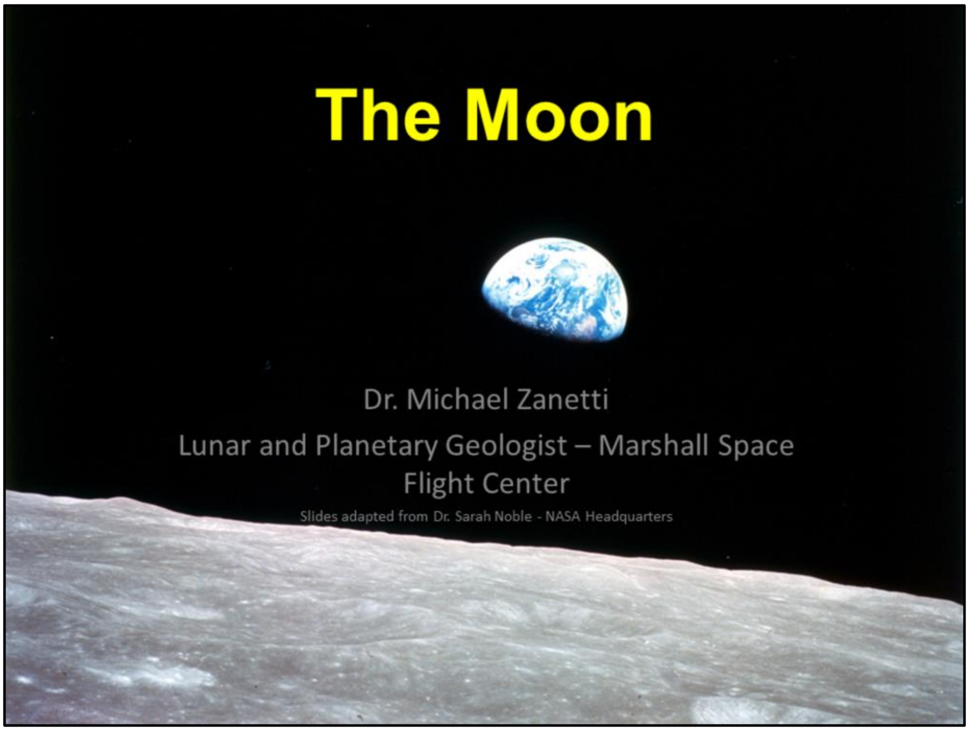
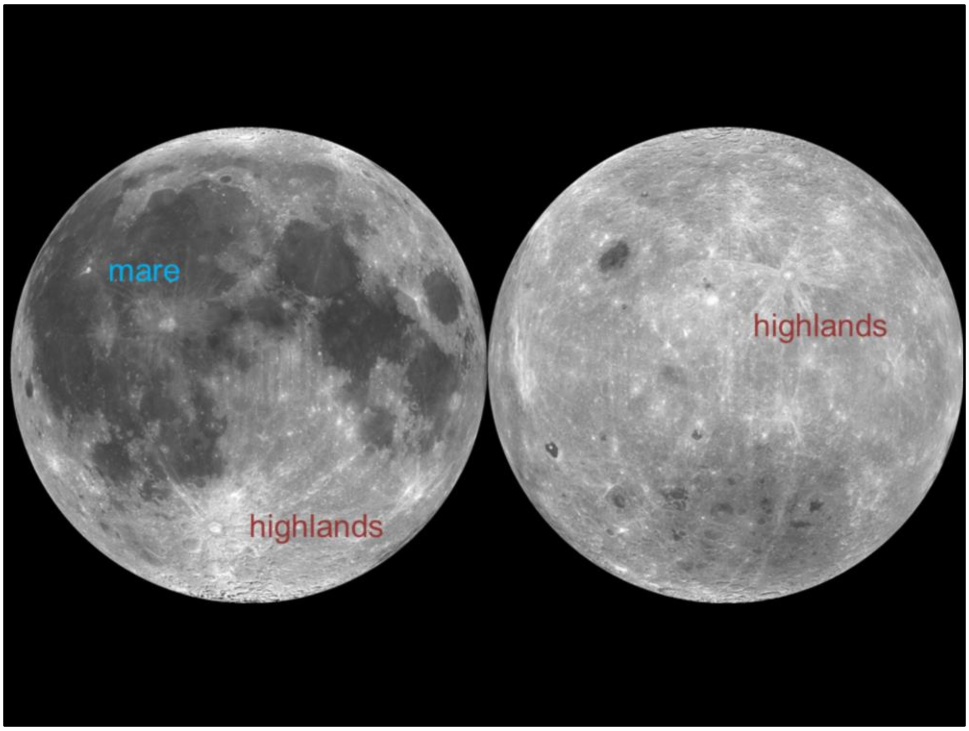


