**For presentation at the Rutgers Symposium on Lunar Settlements,
June 4-8, 2007**

Malapert Mountain: A Recommended Site for a South Polar Outpost

Paul. D. Lowman Jr.
Goddard Space Flight Center, Code 698
Greenbelt, MD 20771
Paul.D.Lowman@nasa.gov

The Moon's poles have emerged as scientifically and strategically valuable areas for a new lunar program as proposed by President George W. Bush in 2004. The Clementine missions showed that there are large areas of permanently-shaded terrain at both poles, but the southern one is more concentrated and well-defined. Consequently most interest has been focused on the south polar region, and specifically on the crater Shackleton because it is thought to be in continual sunlight, and is close to the hydrogen-bearing shaded areas. However. Malapert Mountain appears to have several advantages over Shackleton.

It was shown by D. Schrunk and B. Sharpe that Malapert Mountain is sunlit 90% or more of the lunar year, whereas Lunar Orbiter 4 pictures show that the rim of Shackleton is only partly illuminated at any one time. Furthermore, the illuminated area varies over the lunar year, and no one site is continually sunlit.

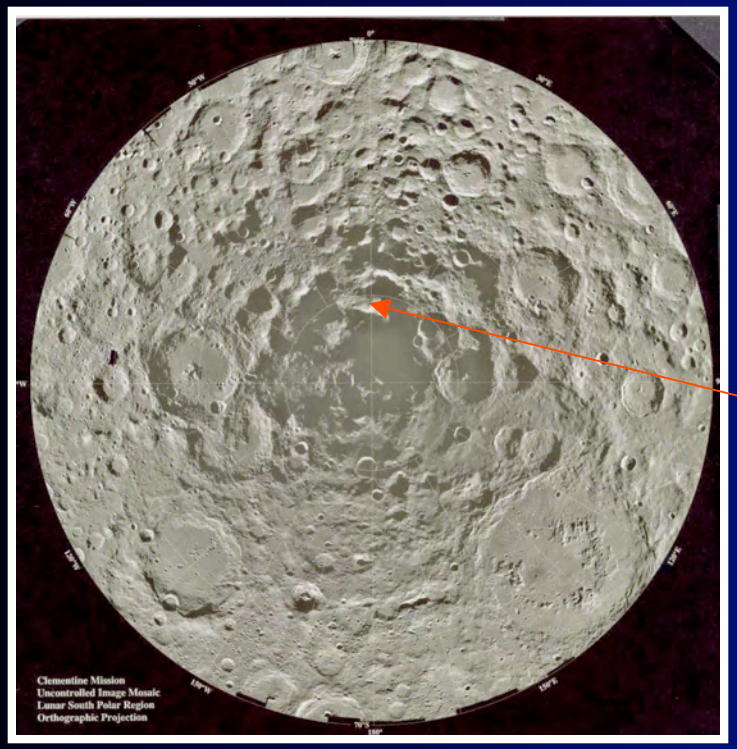
Malapert Mountain is old, pre-Nectarian terrain, probably with a thick regolith saturated with implanted hydrogen and helium. It offers a broad and smooth landing area, demonstrably in continuous microwave visibility of Earth (for tracking and communications). It is close to permanently-shaded areas to the south, which should be easily reached by a vehicle driven down the south flank of Malapert Mountain.

