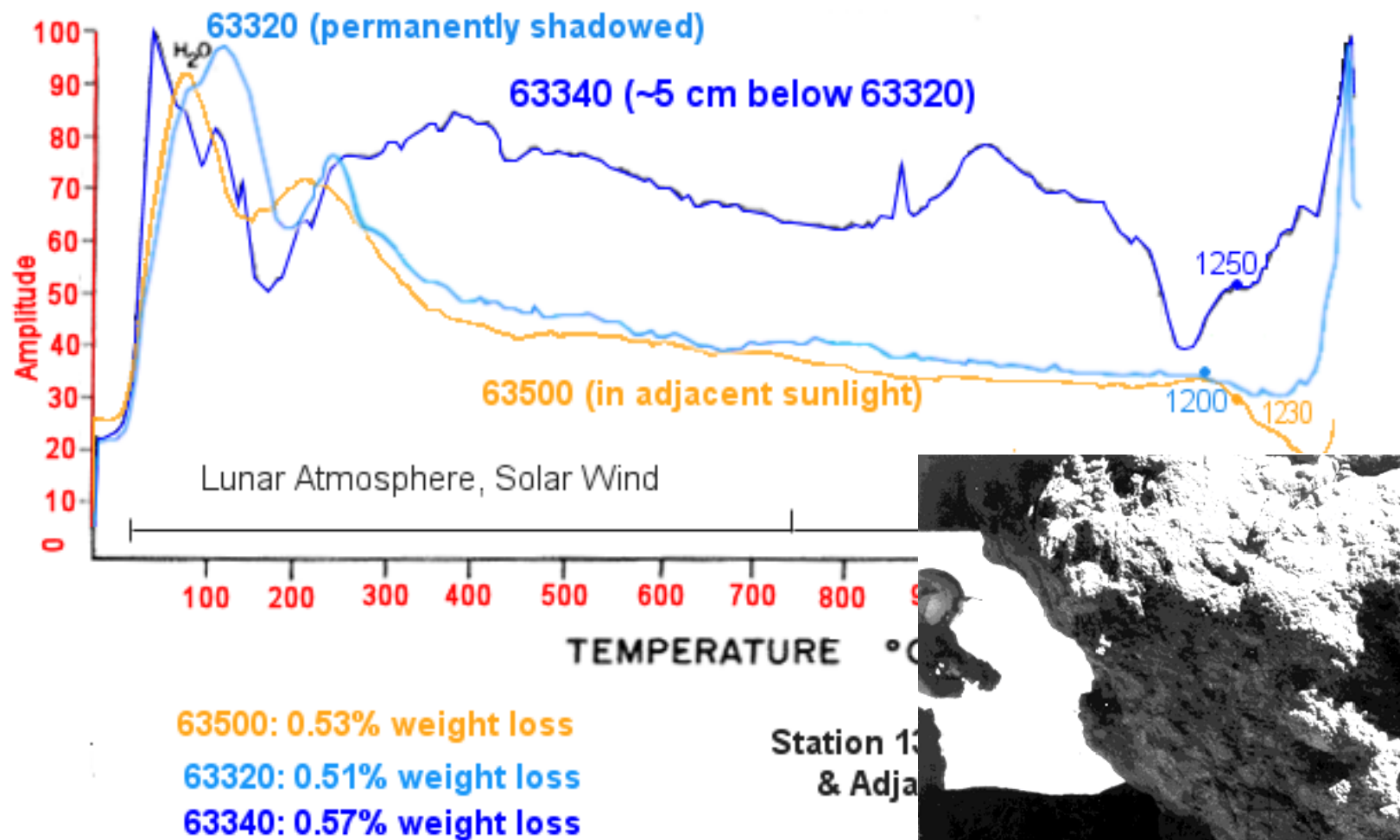


69941: 0.60% weight loss (maturity 85)

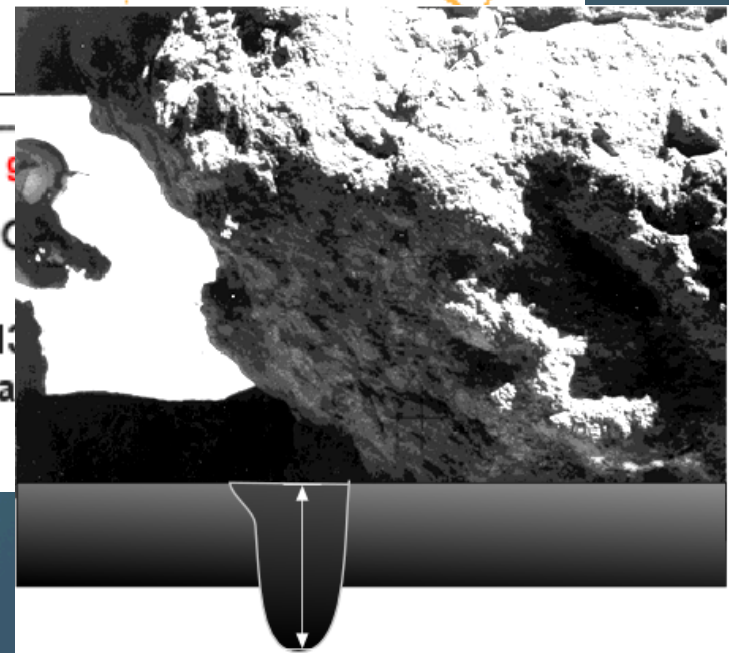
69961: 0.61% weight loss (maturity 92)

Note: weight loss includes H_2O , H_2 , CO , N_2 , CO_2 , C_2H_4 , O_2 ...