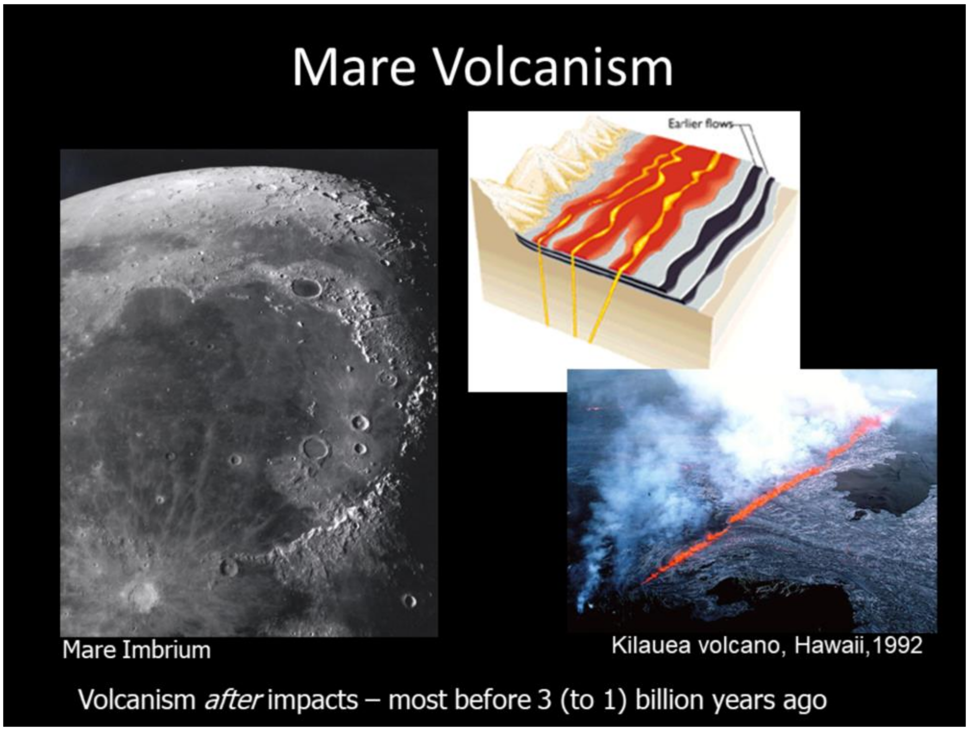
The Moon
Dr. Michael Zanetti
Lunar and Planetary Geologist – Marshall Space Flight Center
Slides adapted from Dr. Sarah Noble - NASA Headquarters


mare
highlands
highlands

Mare = Basalt

Mostly: Pyroxene $(Fe,Mg)Si_2O_6$, Plagioclase $Ca(Si,Al)_4O_8$, Olivine $(Mg,Fe)_2SiO_4$, Ilmenite $FeTiO_3$

