

Walking with the Last Men on the Moon: Revisiting the Apollo 17 Landing Site with the Lunar Reconnaissance Orbiter



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Why Revisit an Apollo Landing Site? Why Study the Moon?

- The Moon is the Cornerstone of our understanding of how planets work.
- The Moon, by its proximity to the Earth, records processes that affected all planets, including the Earth, and preserves a record of the early Solar System that is largely missing from the Earth
- The context of the samples is critical to their interpretation





LRO Instrument Suite



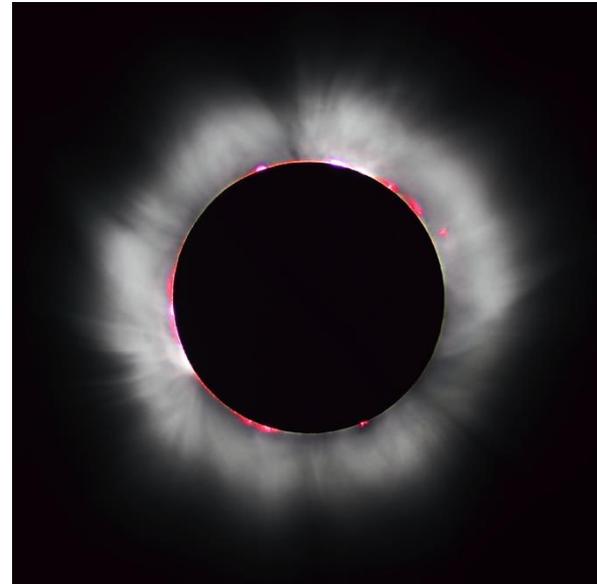
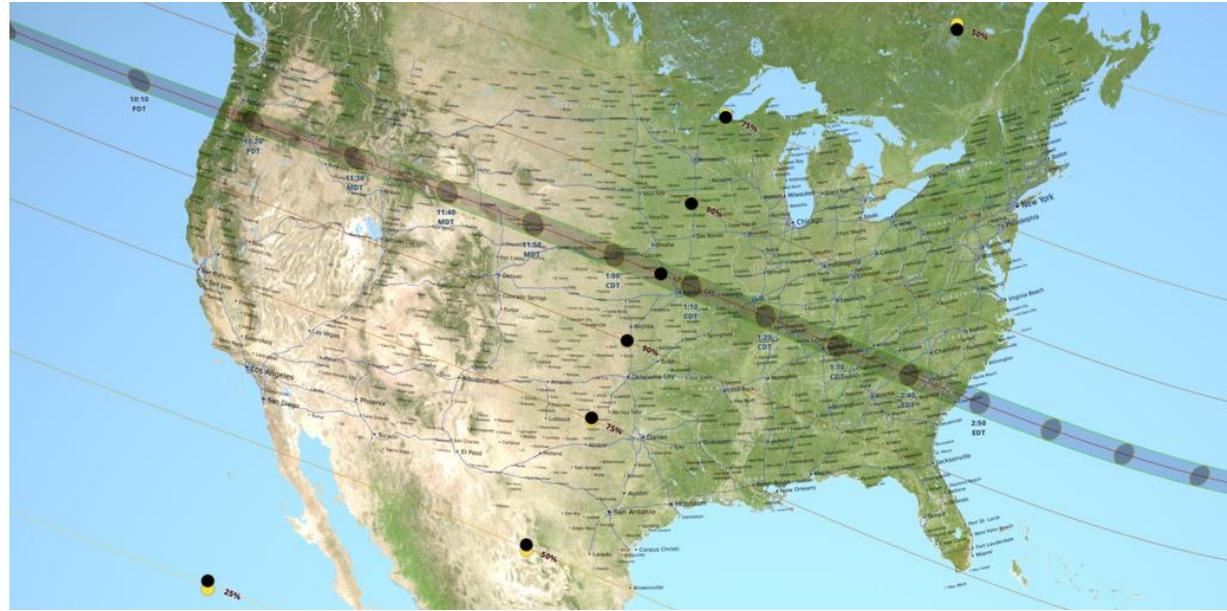
- CRaTER – Radiation Environment
- Diviner – Surface thermal properties
- LAMP – Reflected starlight from areas of permanent shadow
- LEND – Neutron measurements to map Hydrogen
- LOLA – Surface topography
- LROC – Images at ~50cm per pixel, global mapping of resources
- Mini-RF – Radar properties of the upper meter, buried ice





LRO Events and Activities

- August 21, total solar eclipse across the continental US, everyone will see something cool!
- October 28 – International Observe the Moon Night (observethemoonnight.org)



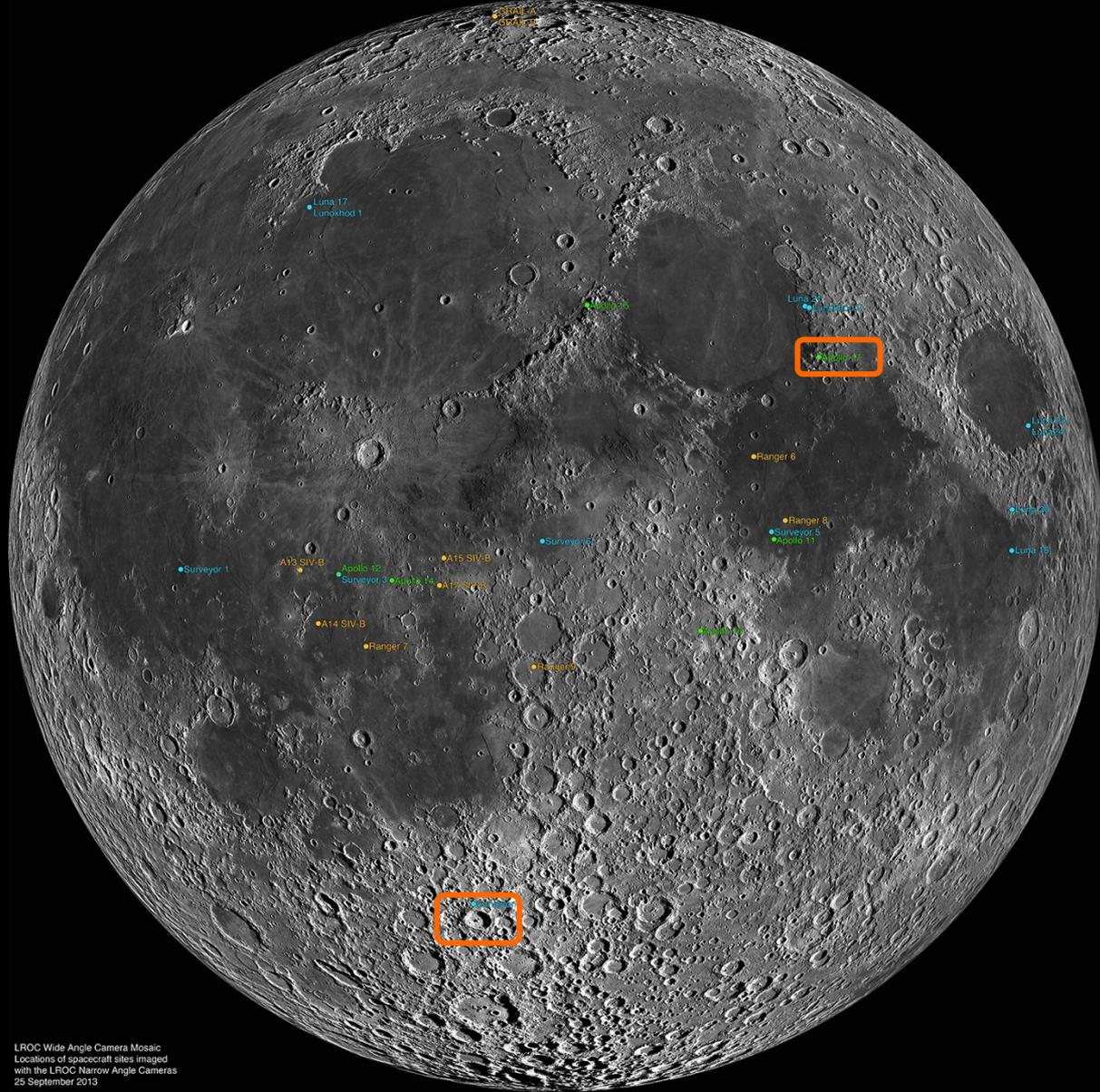


Apollo 17 – ~45Years Later



- Launched in the early hours of December 7, 1972
- Climax of the efforts of the Mercury, Gemini, and Apollo Programs
- Last trip into deep space by humans





LROC Wide Angle Camera Mosaic
Locations of spacecraft sites imaged
with the LROC Narrow Angle Cameras
25 September 2013



Apollo 17 – The Final Mission



- The last of the “J-missions,” included 10 surface experiments, 10 from the Command Module
- One “experiment” represents the culmination of a decade + of development....