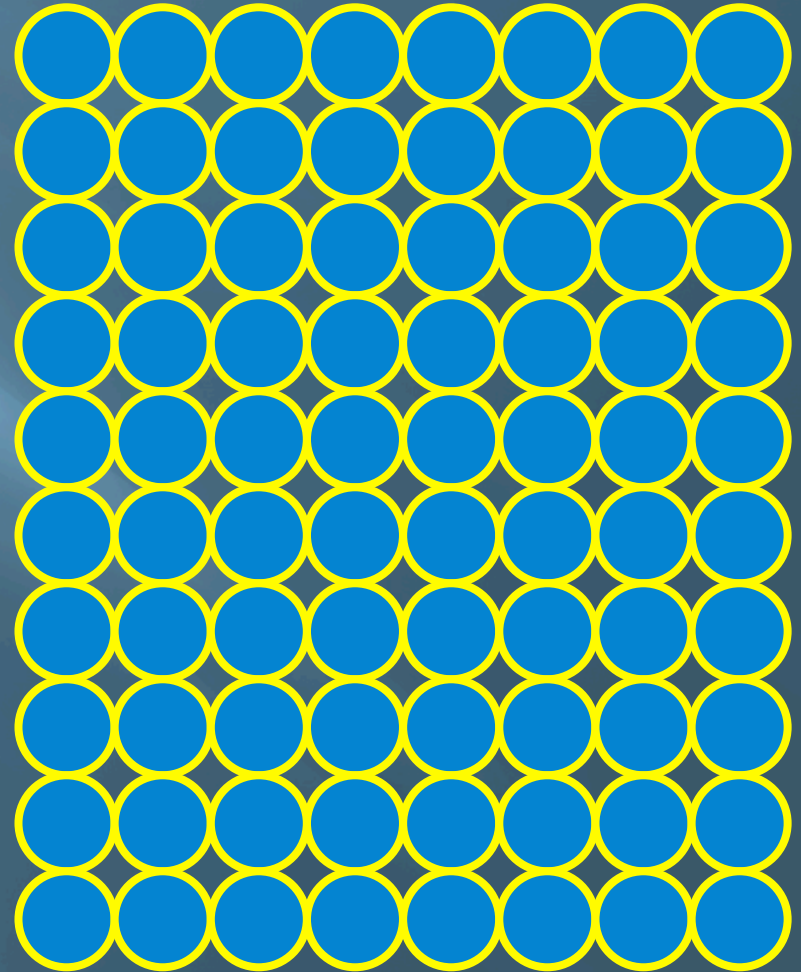
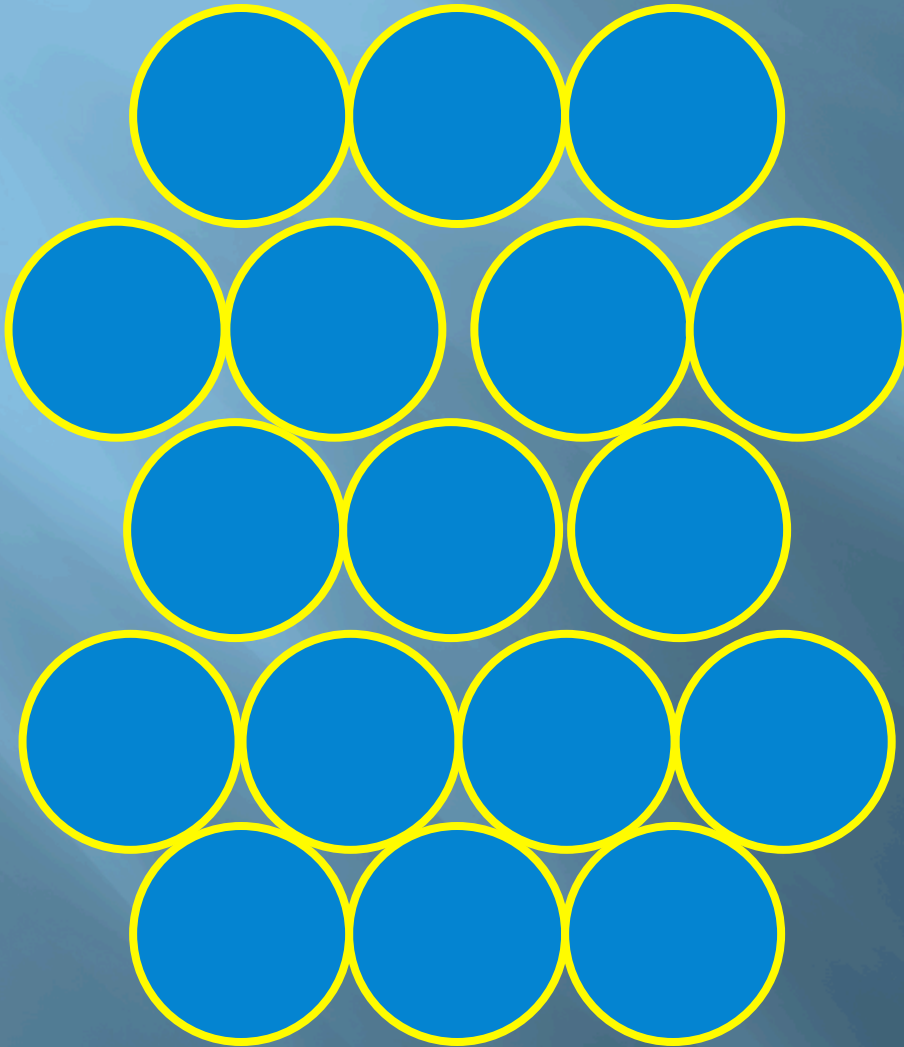
Sunlight or Shadowed