Rare: Armalcolite $(Mg,Fe)Ti_2O_5$, Tranquillityite $Fe_8(Zr,Y)_2Ti_3Si_3O_{24}$

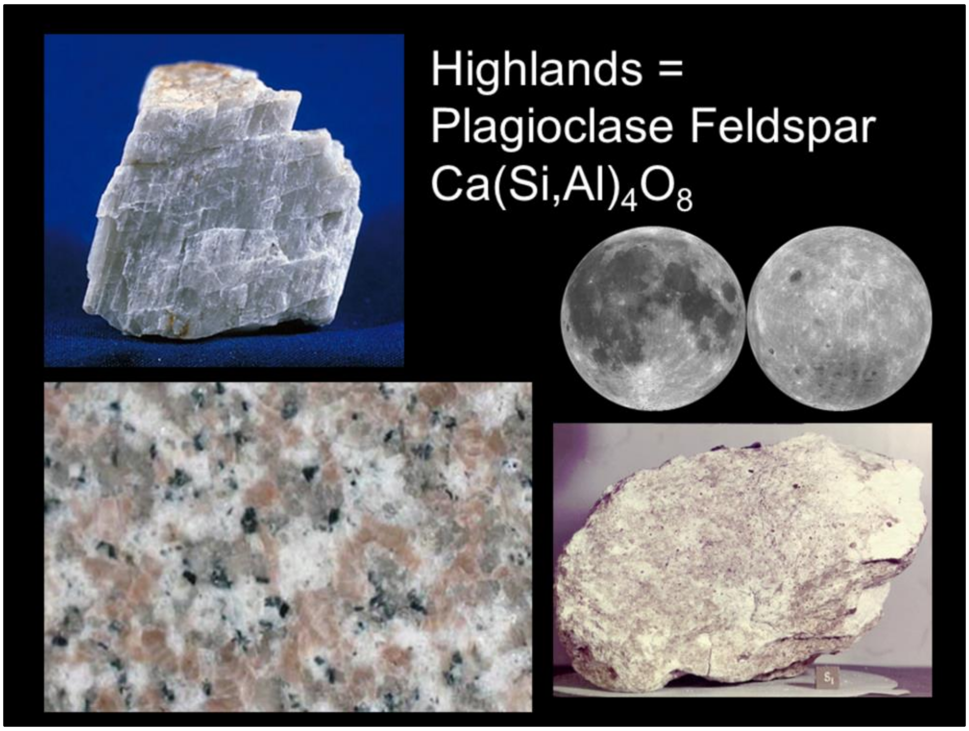


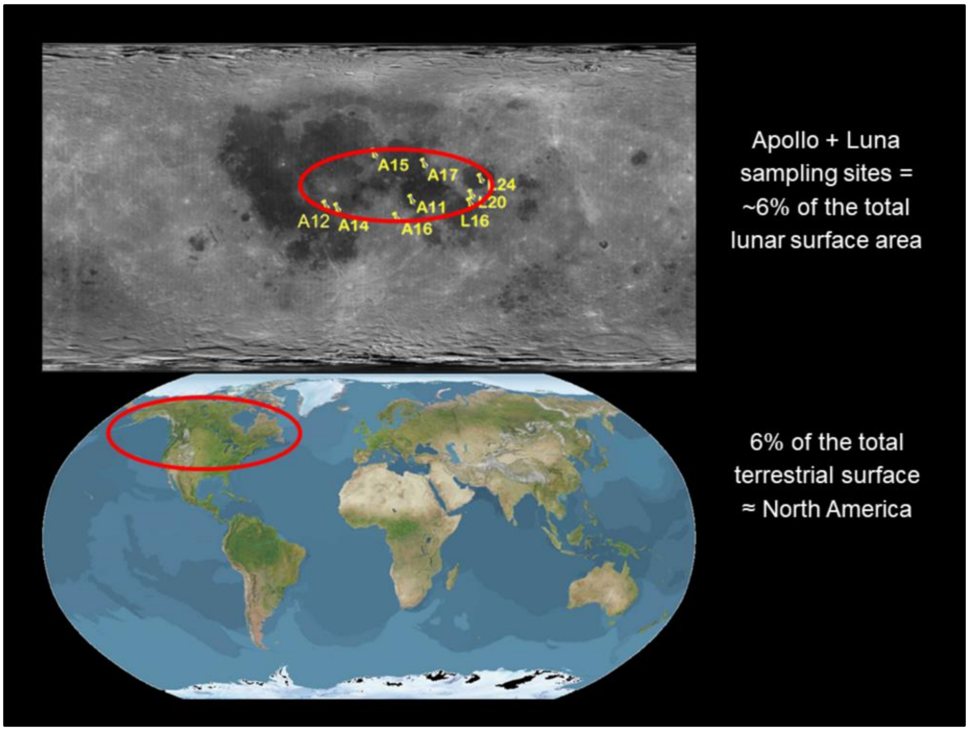
The deep parts of many large impact basins were later filled by eruptions of basaltic lava. This forms the circular Mare Imbrium (left image). At right, shadows reveal the edges of a long lava flow from the lower left to the upper right of the image. The volcanism in Mare Imbrium occurred about 3.3 billion years ago (7 am on our clock). Because of its small size, the Moon cooled quickly and was mostly dead volcanically by 3 billion years ago, although limited volcanism in isolated regions is thought to have occurred as recently as 1 to 2 billion years ago.

Lunar Volcanism

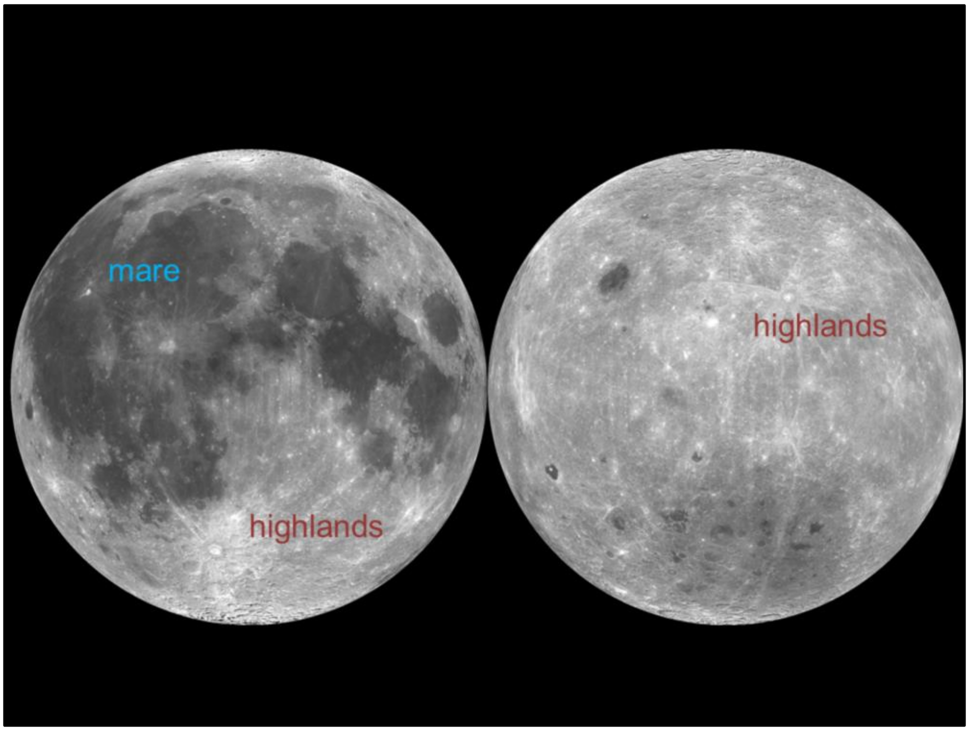
Portions of the Moon's interior remained hot enough to produce magma for more than a billion years after it formed. Molten rock flowed onto the lunar surface through cracks in the crust, spreading out and filling the low regions in the impact basins. The lava cooled quickly, forming the fine-grained, dark rocks — basalt — sampled during the Apollo missions. The dark areas seen on the Moon are basaltic lava plains 4.2 to 1 billion

