

# Geological, geochemical and geophysical studies on the Moon: Combination of manned and robotic approaches

*E. M. Galimov and A. T. Basilevsky*

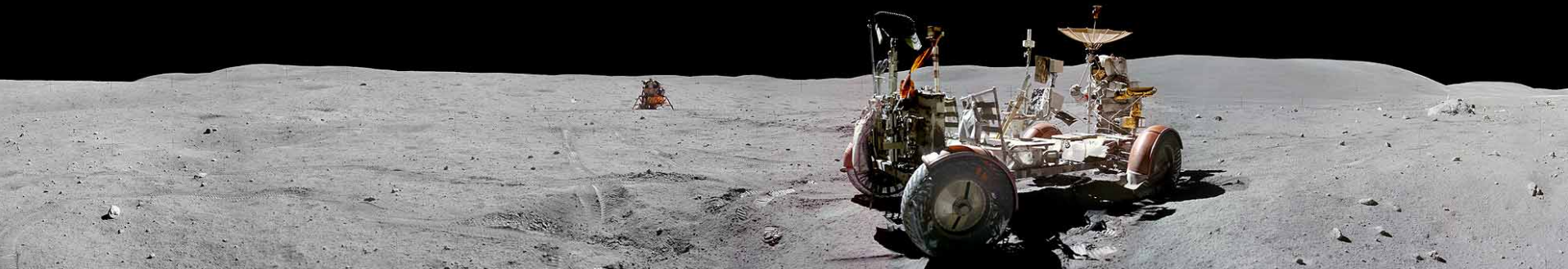
Vernadsky Institute of Geochemistry and Analytical Chemistry  
Russian Academy of Sciences  
Moscow, Russia

A black and white photograph of the lunar surface. In the center-left, an astronaut in a full space suit stands on the dusty ground. To the left, a lunar rover is parked. To the right, a large lunar lander or rover is visible, featuring a prominent parabolic dish antenna. The background shows the dark, cratered horizon of the Moon under a black sky.