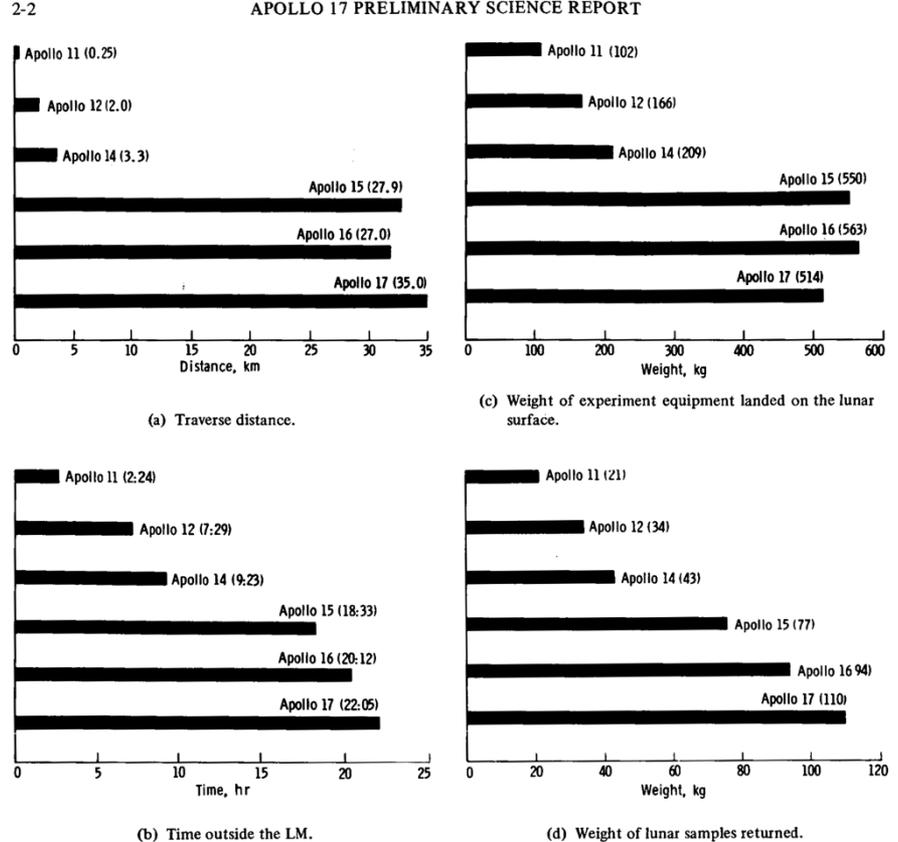


FIGURE 2-1.—Comparison of Apollo missions.



Dr. Harrison H. Schmitt



- “Jack” Schmitt, the only geologist to walk on the Moon, was the 12th and final human to step on the lunar surface
- Selected in the first group of scientist astronauts
- Assisted in the geologic training for prior missions and participated in the analysis of returned samples and surface investigations





Pre-Mission Objectives for Apollo 17



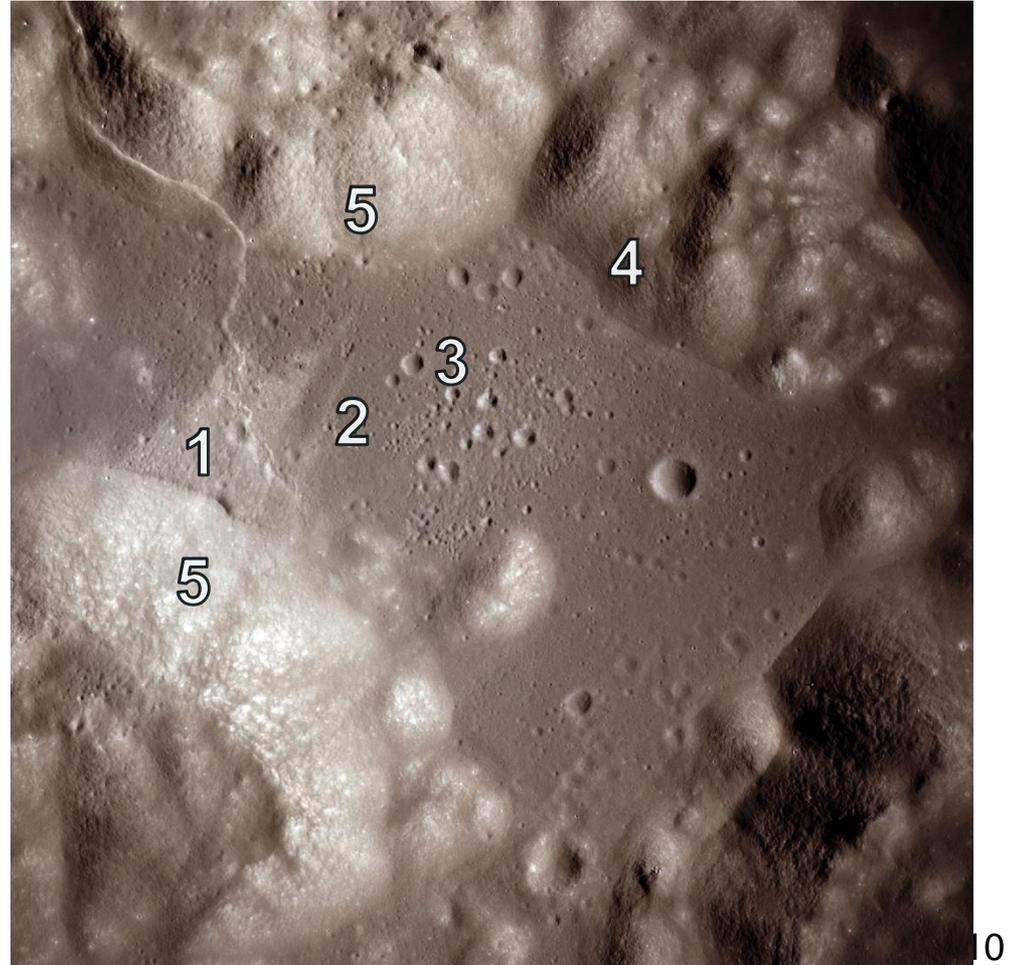
- Based on the successes of Apollo 15 (planning for 17 started before Apollo 16) the following objectives were defined
 1. Sample ancient lunar crust far from the Apollo 15 site
 2. Sample “young volcanics”
 3. Increase surface coverage by the orbiting Command Module
 4. Perform geophysical measurements in an area with subsurface layers
 5. Deploy the Apollo lunar surface experiments package
- The Apollo 17 site was selected on Feb. 11, 1972
- Following the selection, specific traverses were developed to address the 5 objectives



Specific Sampling Objectives



- Five geologic units were identified in pre-mission images
 1. The Light Mantle
 2. The Dark Mantle
 3. The Subfloor
 4. The Sculptured Hills
 5. The Massifs



Apollo 15 image

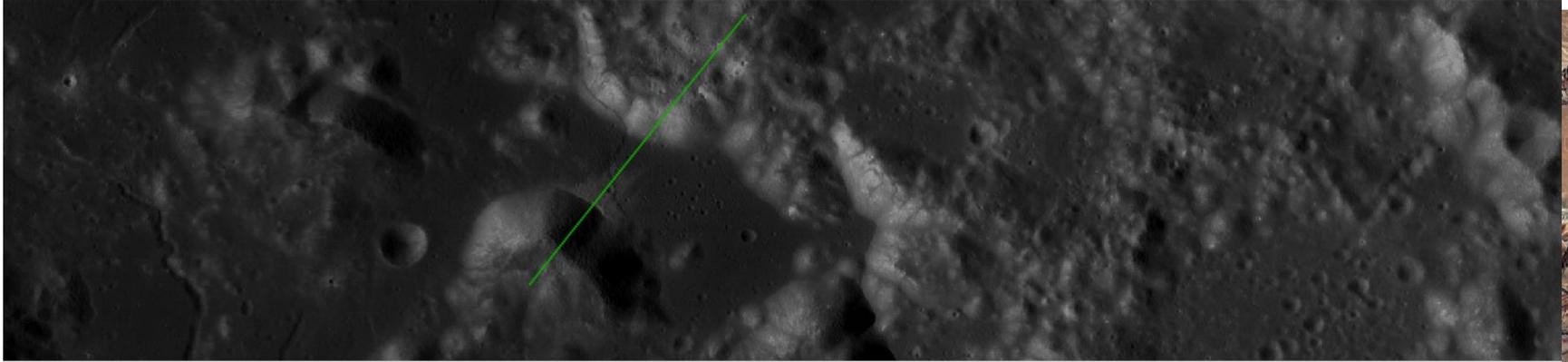


Taurus-Littrow Valley Comparison





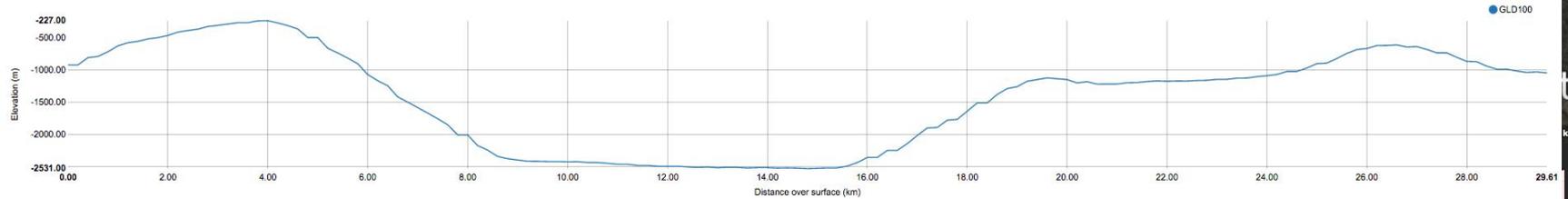
Taurus-Littrow Valley Comparison



Path Query

Geodetic Distance (distance over surface of the spheroid)
29.931 km

2.3 km of elevation change



1.8 km of elevation change





Objectives Addressed But Questions Remained



- Five geologic units were identified in pre-mission images

1. The Light Mantle

- Interpretation that a single landslide was triggered by ejecta from Tycho Crater