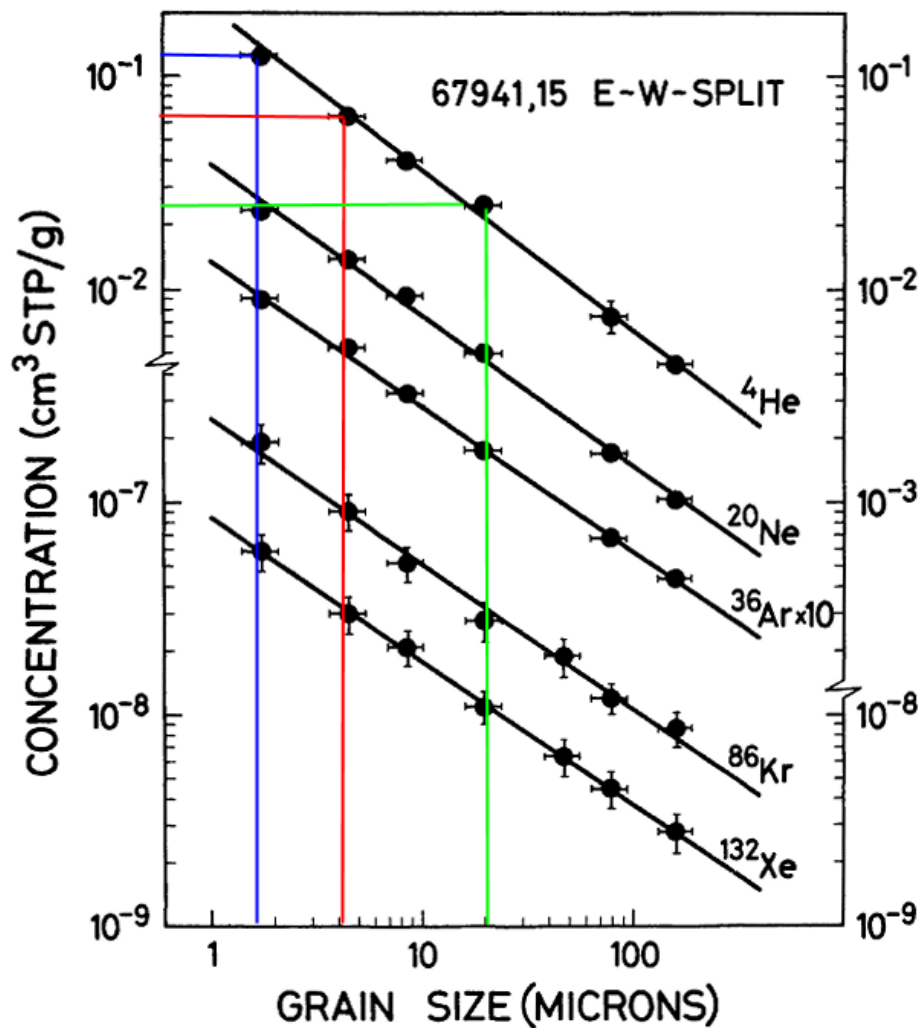
Note: weight loss includes H₂O, H₂, CO, N₂, CO₂, C₂H₄, O₂...