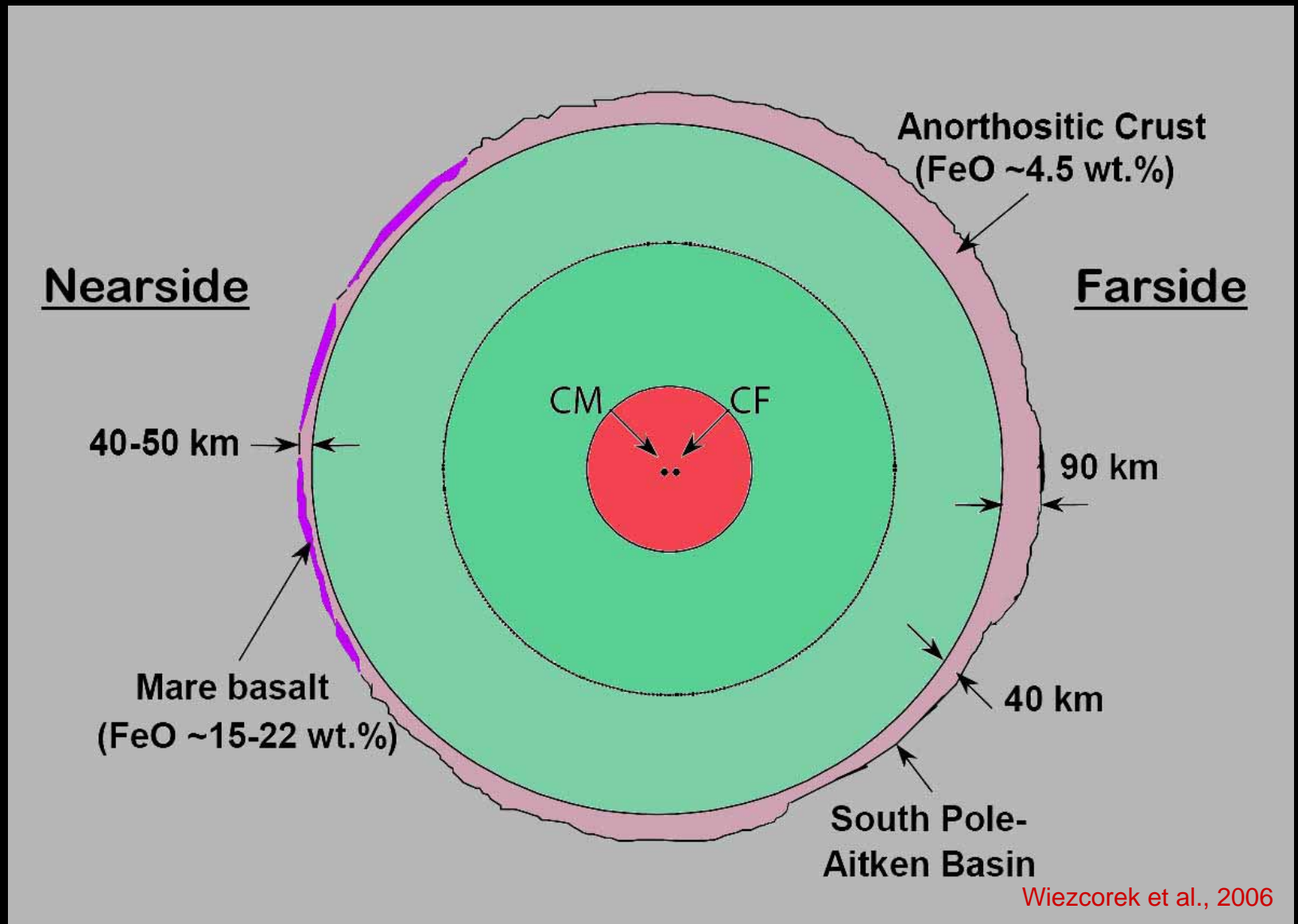
*International Conference*  
Moon Base: a Challenge for Humanity  
“The Precursor Age”  
November 16-17, 2006  
Moscow

# Moon: What we know and what we do not know?

- Internal structure is known not very well.
- Polar “caps” => Volatiles in eternal shadow => What they are?
- He-3 accumulations in lunar regolith => How to prospect?
- What happened on the Moon during the first 600 m.y.
- Until what time lasted waning stages of lunar volcanism?