2. The Dark Mantle

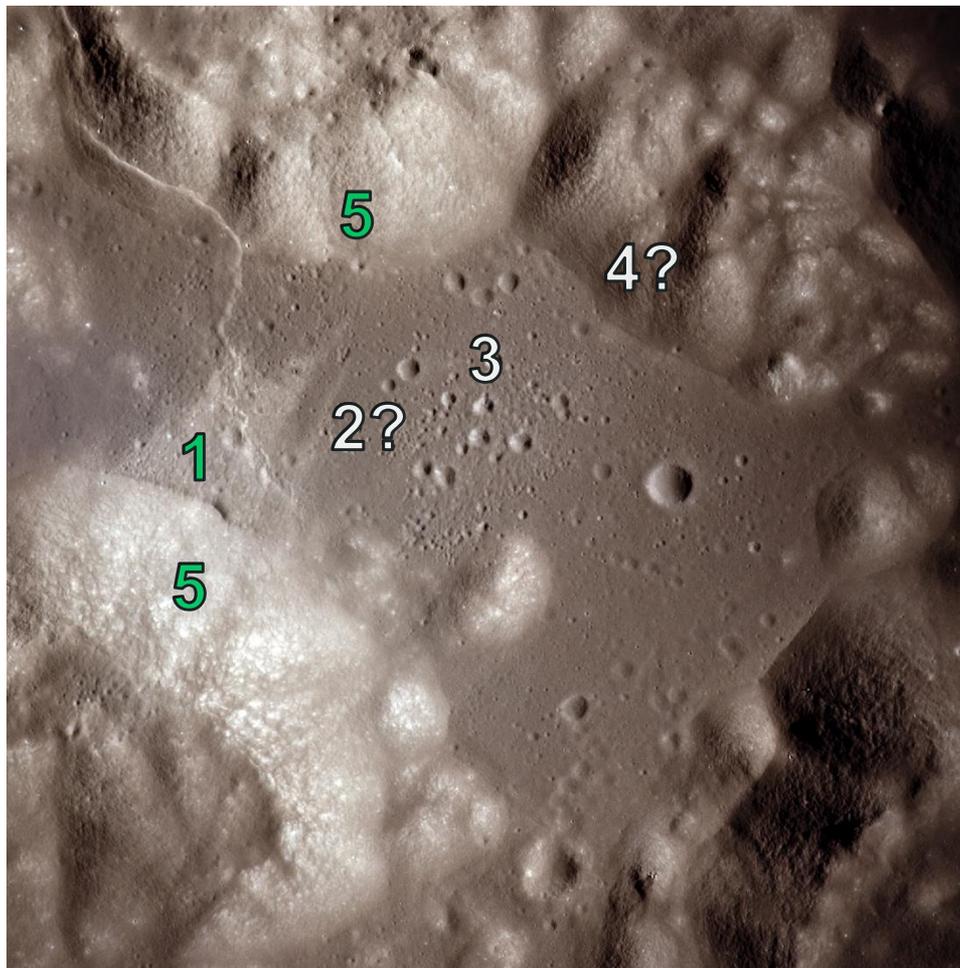
- "...remains on of the enigmas of the Apollo 17 mission."