Surface Area

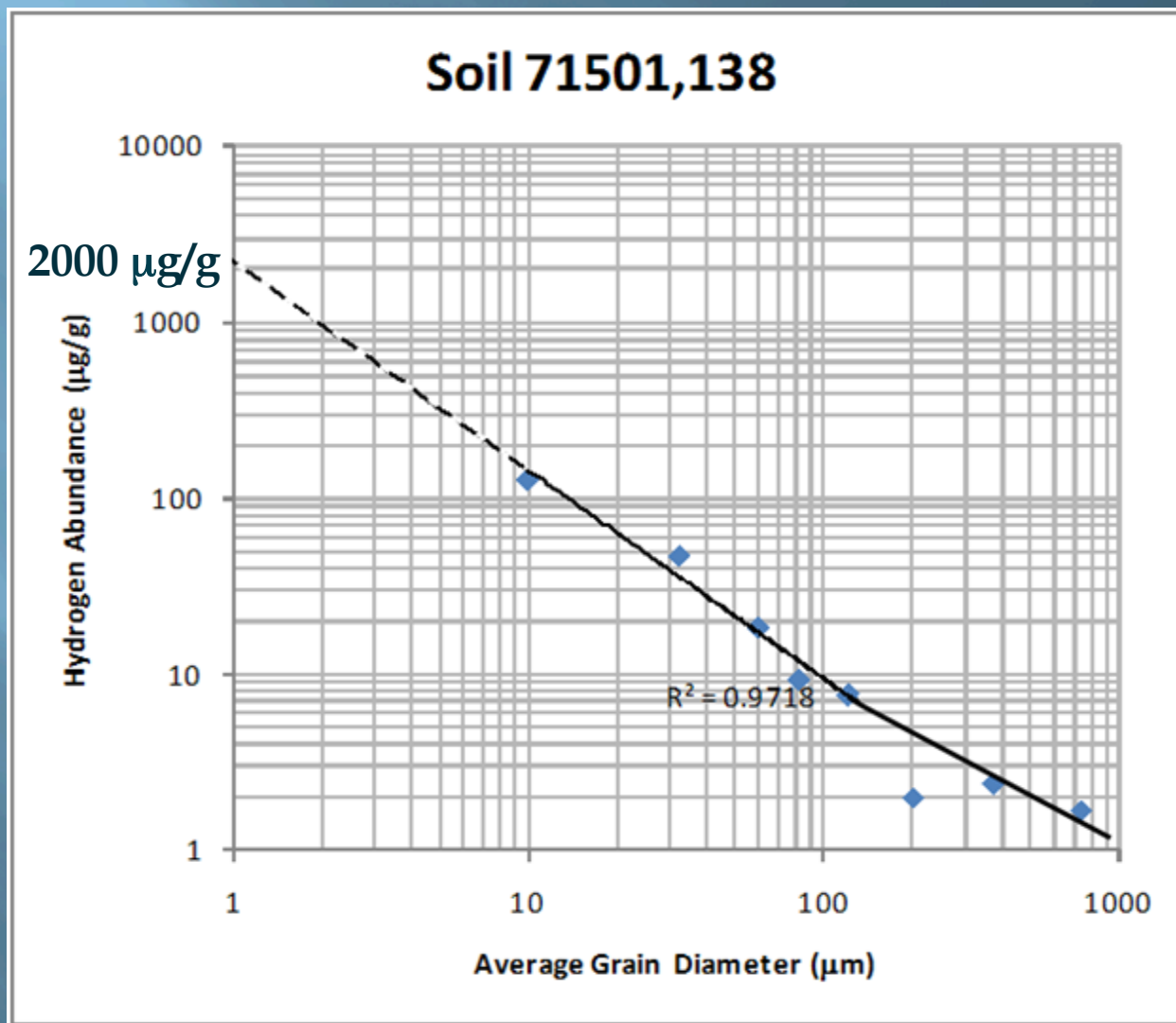


Smaller Particles ⇒ More Volatiles



Grain-size dependency of trapped ⁴He, ²⁰Ne, ³⁶Ar, ⁸⁶Kr, and ¹³²Xe concentrations in the East-West split soil 67941,15.