# Internal structure of the Moon

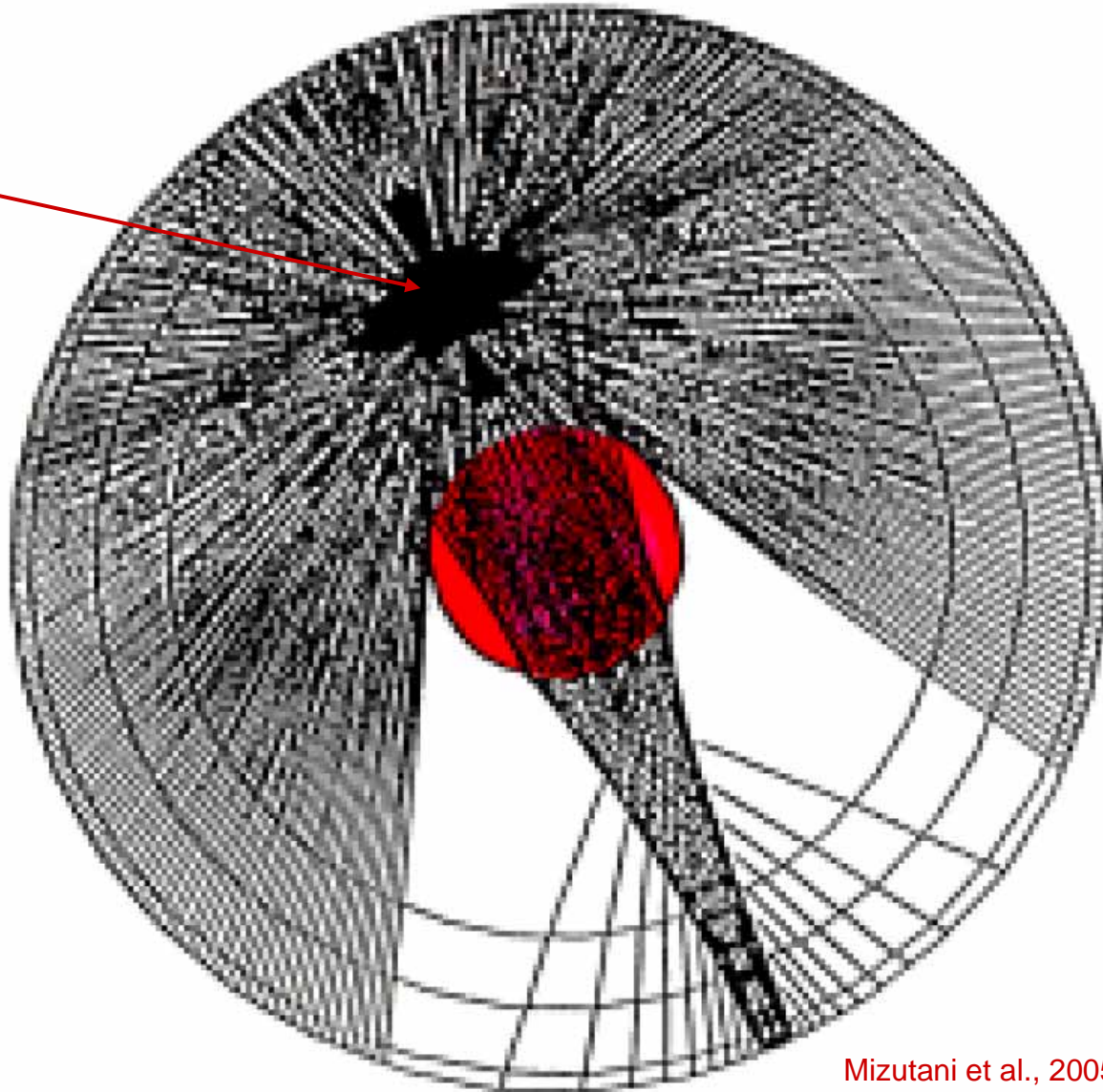


Known not very well. Indicative on how the Moon formed