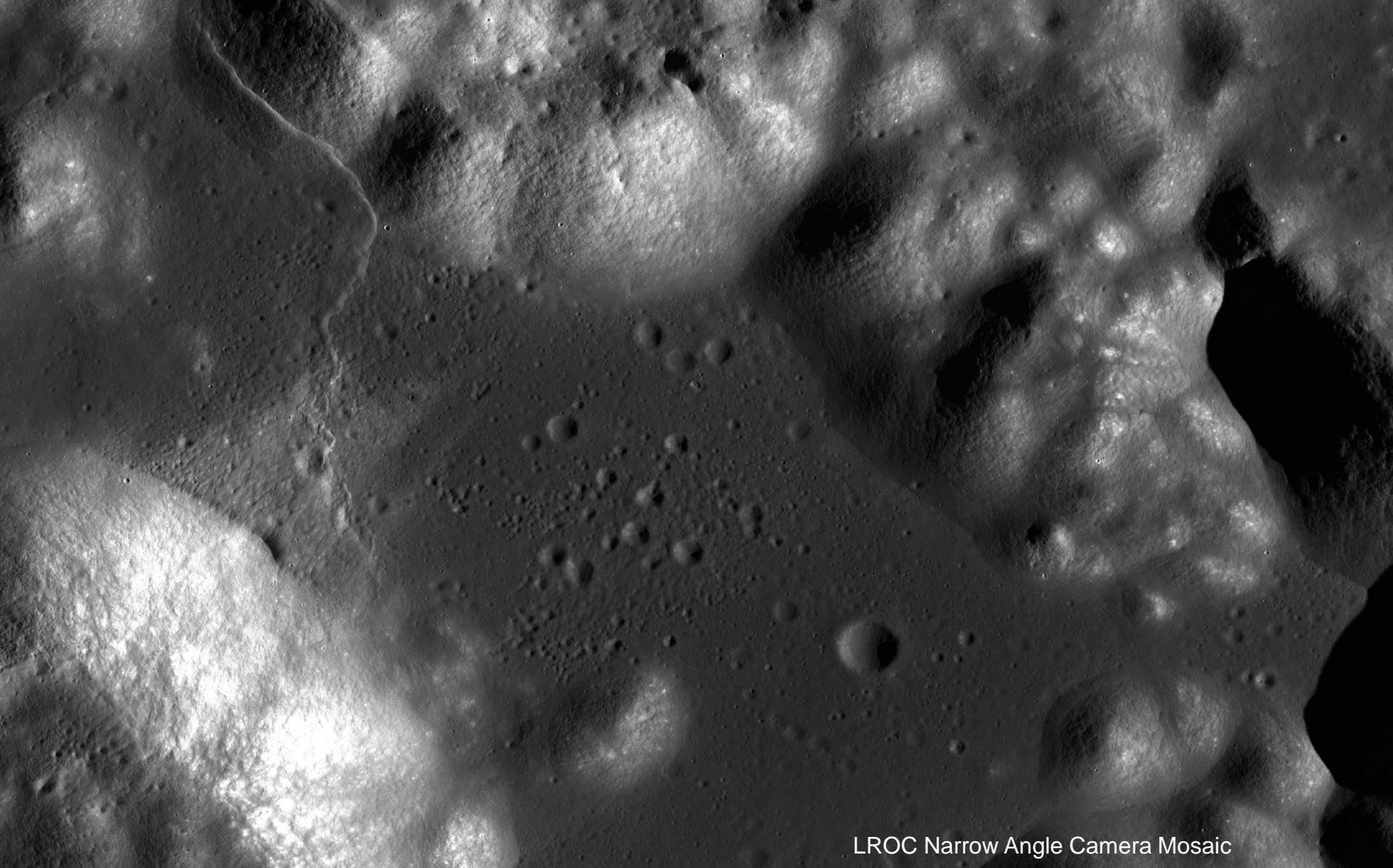
3. The Subfloor

4. The Sculptured Hills

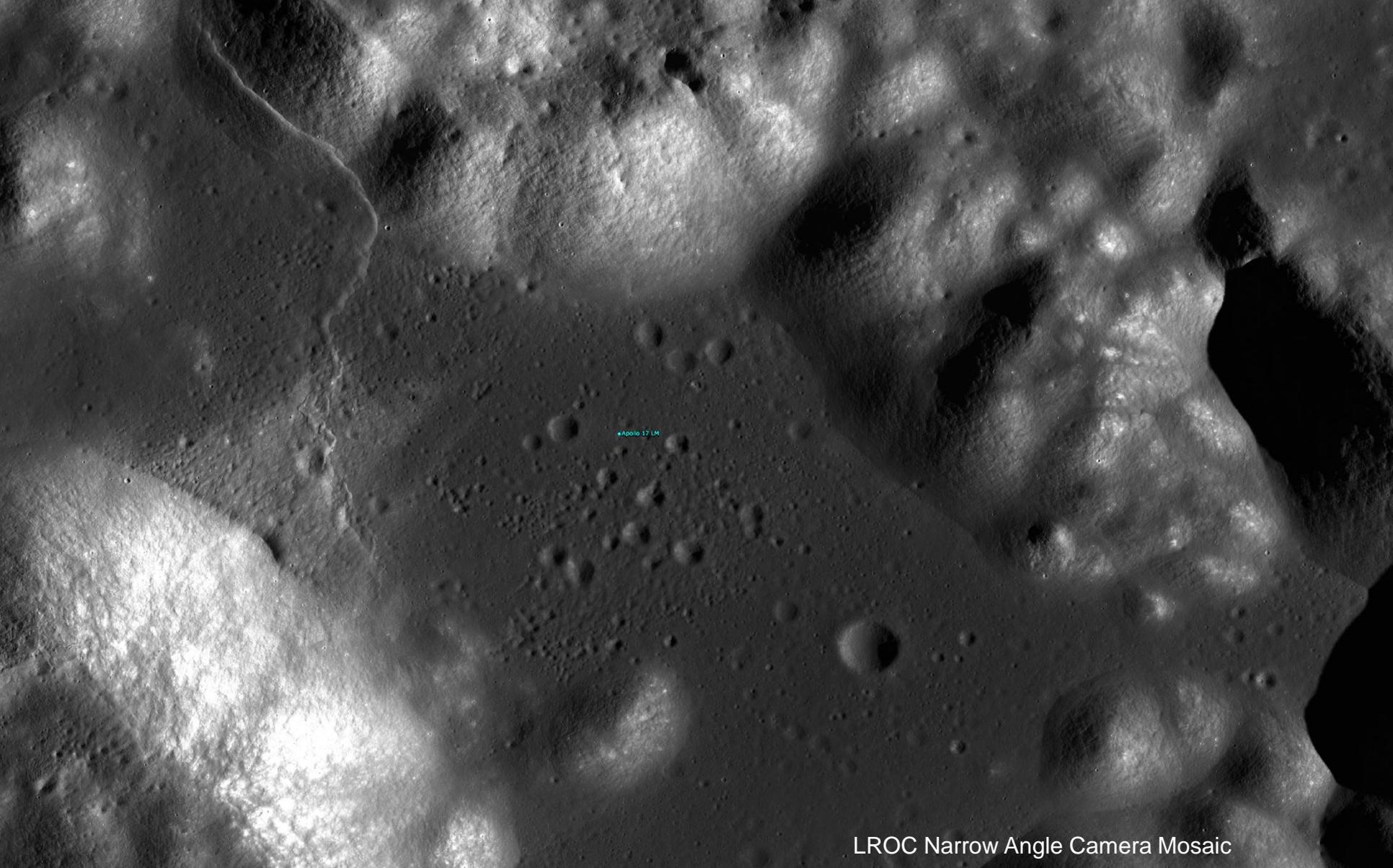
- Uncertain sampling, "...no more is known about the SH unit than that is is different from the massifs and the reasons for this difference are unknown."

5. The Massifs

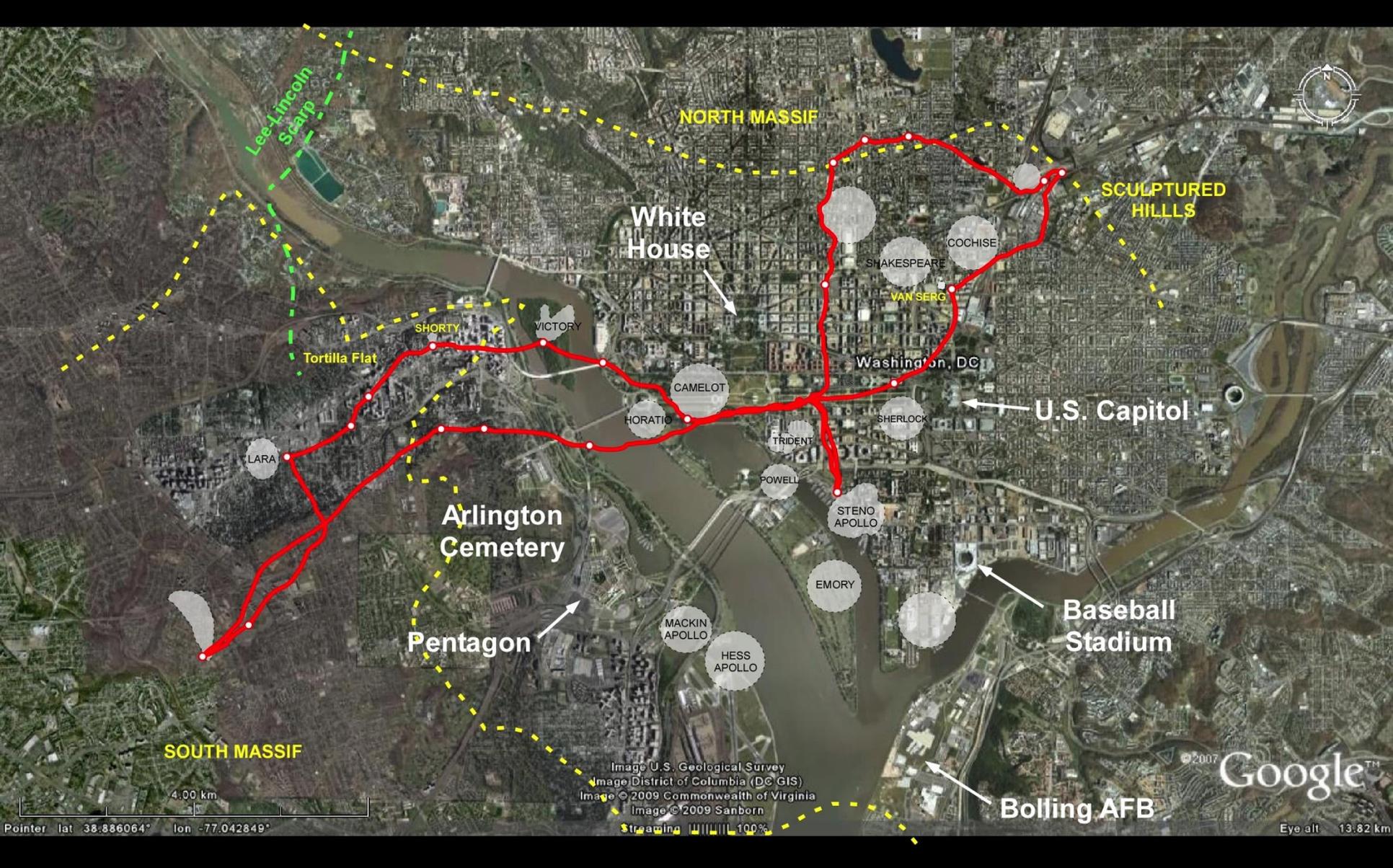




LROC Narrow Angle Camera Mosaic



▲ Apollo 17 LM



NORTH MASSIF

SCULPTURED HILLS

White House

COCHISE

SHAKESPEARE

VAN SERG

Tortilla Flat

SHORTY

VICTORY

Washington, DC

U.S. Capitol

LARA

Arlington Cemetery

HORATIO

TRIDENT

STENO APOLLO

Baseball Stadium

POWELL

EMORY

SOUTH MASSIF

Pentagon

MACKIN APOLLO

HESS APOLLO

Image U.S. Geological Survey
Image District of Columbia (DC GIS)
Image © 2009 Commonwealth of Virginia
Image © 2009 Sanborn