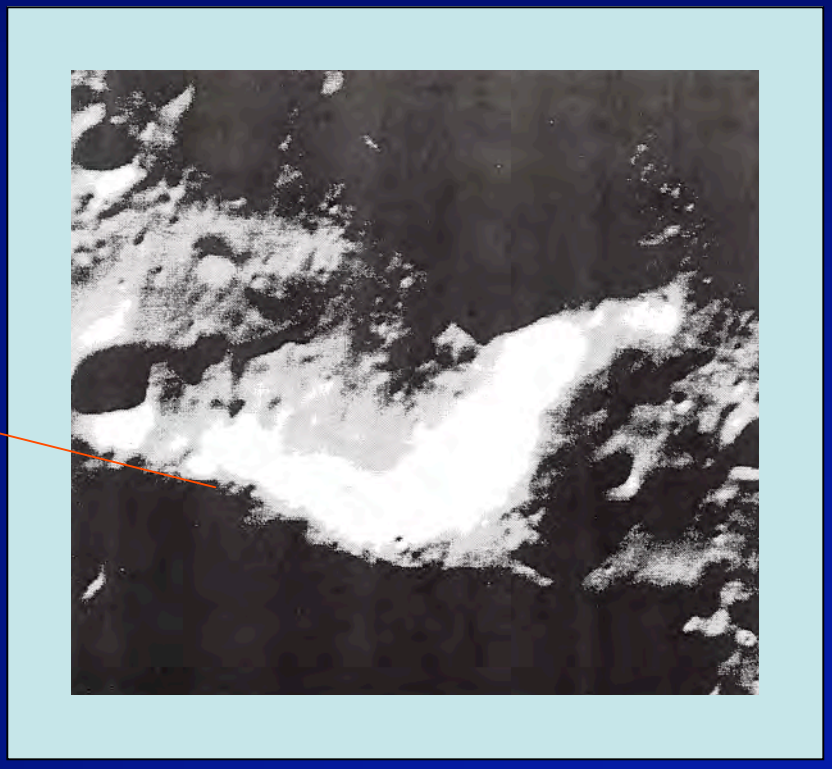
Malapert Mountain, in summary, deserves careful study in light of mission safety, scientific importance, and evaluation of lunar resources.