# Seismic sounding and monitoring

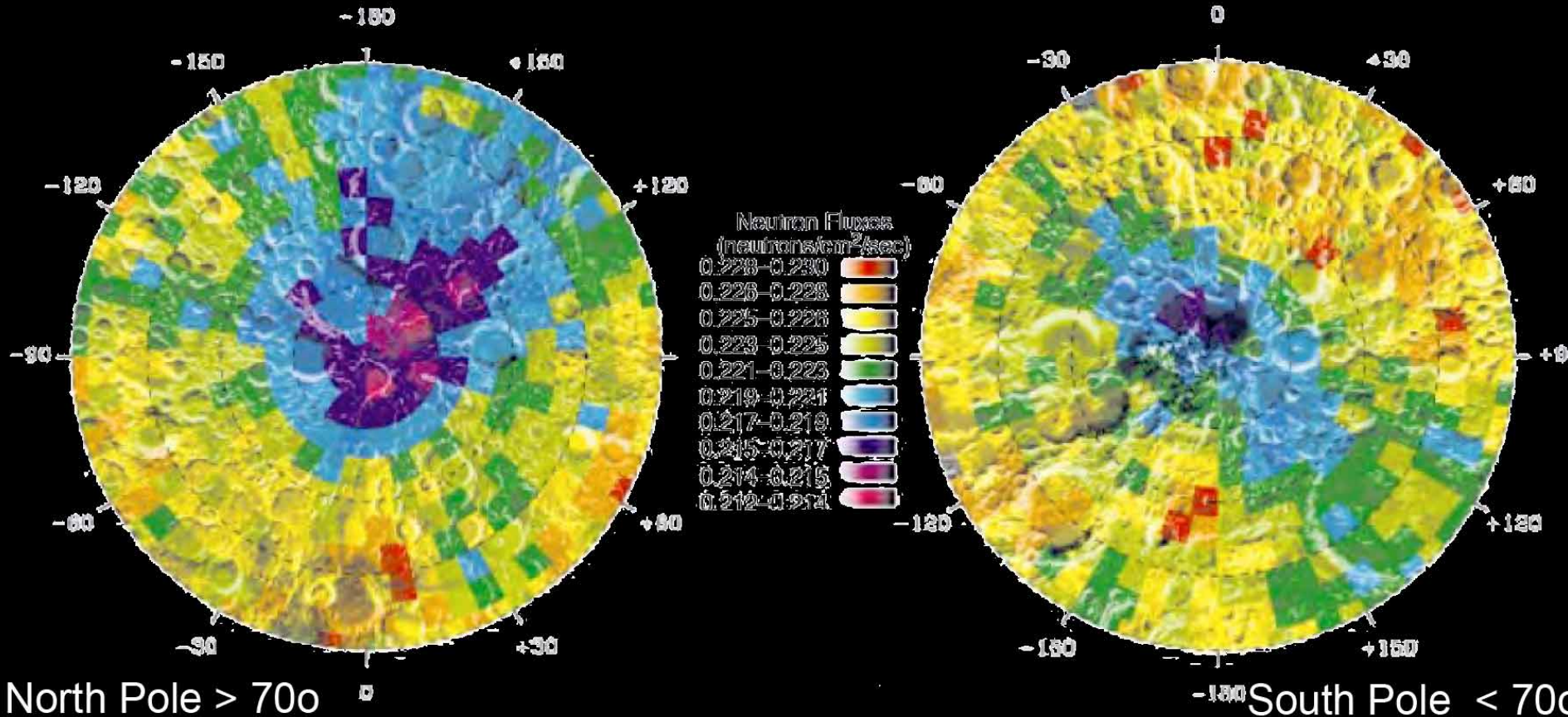
Theoretical Seismic Ray Path Pattern,  $R_{\text{Core}} = 400 \text{ km}$