© 2007 Google™

Bolling AFB

4.00 km

Pointer lat 38.886064° lon -77.042849°

Streaming 100%

Eye alt 13.82 km



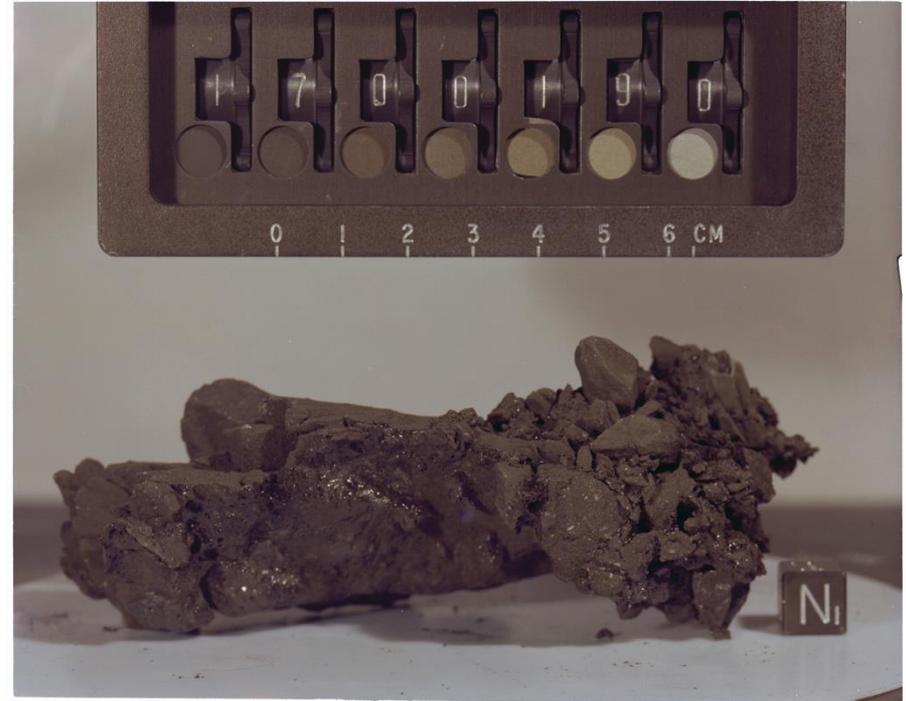


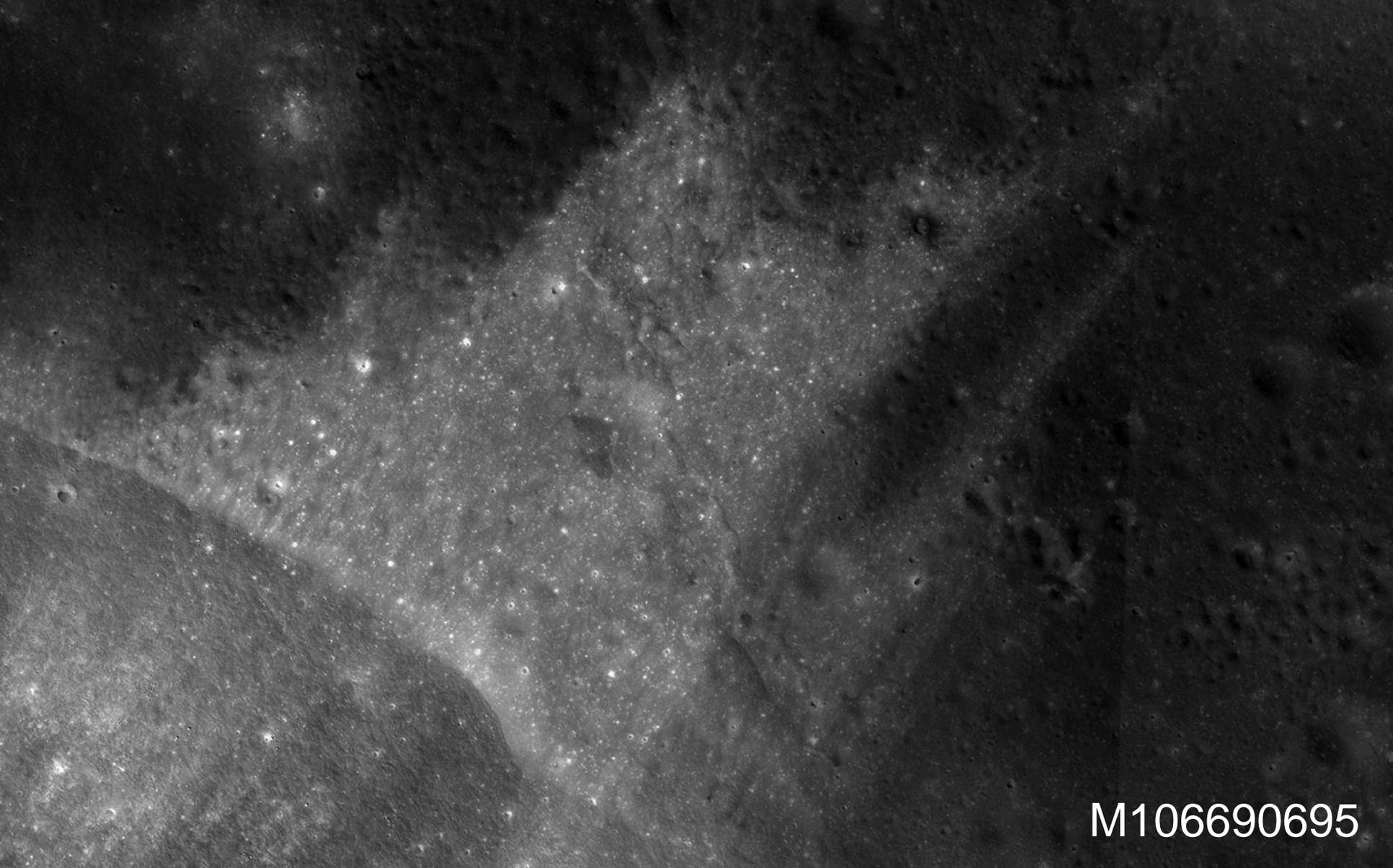


Revisit Outstanding Questions from Apollo 17 with LRO Data