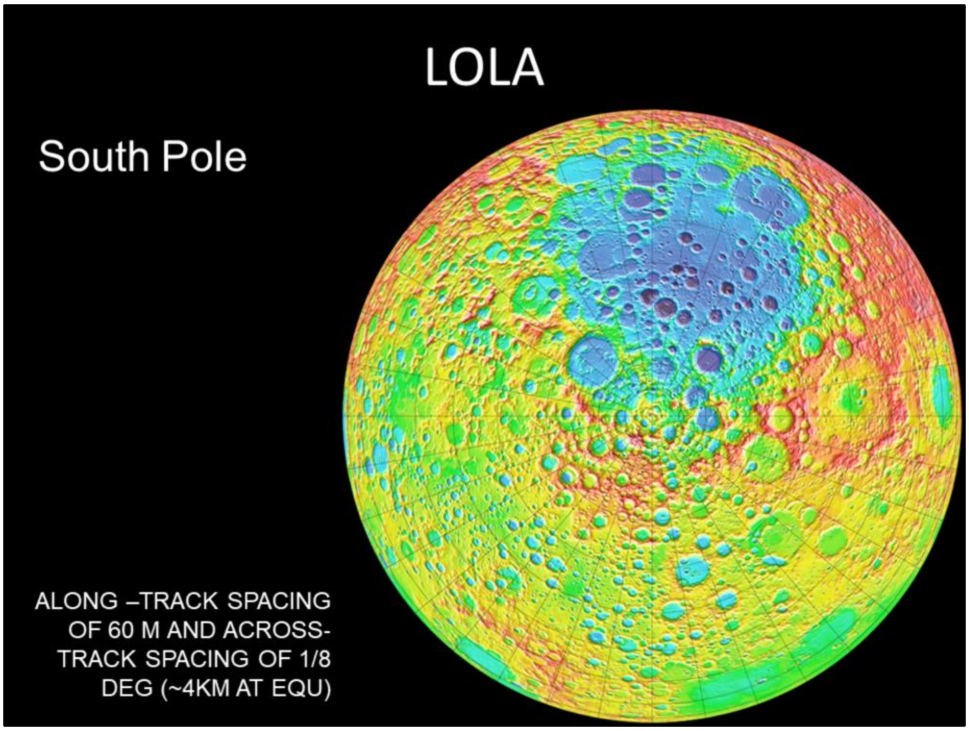
(place at 3.5) Lunar volcanism decreased significantly by 3 billion years ago and ceased completely by about 1 billion years ago as the interior of this small body cooled. 3.0 Ga