Malapert Mountain as a Lunar Outpost

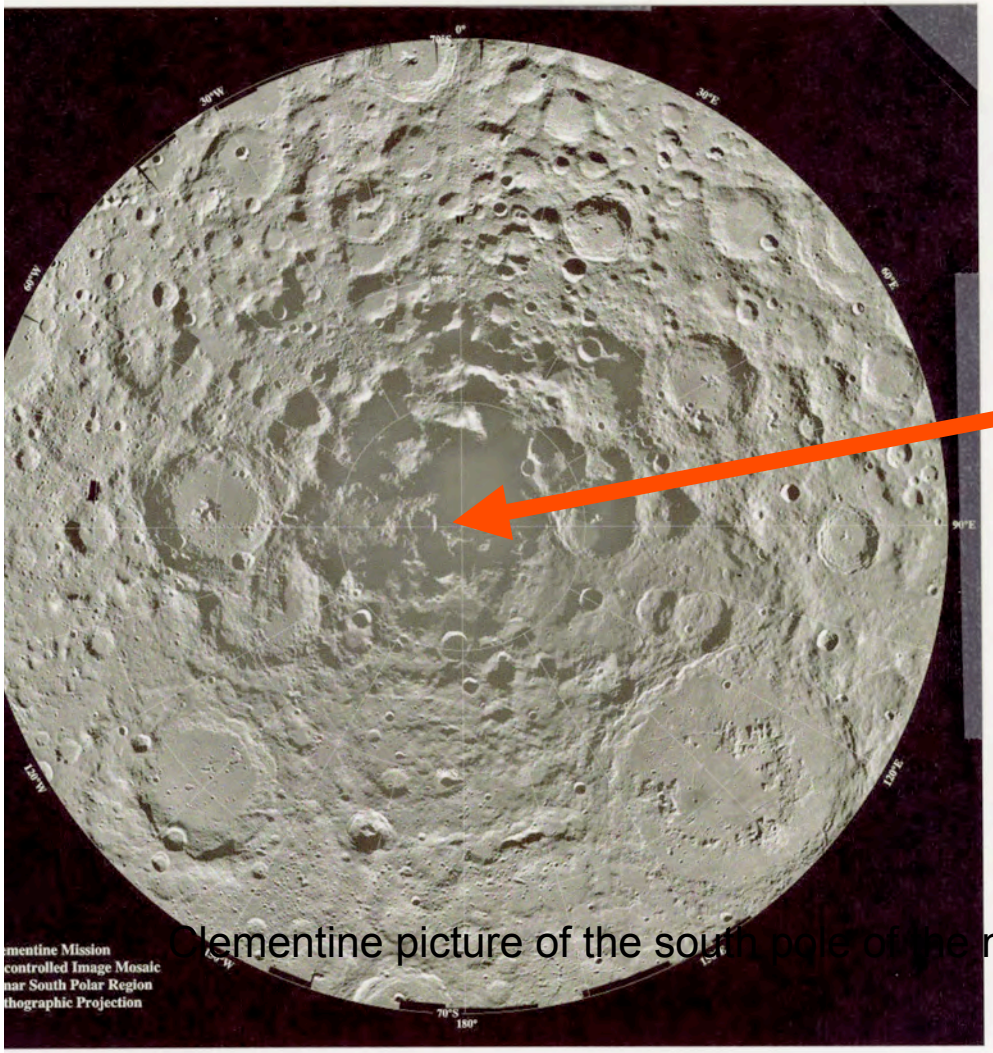
Paul Lowman

Planetary Geodynamics Lab



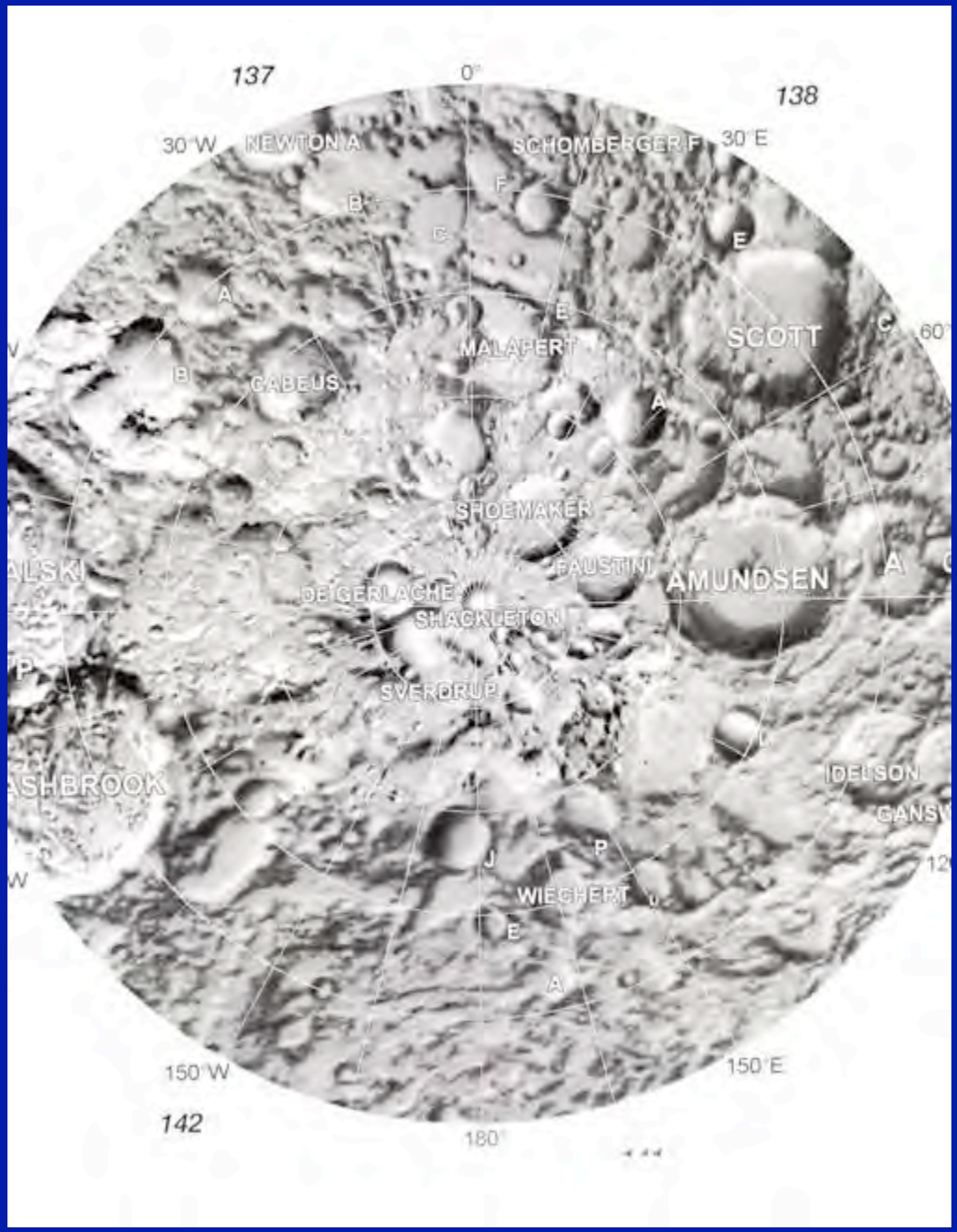


Clementine Mosaic of the Moon's South Pole