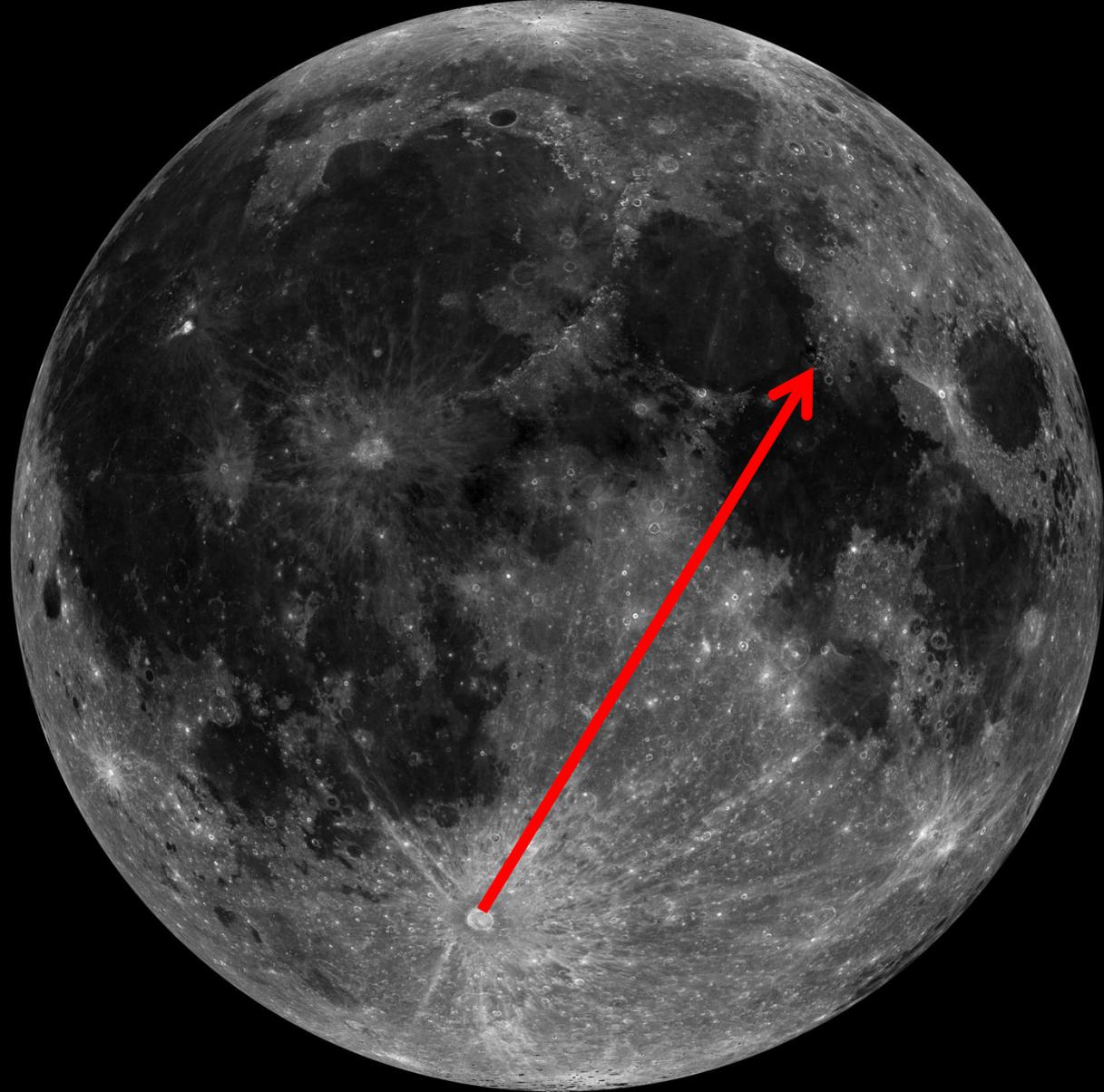


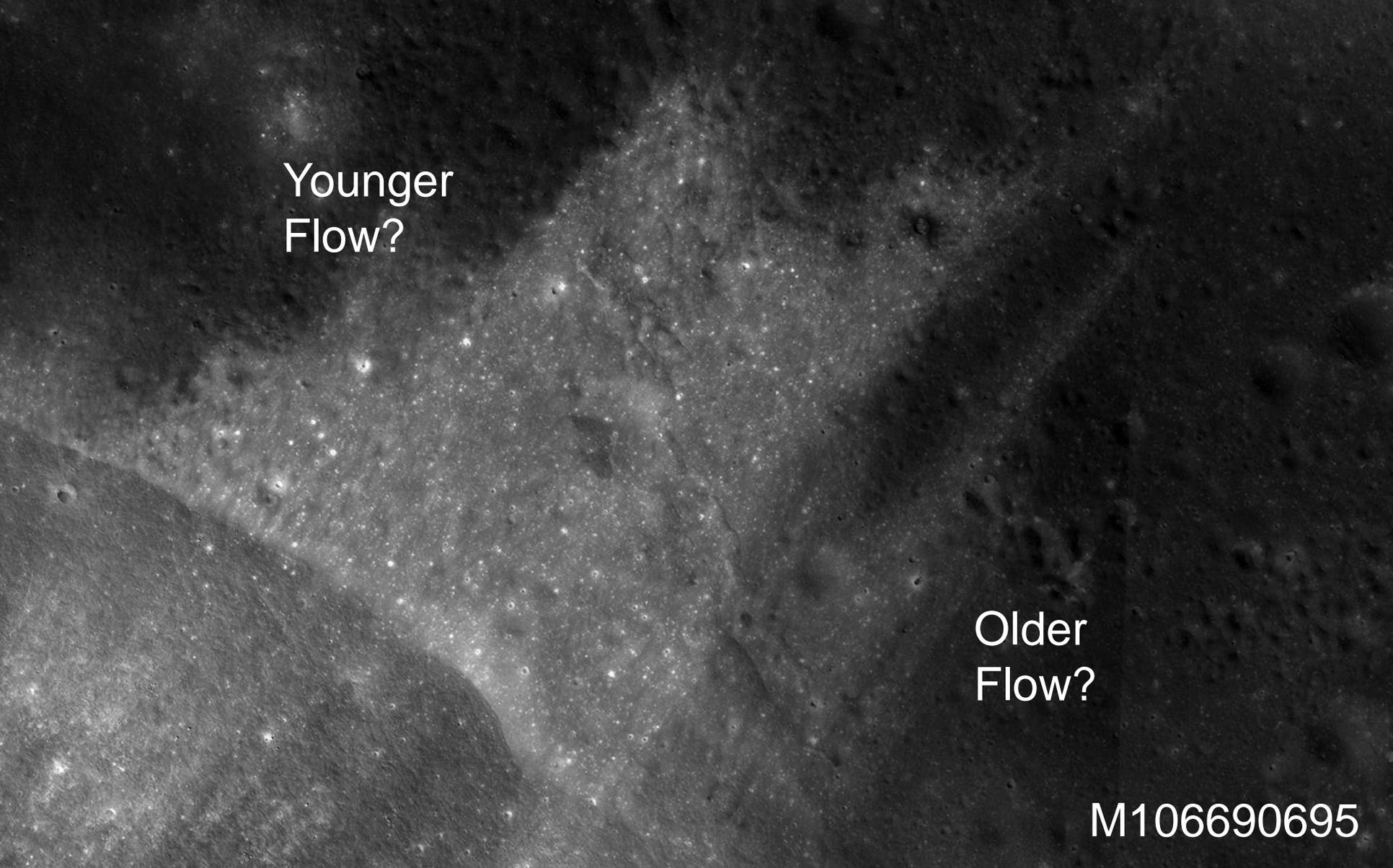
- What is the origin of the light mantle deposit?
- Where was sample 70019 collected?





M106690695

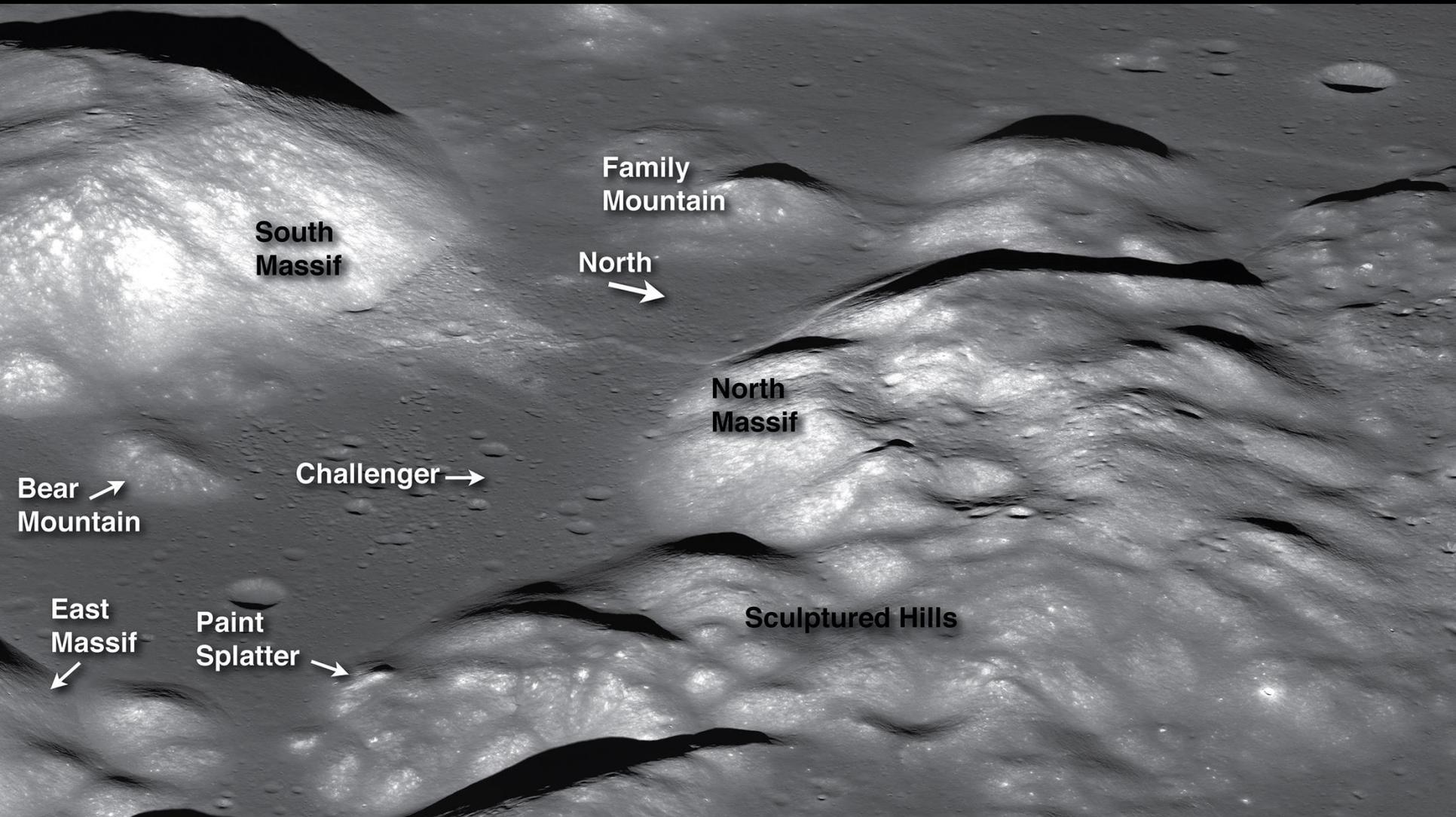




Younger
Flow?

Older
Flow?