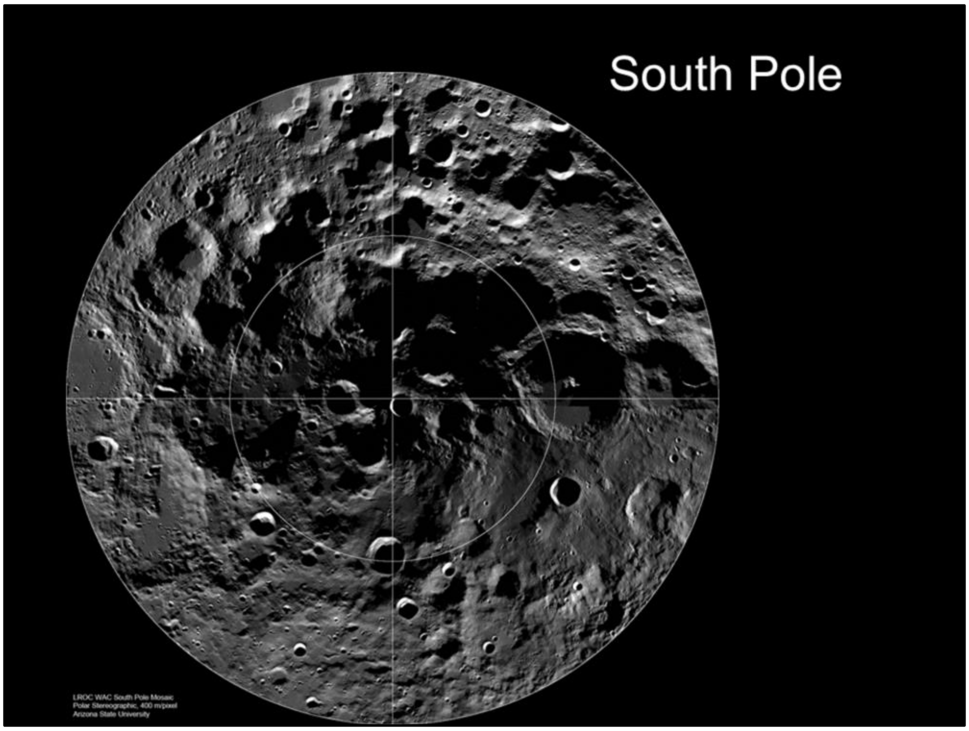

Highlands =
Plagioclase Feldspar
$Ca(Si,Al)_4O_8$



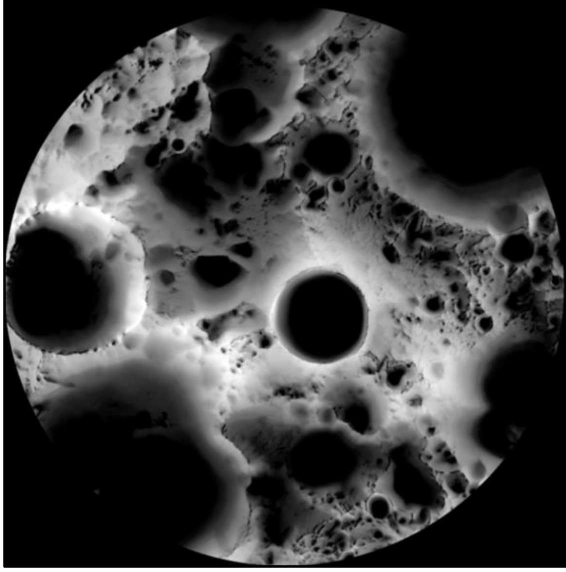
A15
A17
L24
A11
L20
A12
A14
A16
L16
Apollo + Luna sampling sites = ~6% of the total lunar surface area
6% of the total terrestrial surface ≈ North America


mare
highlands
highlands


LOLA
South Pole
ALONG –TRACK SPACING
OF 60 M AND ACROSS-
TRACK SPACING OF 1/8
DEG (~4KM AT EQU)


South Pole
LROC WAC South Pole Mosaic
Polar Stereographic, 400 m/pixel
Arizona State University

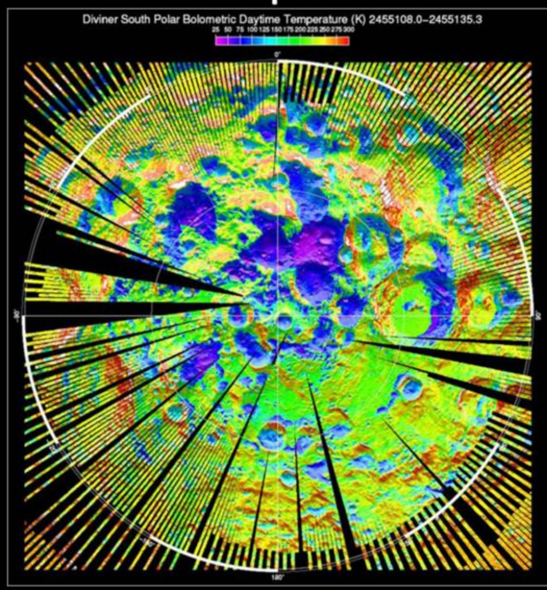
Light and Shadow



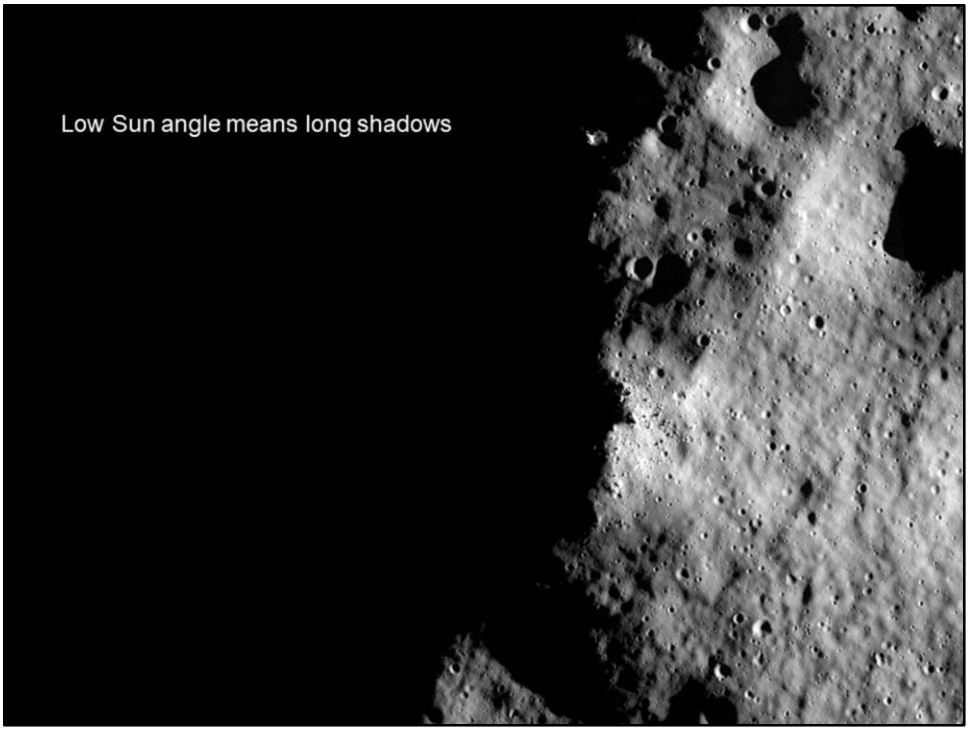
Illumination map of the South Pole compiled over 6 months.