Hydrogen—the the Number One Element



Size Matters

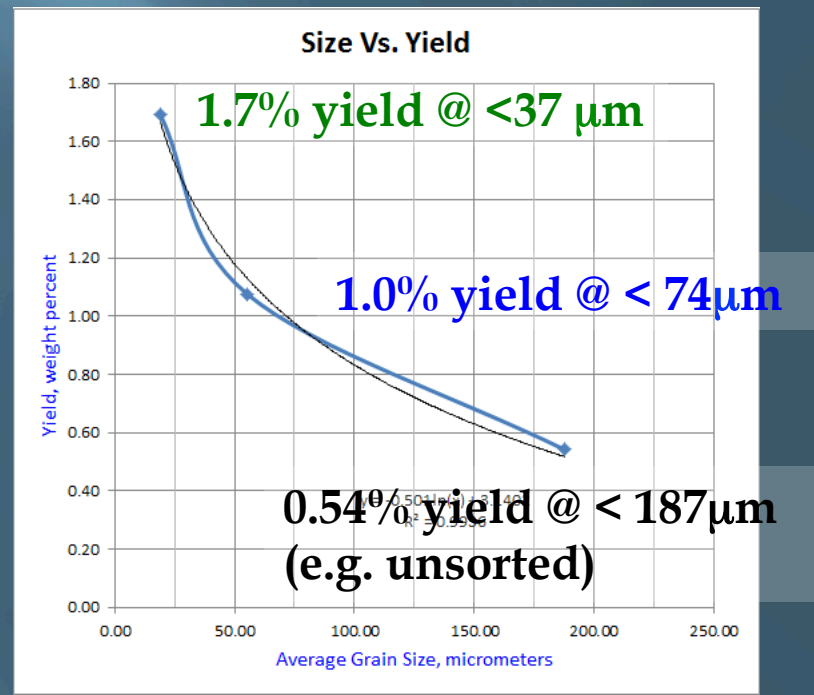


Particle sizes of at least 130 μm are required in order to have sufficient pore space for plant growth (Helmke and Corey (1989).

Hydrogen reduction process efficiently is greatly enhanced when particles are smaller than 74 micrometers.

Yield almost doubles again when particles are smaller than 37 micrometers.

(Data from PNNL Contractor report)