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**South
Massif**

**Family
Mountain**

North
→

**North
Massif**

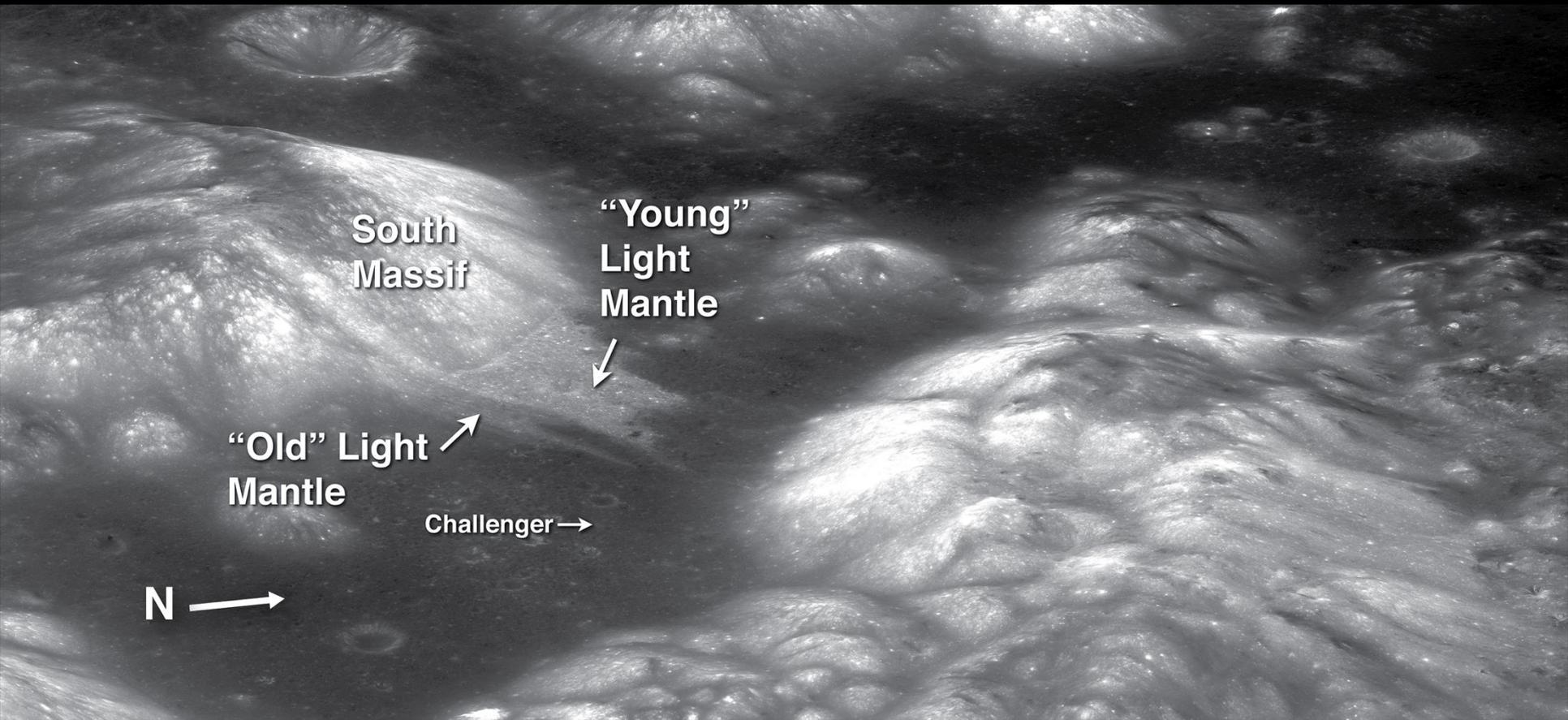
Sculptured Hills

Bear ↗
Mountain

Challenger →

**East
Massif**
↙

**Paint
Splatter** →



South
Massif

“Young”
Light
Mantle

“Old” Light
Mantle

Challenger →

N →



Origin of Sample 70019



- Sampled by Schmitt near the Lunar Module
- Very well documented sample, but overlooked for > 40 years
- We now know exactly where it came from





The Last Mission to the Moon

Apollo 17

Real-Time Mission Experience

Wed Dec 13 1972 1:13:38 AM

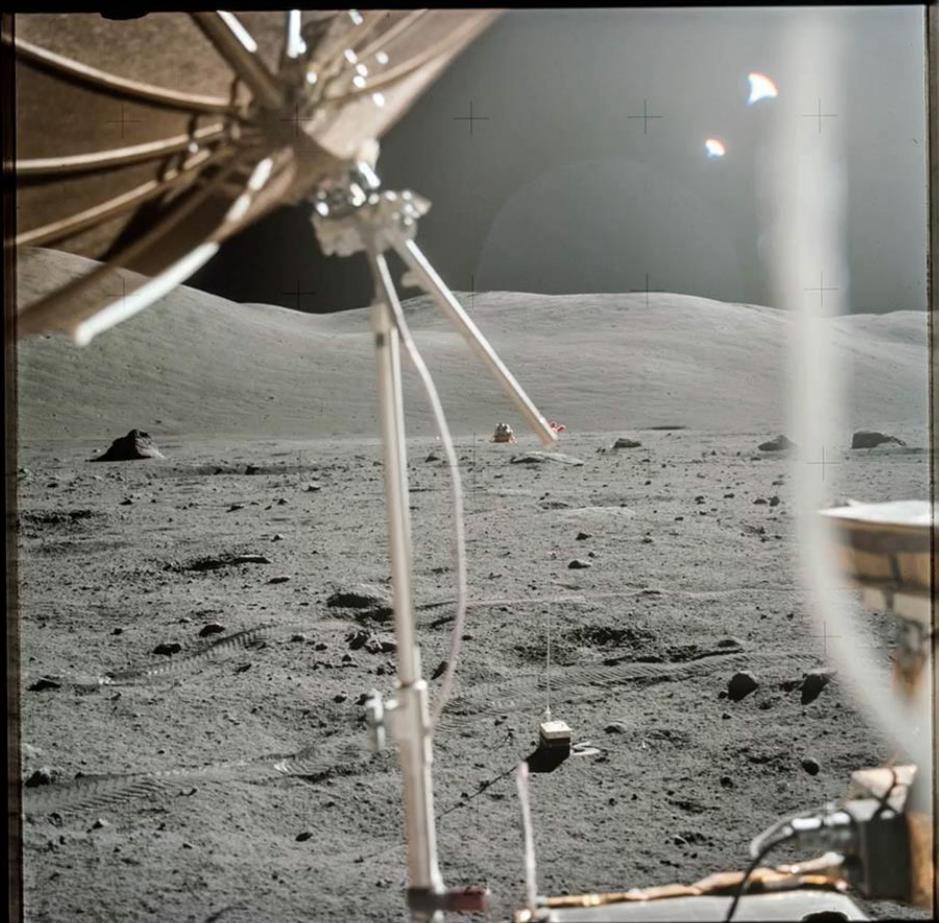
Mission Elapsed Time: 147:20:38



Apollo 17 - 146:40 - 154:40 V2



147:19:45:00



TRANSCRIPT | GUIDED TOUR | COMMENTARY

🔍 ⏪ ⏩ 🔄 🗑️

147:19:45 **Schmitt** Hey, Bob.

147:19:47 **Mission** Go ahead.
Control

147:19:47 **Schmitt** I cheated on you.

147:19:49 **Mission** I was sure you would. What did you do?
Control

147:19:52 **Schmitt** I just sampled the glass in the bottom of a crater. I documented it by shooting the LM across the crater at infinity and then shooting the crater with stereo at 11 feet and in that cross-Sun pair at 7; and then I sampled it.

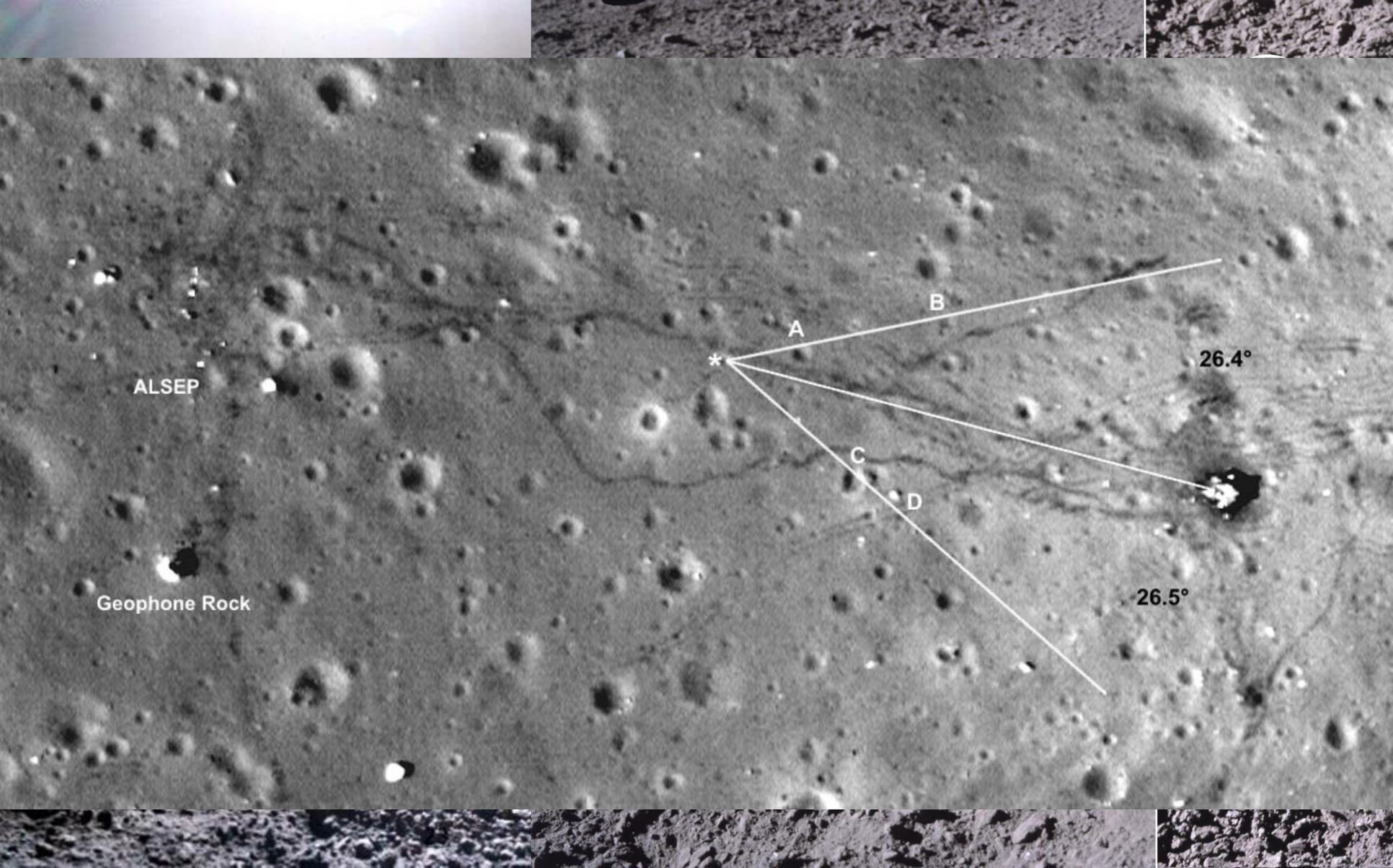
147:20:13 **Mission** Okay.
Control

147:20:14 **Schmitt** Then I took a cross-Sun pair at 7 after.