Brighter = more days of sunlight, Darker = more days in shadow

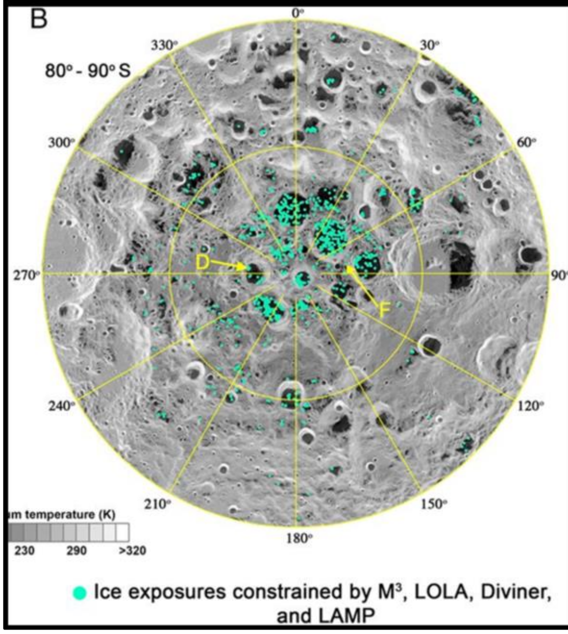
DIVINER Temperature Map



South Pole Noon Solstice


Low Sun angle means long shadows

Water at the Poles

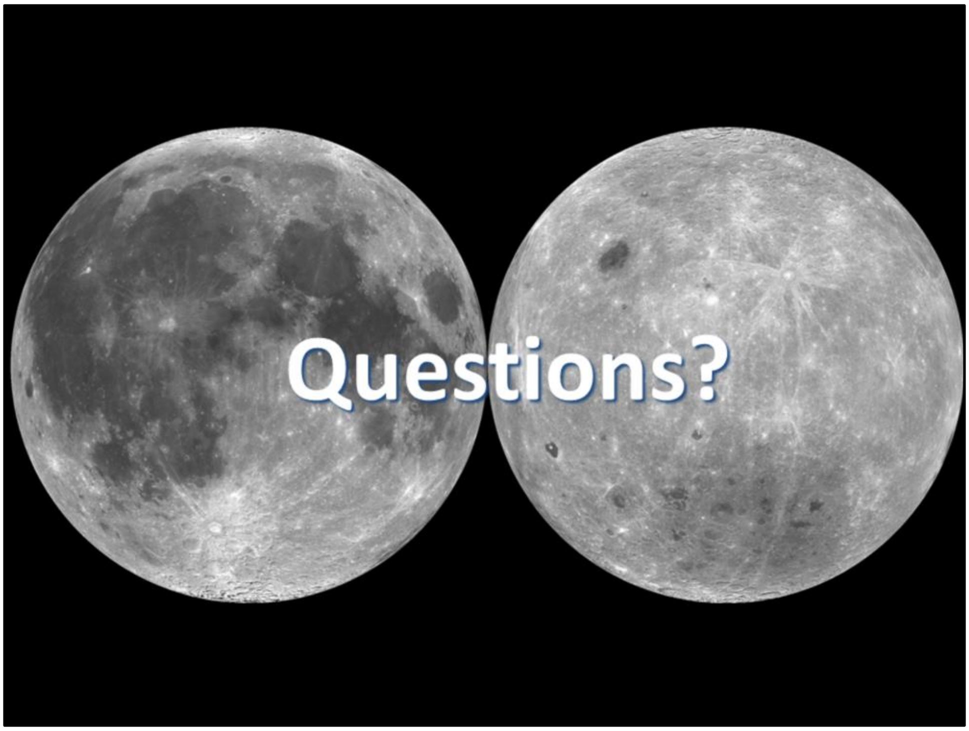


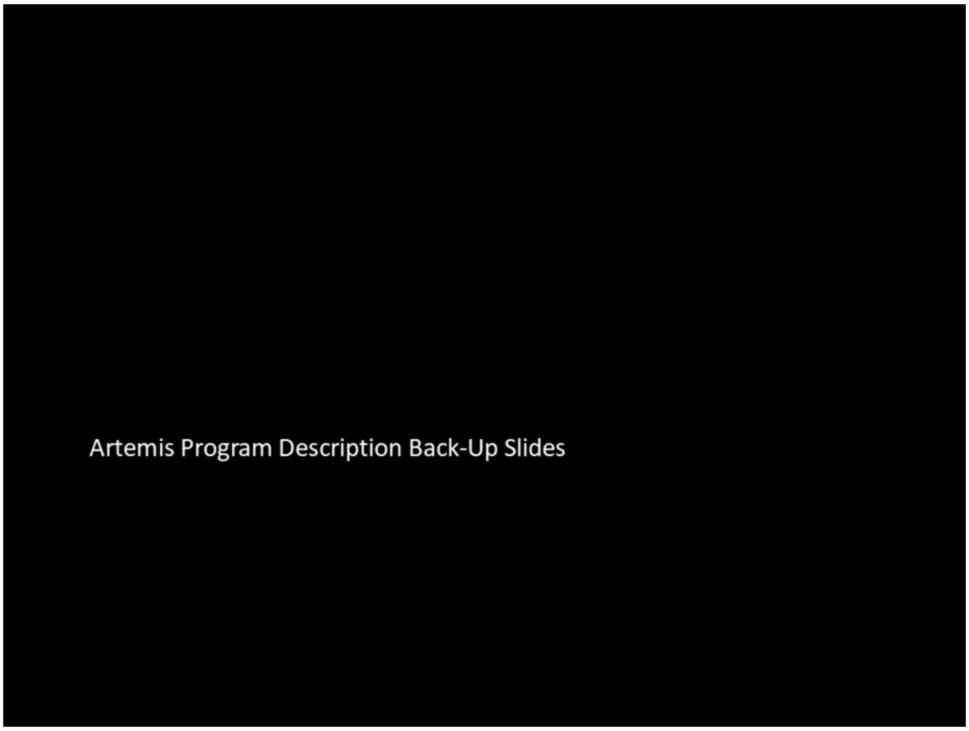
Direct evidence of surface exposed water ice in the lunar polar regions