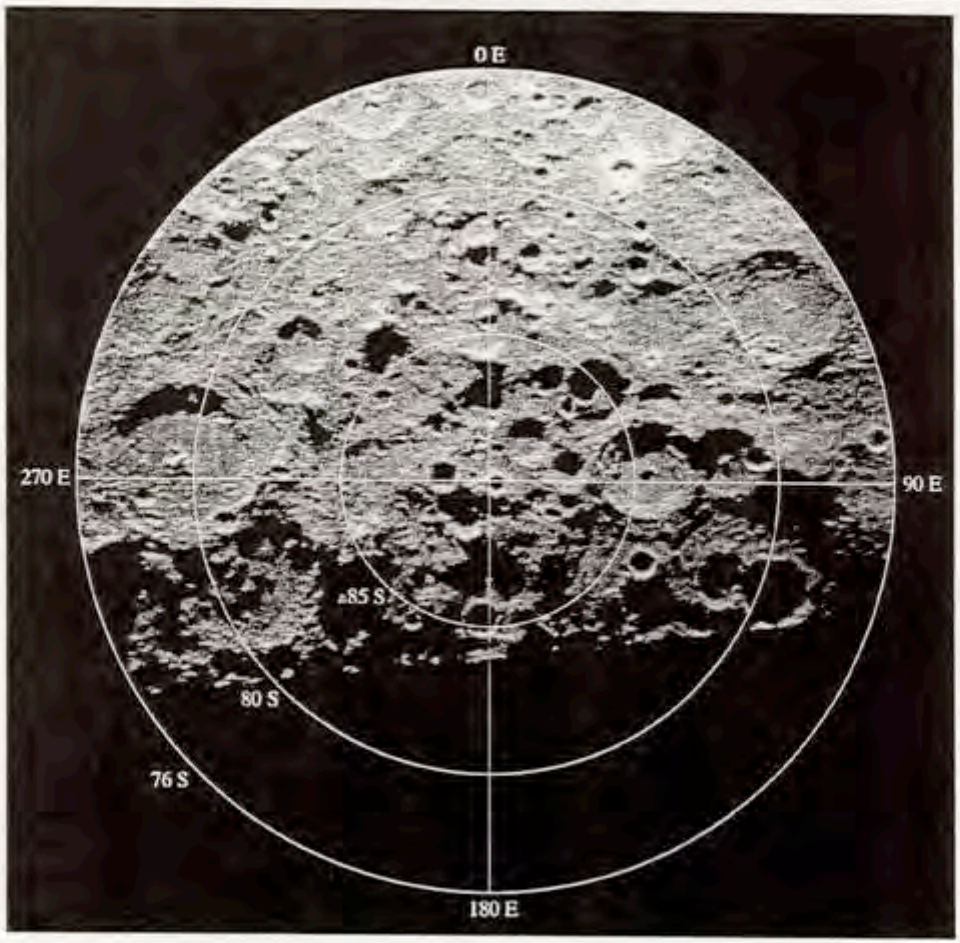
Clementine picture of the south pole of the moon

Arrow points to Shackleton Crater; rim thought to be continually sunlit, recommended as a lunar outpost site