147:20:17 **Mission** I guess - I guess now gnomon is a LM.
Control

147:20:20 **Schmitt** It's very fragile. That's right. It's very fragile, and I double bagged it. I don't know whether we can keep it or not.

147:20:38 **Mission** Okay. We'll hope.



ALSEP

Geophone Rock

*

A

B

C

D

26.4°

26.5°

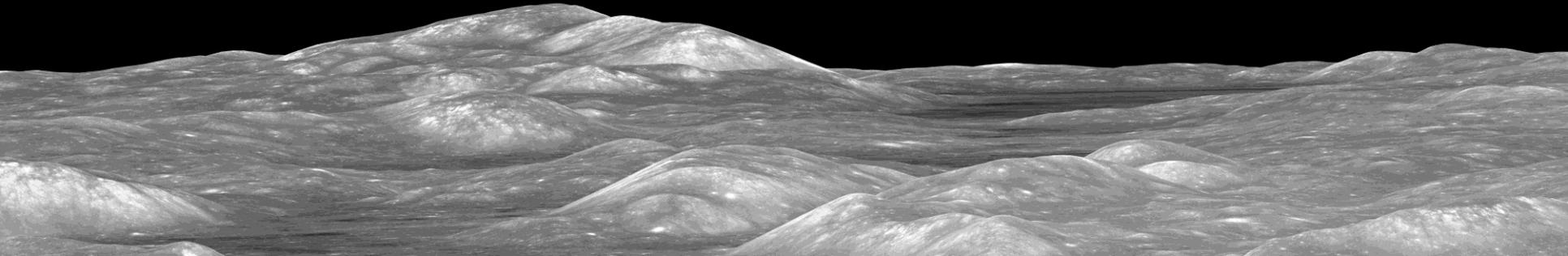
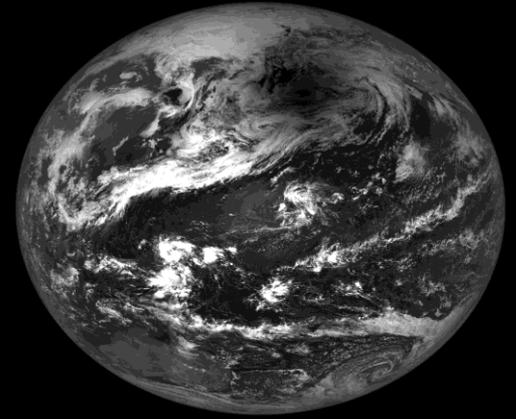
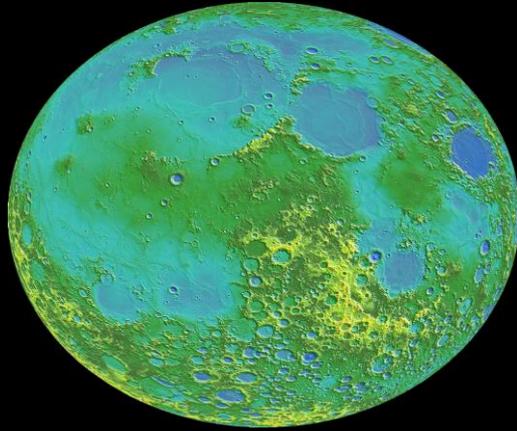


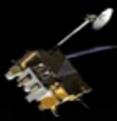
Apollo 17 – Still New After All These Years



- We have a lot left to learn about the Moon, from potential future missions, successful current missions, and a wealth of past missions
- Apollo has left an incredible legacy that we are still understanding
- The Solar System is an amazing, diverse place, and the Moon gives us an opportunity to best understand the processes that have shaped all of its solid bodies

The Moon: the Central Player in the Total Solar Eclipse





LUNAR RECONNAISSANCE ORBITER

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Science and Data

Education & Outreach

Javier Colon & Matt Cusson: The Moon and More (NASA Collab...  



Tweets by @LRO_NASA



NASA Lunar Orbiter

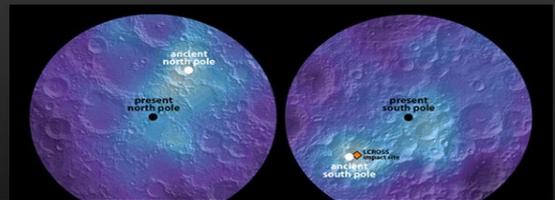
@LRO_NASA

Happy #MoonCrushMonday. In many languages, this day of the week is named for our Moon. Can you think of examples?



Embed

View on Twitter

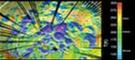


LRO DATA USERS WORKSHOP

LPSC
Sunday March 15, 2015

Schedule:

- 9:00am Introductions
- 9:15am LRO
- 9:45am LAMP
- 10:15am MinisF
- 10:45am DRAC
- 11:00am CRATER
- 11:30am General Q&A
- 12:00pm Lunch
- 1:00pm LOLA
- 1:30pm Overview
- 2:00pm Break
- 2:15pm LROC
- 2:45pm OLA
- 3:00pm Wrap-up

<https://lunar.gsfc.nasa.gov>



Tracing the 2017 Solar Eclipse

Anyone within the path of totality can see one of nature's most awe inspiring sights - a total solar eclipse.

Eclipse Countdown Until First Contact in Oregon August 21, 2017 UT

11:00:05:01

11 weeks, 0 days, 5 hours, and 1 minute left



<https://eclipse2017.nasa.gov>



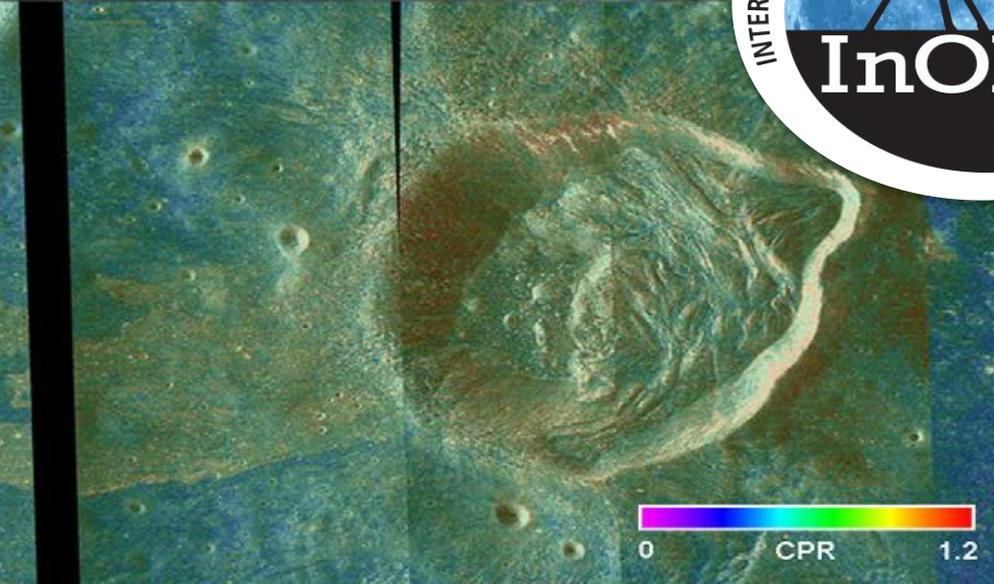
August 21, 2017 Eclipse



<https://svs.gsfc.nasa.gov/gallery/suneclipse2017.html>

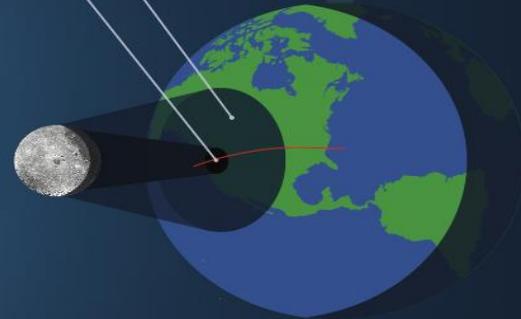
International Observe the Moon Night is a perfect opportunity to sustain the interest in space science and momentum following the solar eclipse.





Catch the
**SOLAR
ECLIPSE**
AUGUST 21
2017

PARTIAL SOLAR ECLIPSE
TOTAL SOLAR ECLIPSE



#eclipse2017

ECLIPSE2017.NASA.GOV

THEN CATCH
International
OBSERVE THE
**MOON
NIGHT**
OCTOBER 28
2017



The Moon: the central player in the total solar eclipse and the highlight of International Observe the Moon Night!



#observethemoon

OBSERVETHEMOONNIGHT.ORG

Questions? Comments?

andrea.j.jones@nasa.gov

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