Moonquake



Mizutani et al., 2005

# Polar deposits on the Moon as a source of water

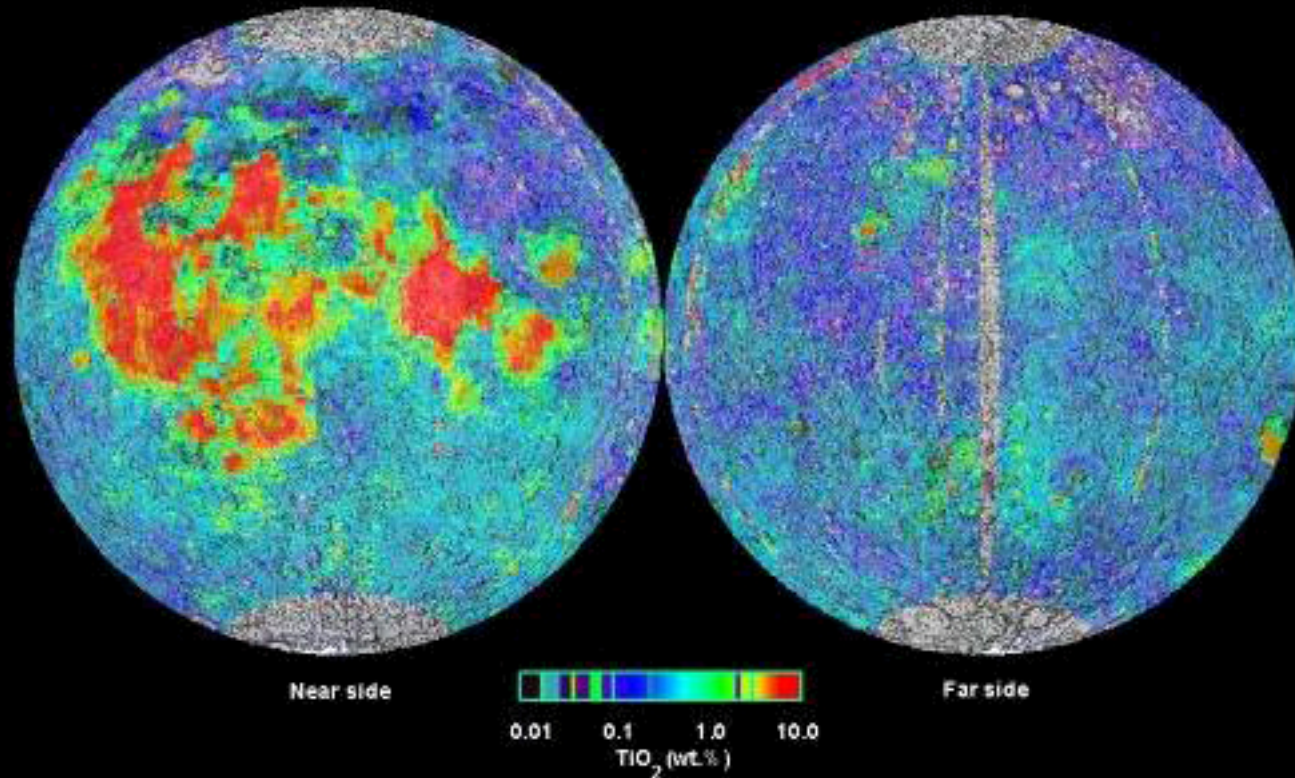


Low neutron flux = high content of H

In what form hydrogen is present:  
Water ice, ammonia, organics, protons captured by solids?  
How large these resources are?

# Helium-3 resources on the Moon

*Clementine* Titanium Map of the Moon  
Equal Area Projection



Maximum concentrations of He-3 are found in regolith samples formed on high-titanium basalts

# Lunar rock types

Maria



Basalt



Basalt



Breccia



Anorthosite



Impact melt



Norite



Troctolite



Highlands

# Lunar ages

Maria

3-3.9 b.y.