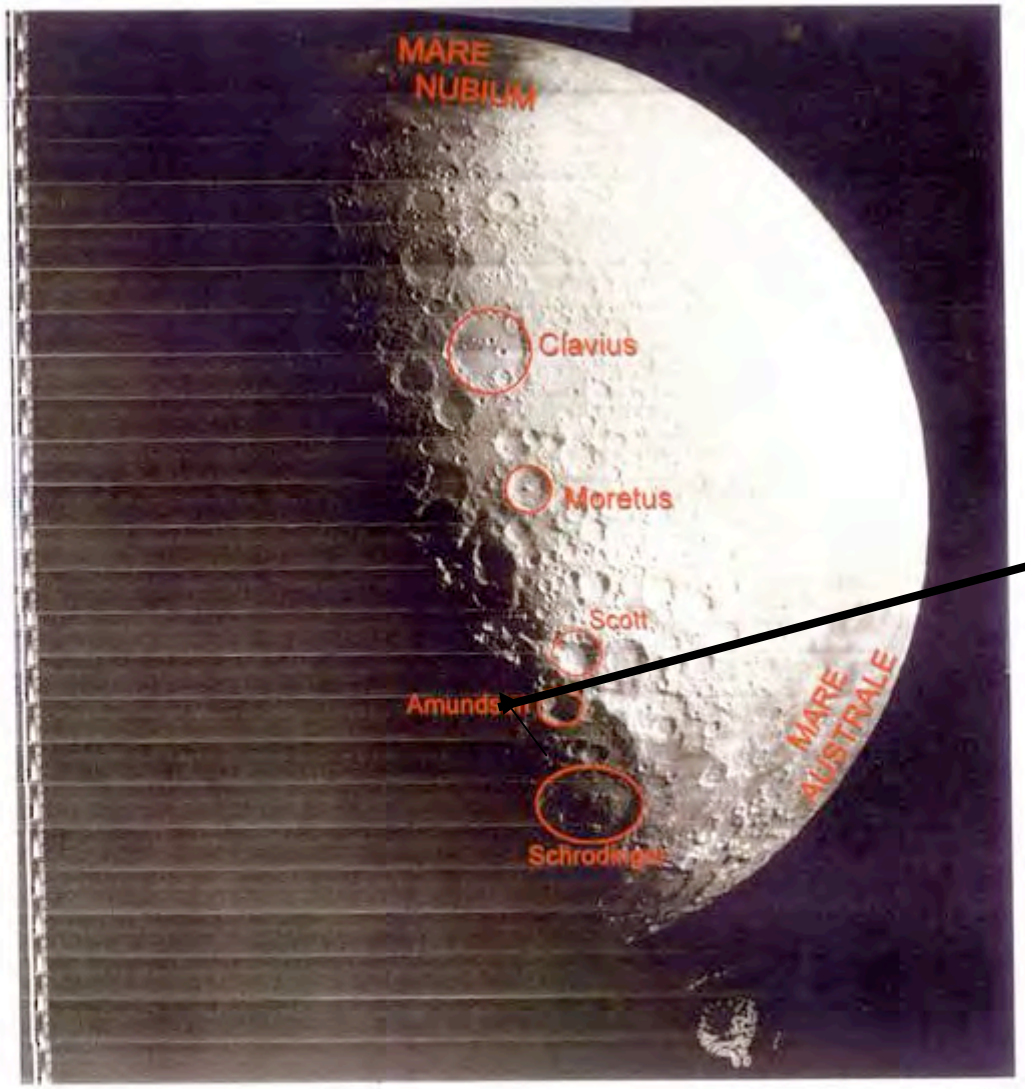
Relief Map of Lunar South Pole

From Clementine Atlas of the Moon (Busse and Spudis, 2004). Zero meridian (top) points north, toward Earth



Arecibo Radar Image of South Pole

Earth-based radar shows area of Moon in continual microwave and earthshine visibility.