Shuai et al, 2018

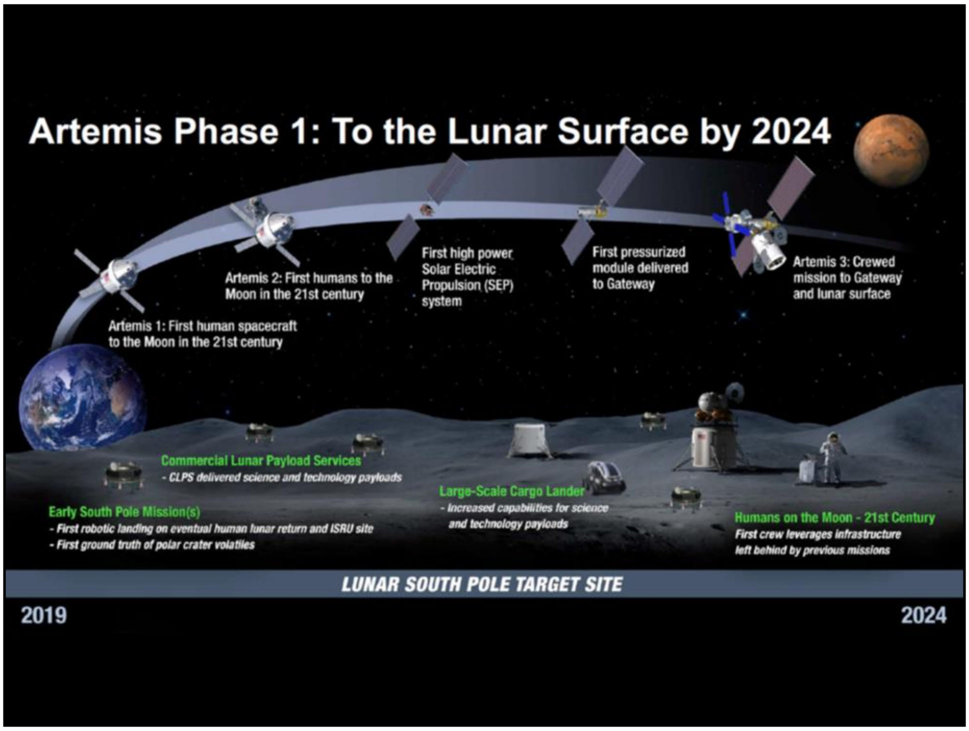
Big Science Questions

- Where are the polar volatiles and how did they get there?
  - What are the chemical and isotopic compositions of volatile deposits?
- How did the Moon form/evolve?
  - Sampling of ancient crust/mantle material, and geophysical measurements (seismometer/heat flow probe) will provide new insight into the lunar interior structure and composition, and of the Moon's geologic evolution
- Are there rock types that we didn't sample in Apollo, and what can they tell us about the Moon's evolution?
- Can we use the Moon to understand the distribution and timescale of impacts and volcanism on the inner planets?
- Can we explore craters to understand the physics of impact cratering, the most prevalent geologic process in the Solar System


Questions?



Following slides taken from Administrator Bridenstein’s presentation to the public on June 6, 2019.
https://www.nasa.gov/sites/default/files/atoms/files/america_to_the_moon_2024_artemis_20190523.pdf



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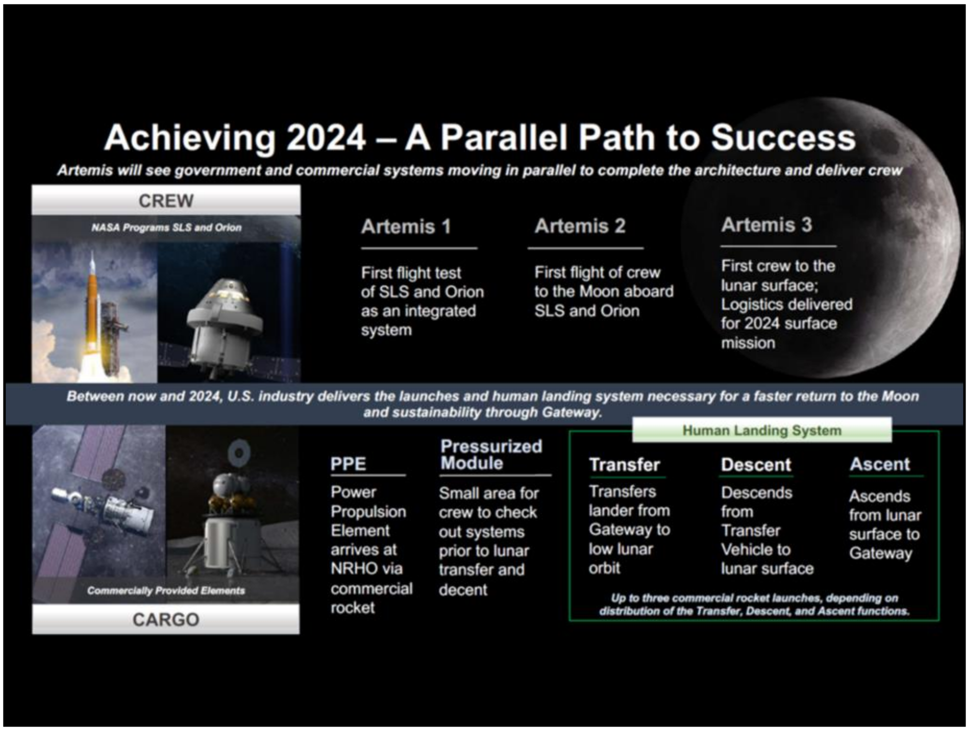