Highlands

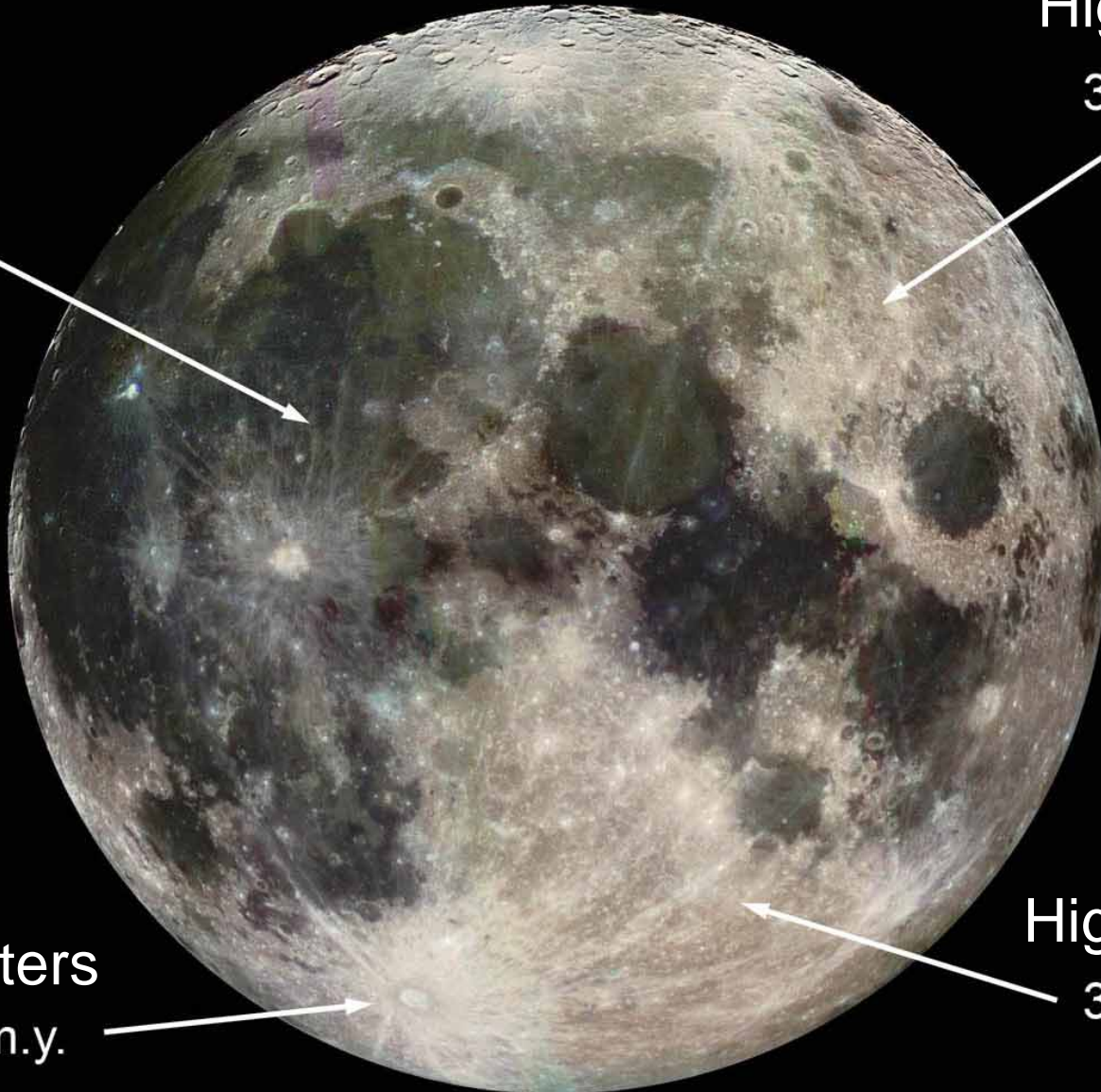
3.9-4 b.y.

Young craters

100 m.y.

Highlands

3.9-4 b.y.