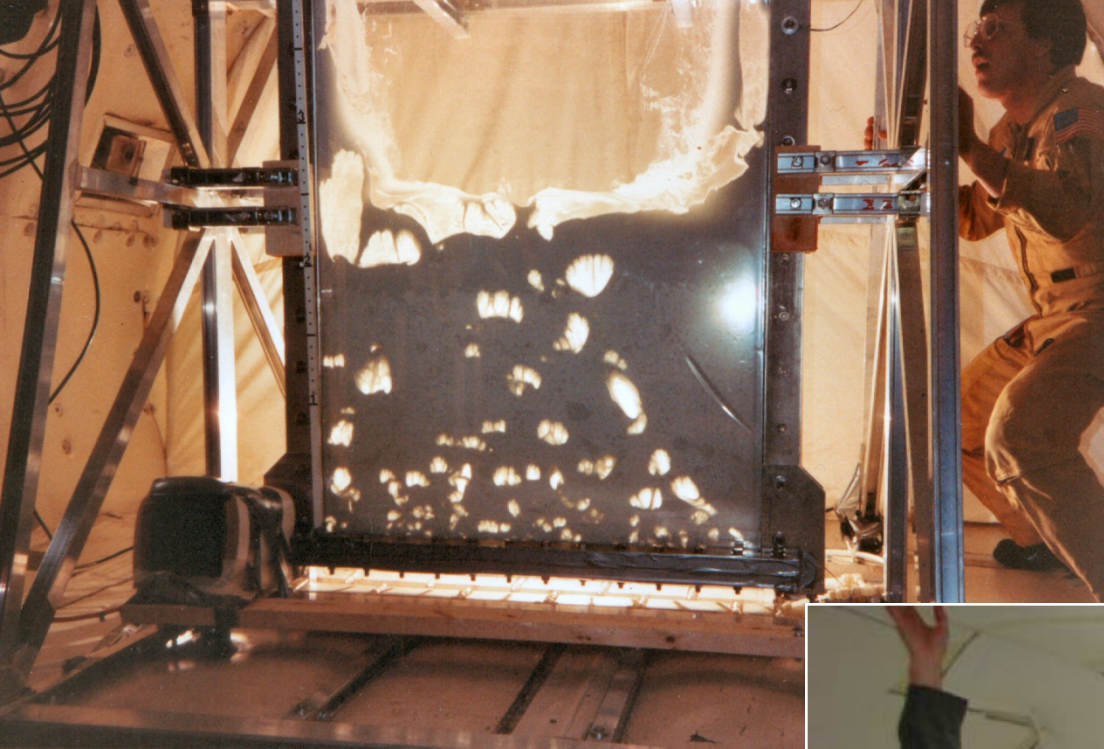




Pneumatic size separation down to 1.7 micrometers has been achieved

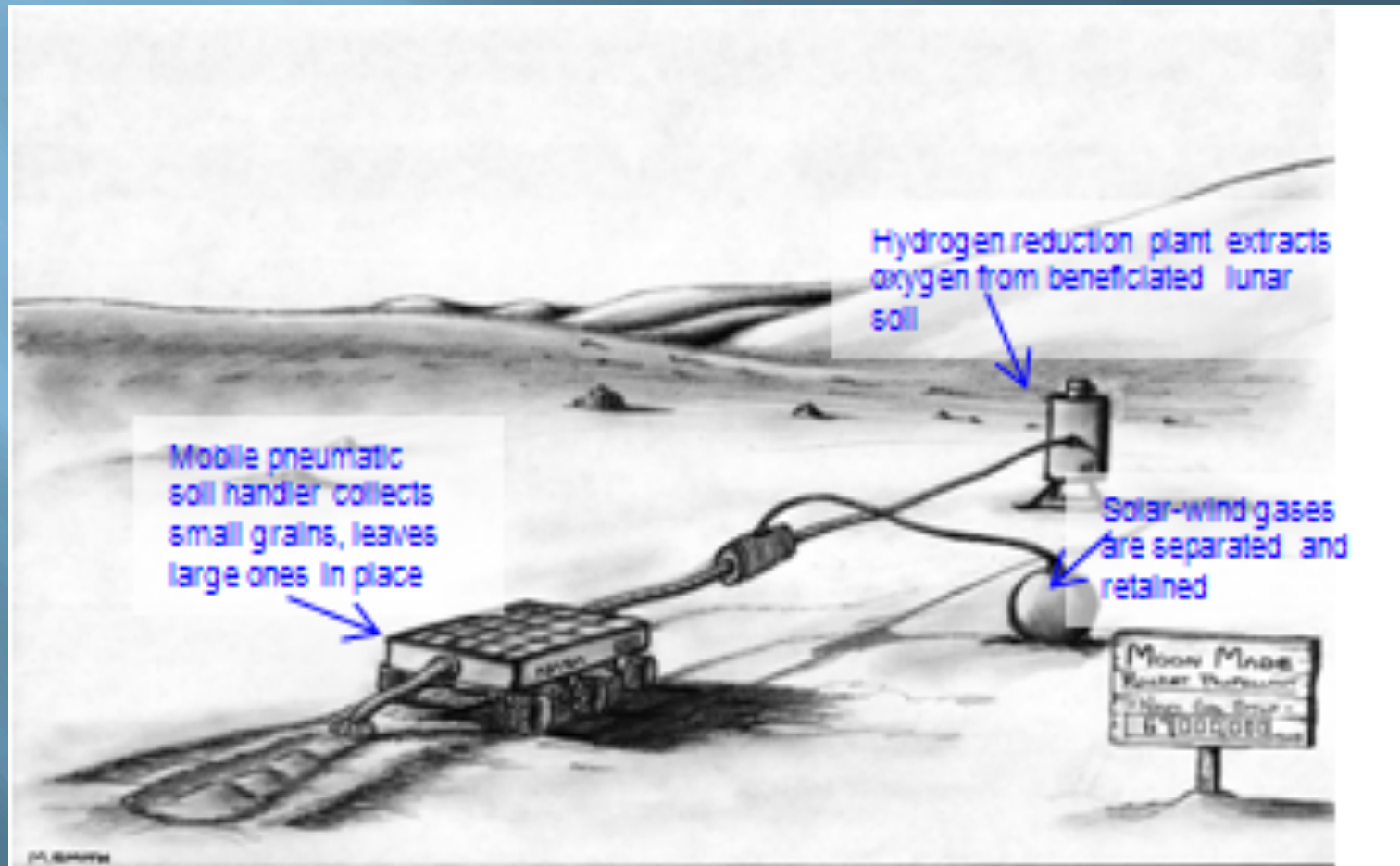



Pneumatic soil transport in vacuum has been achieved

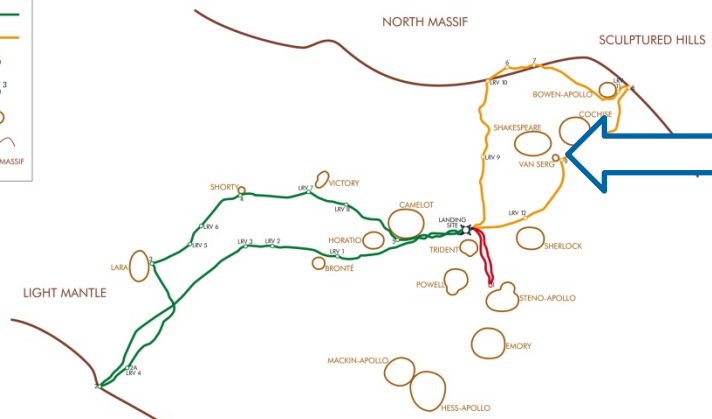


Pneumatic soil
transport in
 $1/6g$ has been
achieved





EXPLANATION	
landing site	
traverse track EVA 1	
traverse track EVA 2	
traverse track EVA 3	
traverse station	
sample station	
lunar sample obtained with scoop from lunar roving vehicle	
crater	
edge of valley floor	
Lunar features	
NORTH MASSIF	