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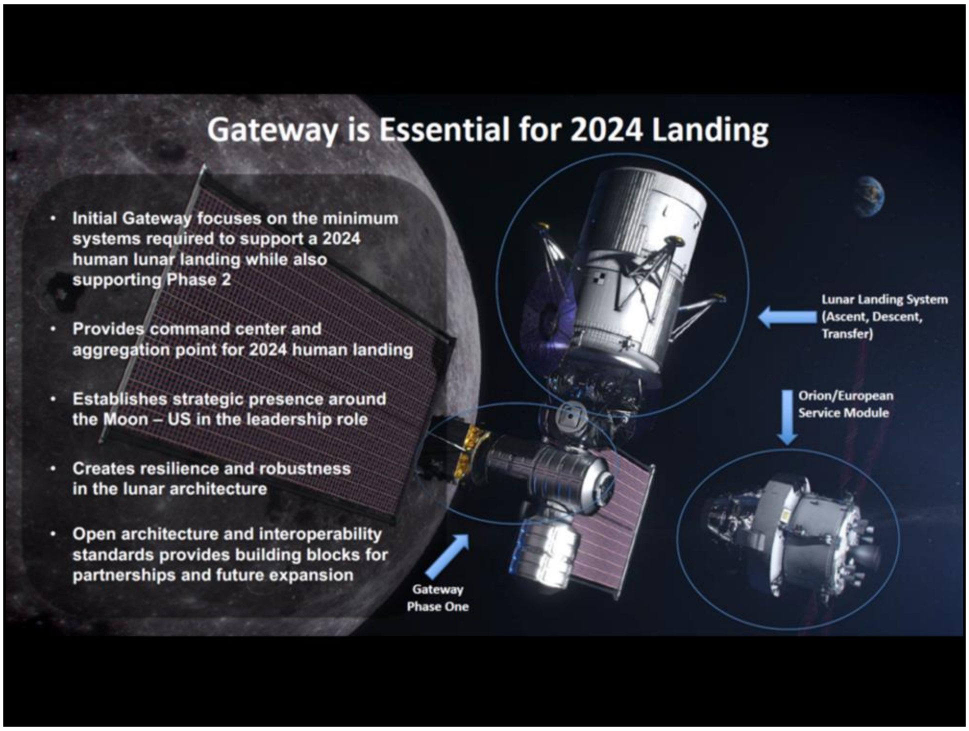

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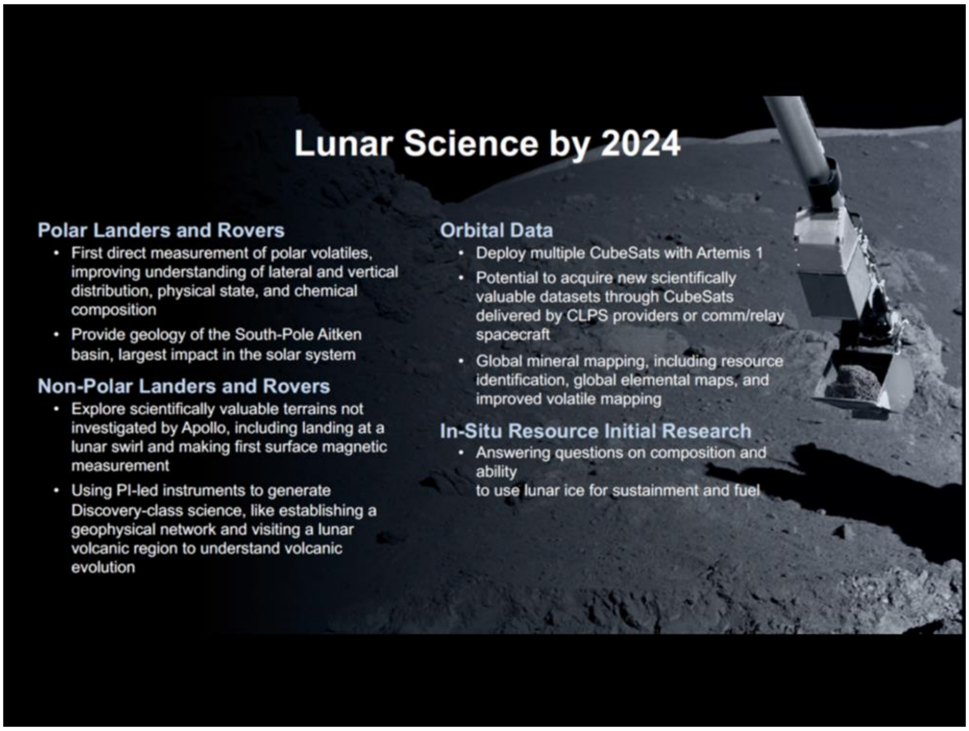

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