# Geologic history of the Moon

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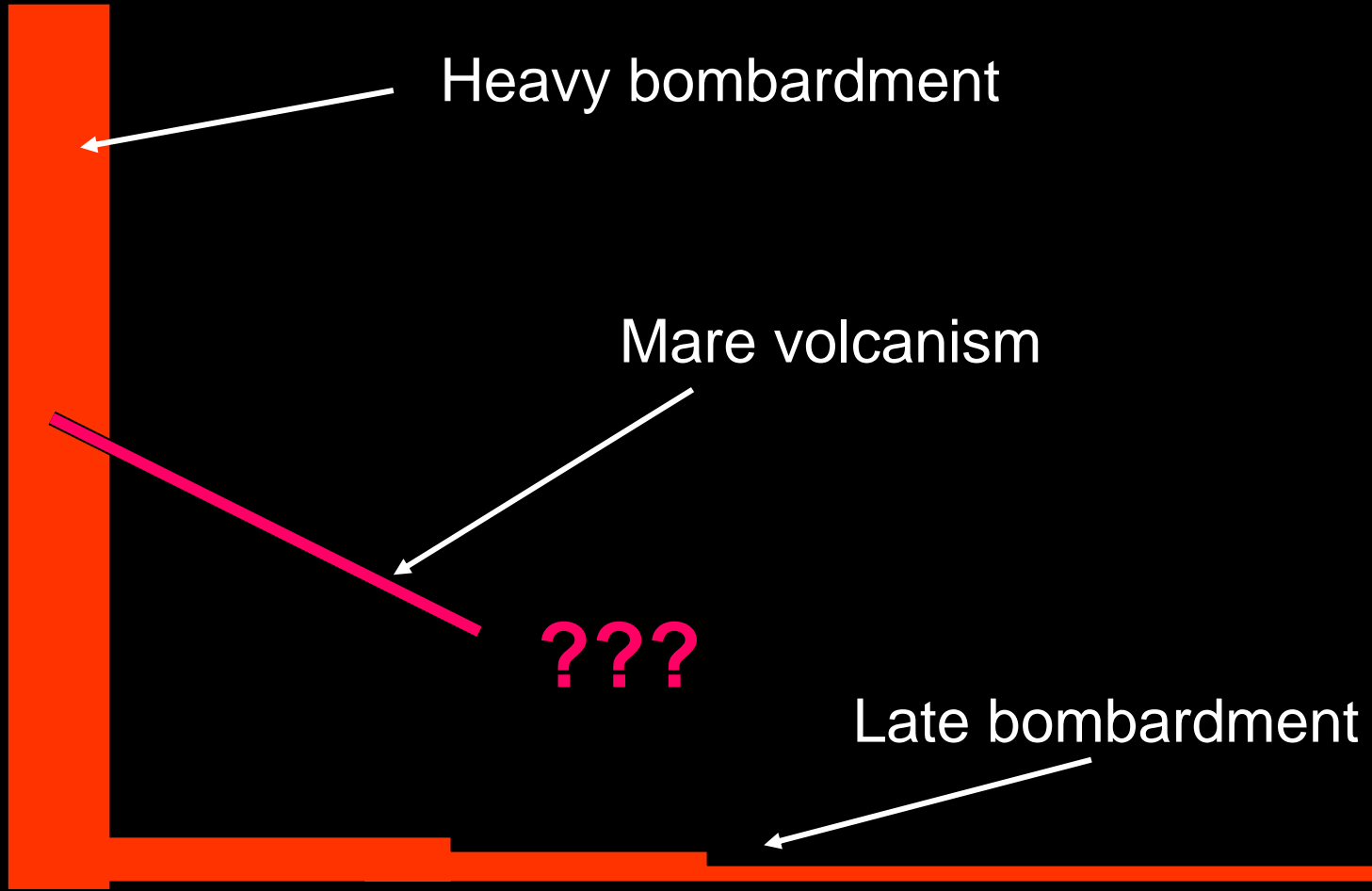
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Heavy bombardment

Mare volcanism

???