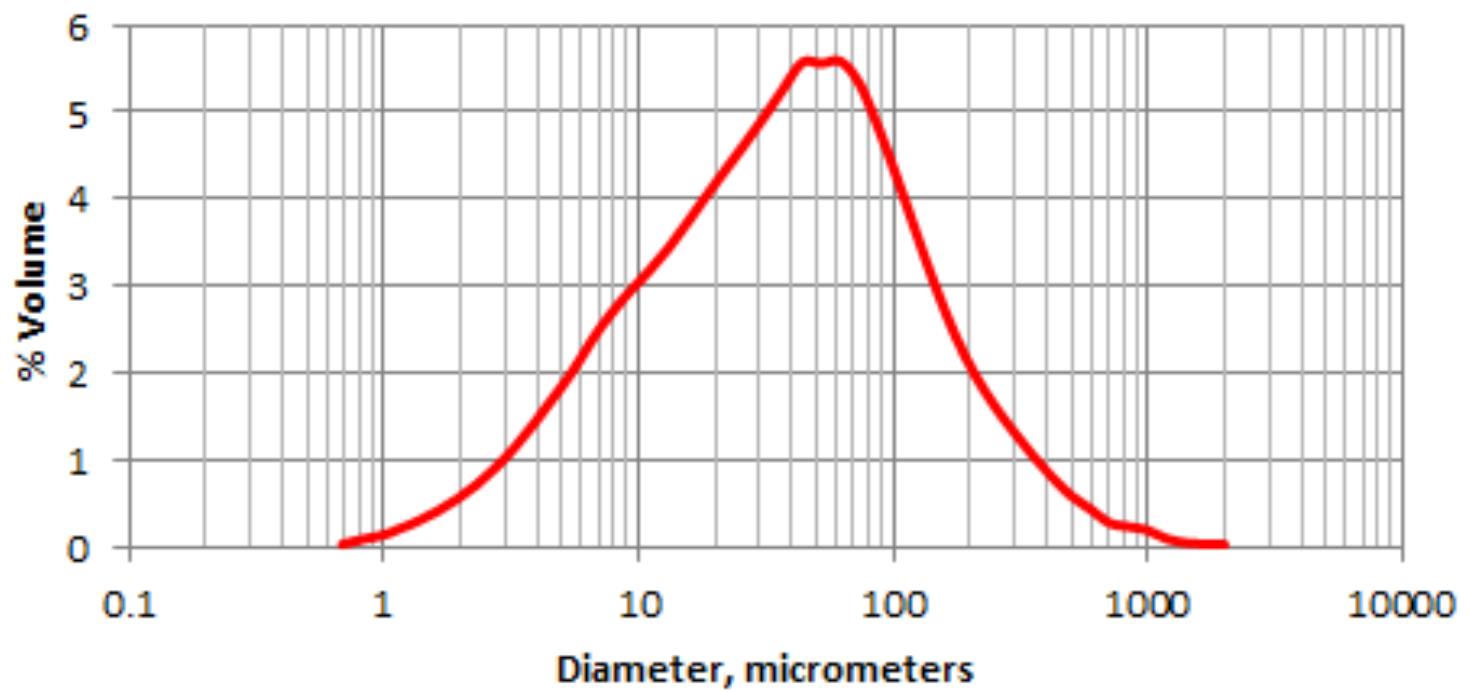
Apollo 17
traverse tracks



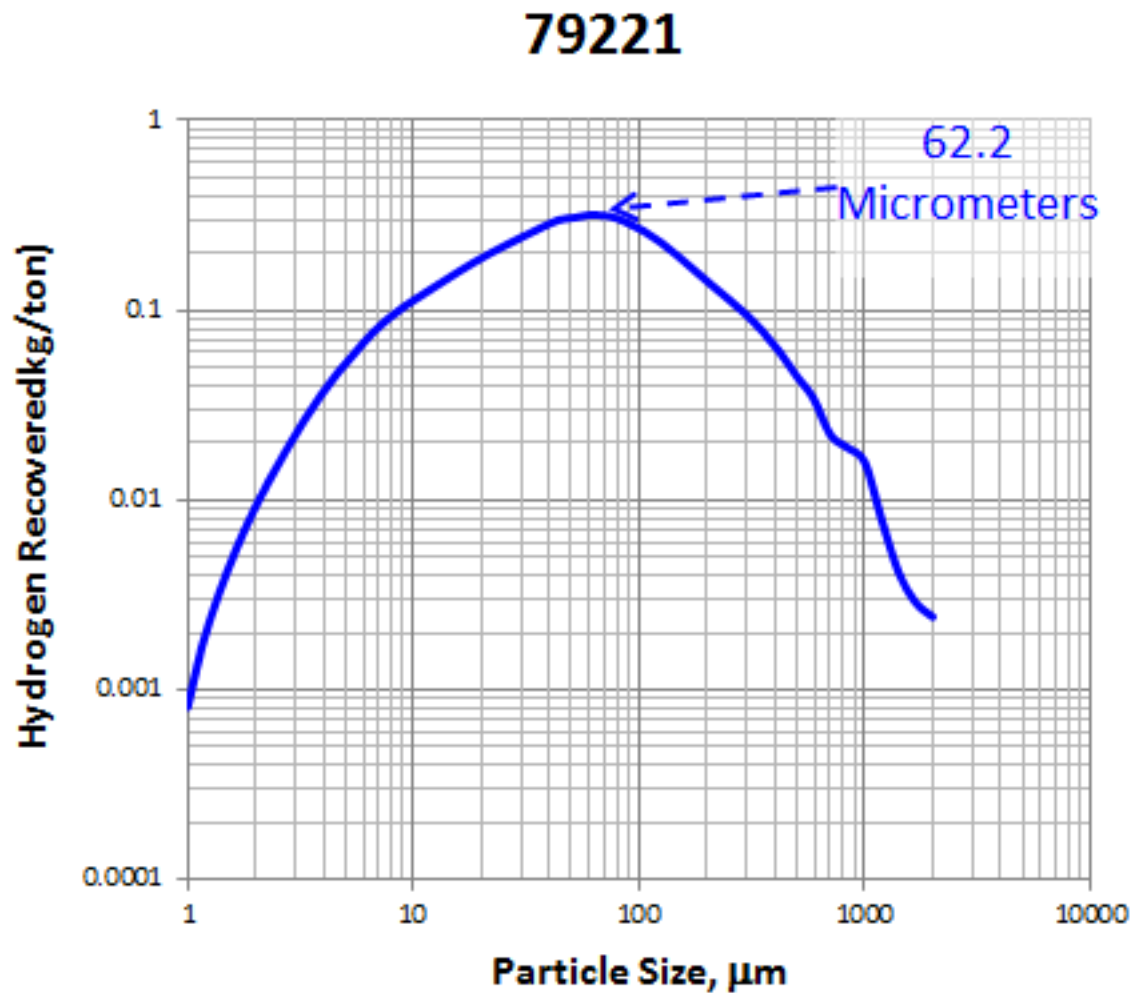
79221

Trench near Van Serg Crater

79221 PSD



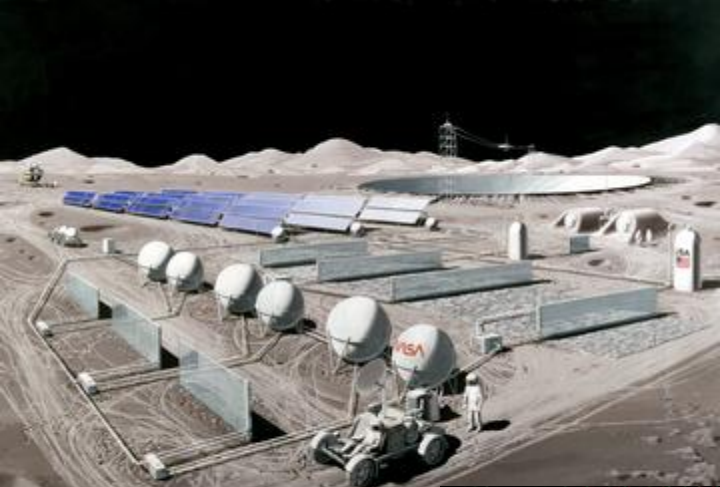
Apollo 17 Soil 79221





ARES

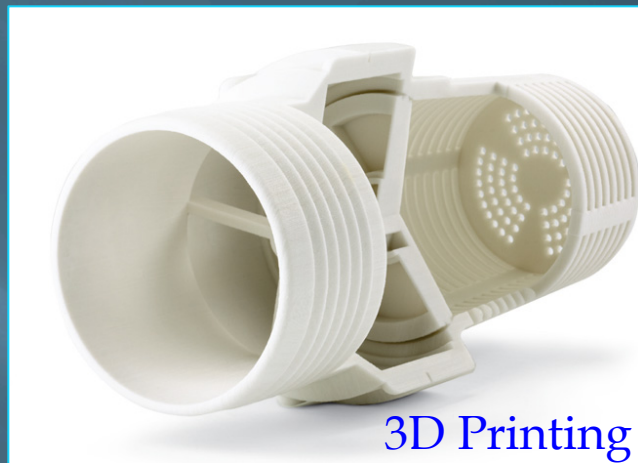
ASTROMATERIALS RESEARCH & EXPLORATION SCIENCE



Opportunities



← Jim Keravala

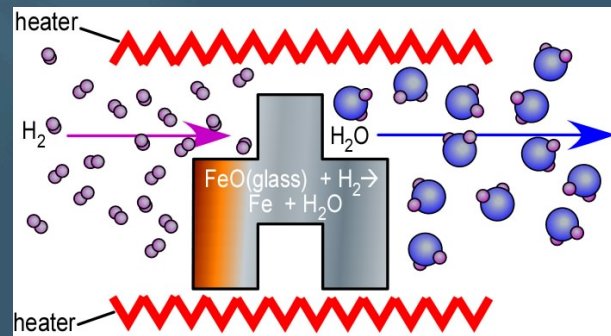


3D Printing



Pneumatic Transport of All Kinds of Things

Magnetic Building Materials



Reduction-Assisted Sintering

Thank you