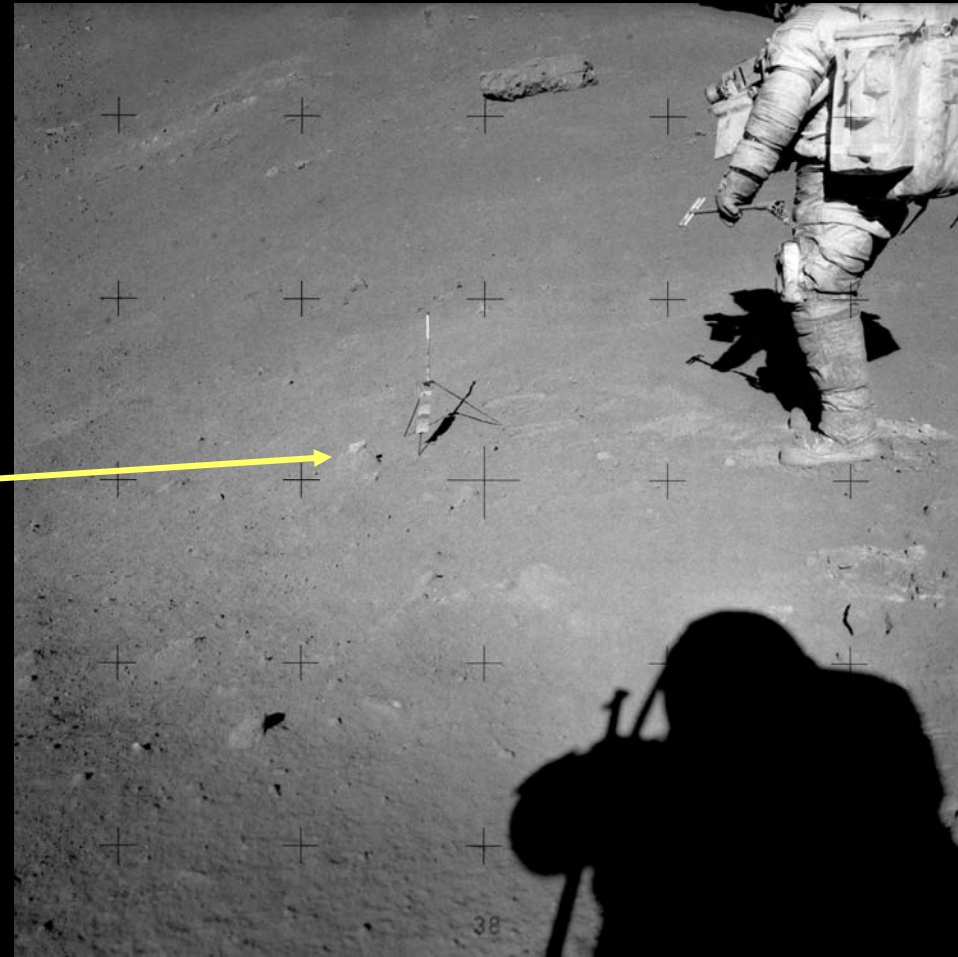
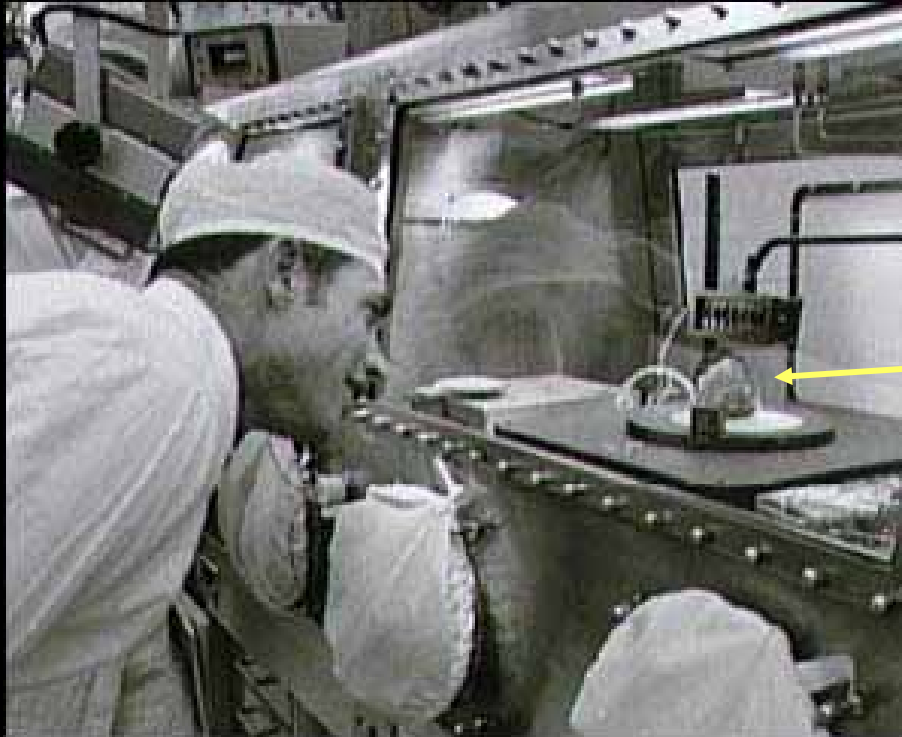
Late bombardment



4.55 b.y.  
ago

Present

# Genesis rock, Anortosite of 4.5 b.y. old Found by Apollo 15 expedition



*We should hunt for such rocks in future studies*

# Field and other activities on the Moon: Combination of man power and robots

People are good where creativity and ingenuity are needed.

Robots are good for monotonous and risky activities.