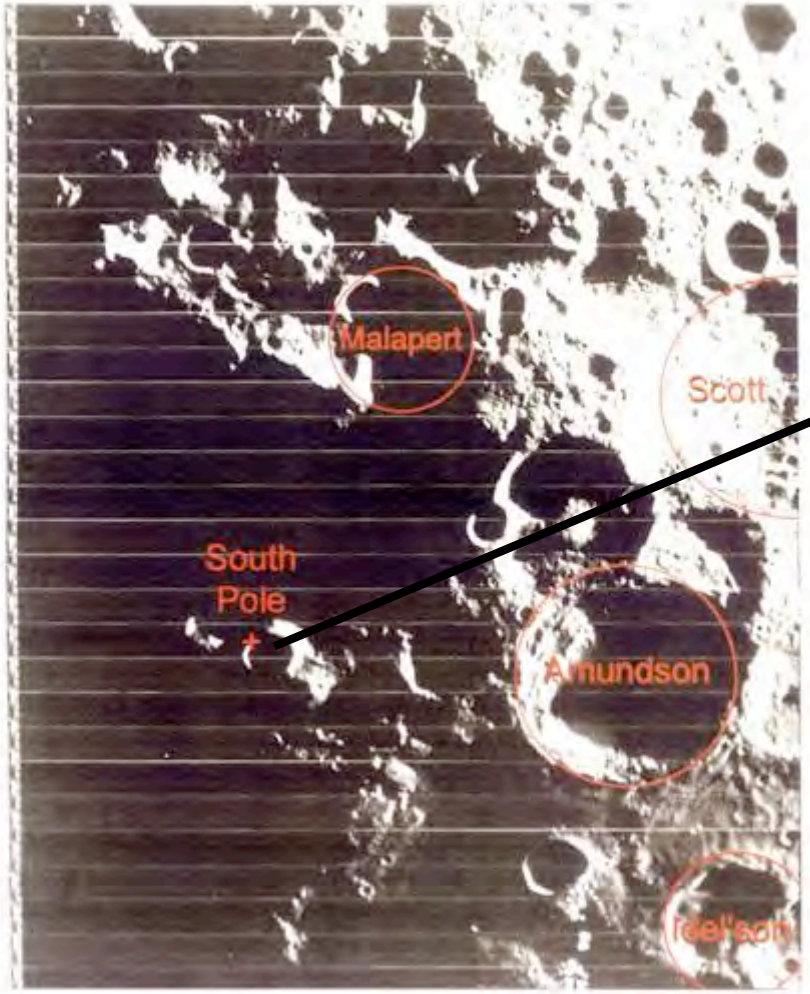


LO IV-118-M

6

Lunar Orbiter 4 View of South Pole

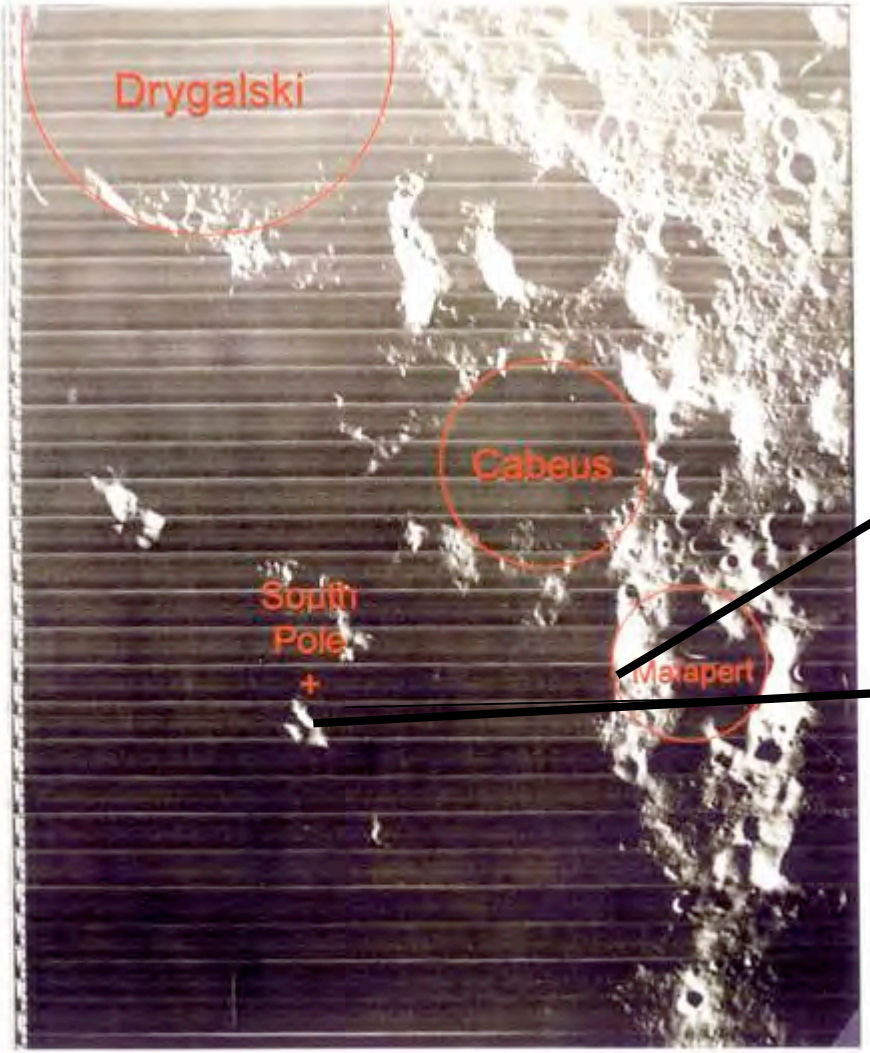
Location of Shackleton Crater



Lunar Orbiter 4 Picture of Shackleton

Most of rim sunlit, but not all (note dark segment on south rim)

Lunar Orbiter 4 Picture of Shackleton and Malapert Mountain

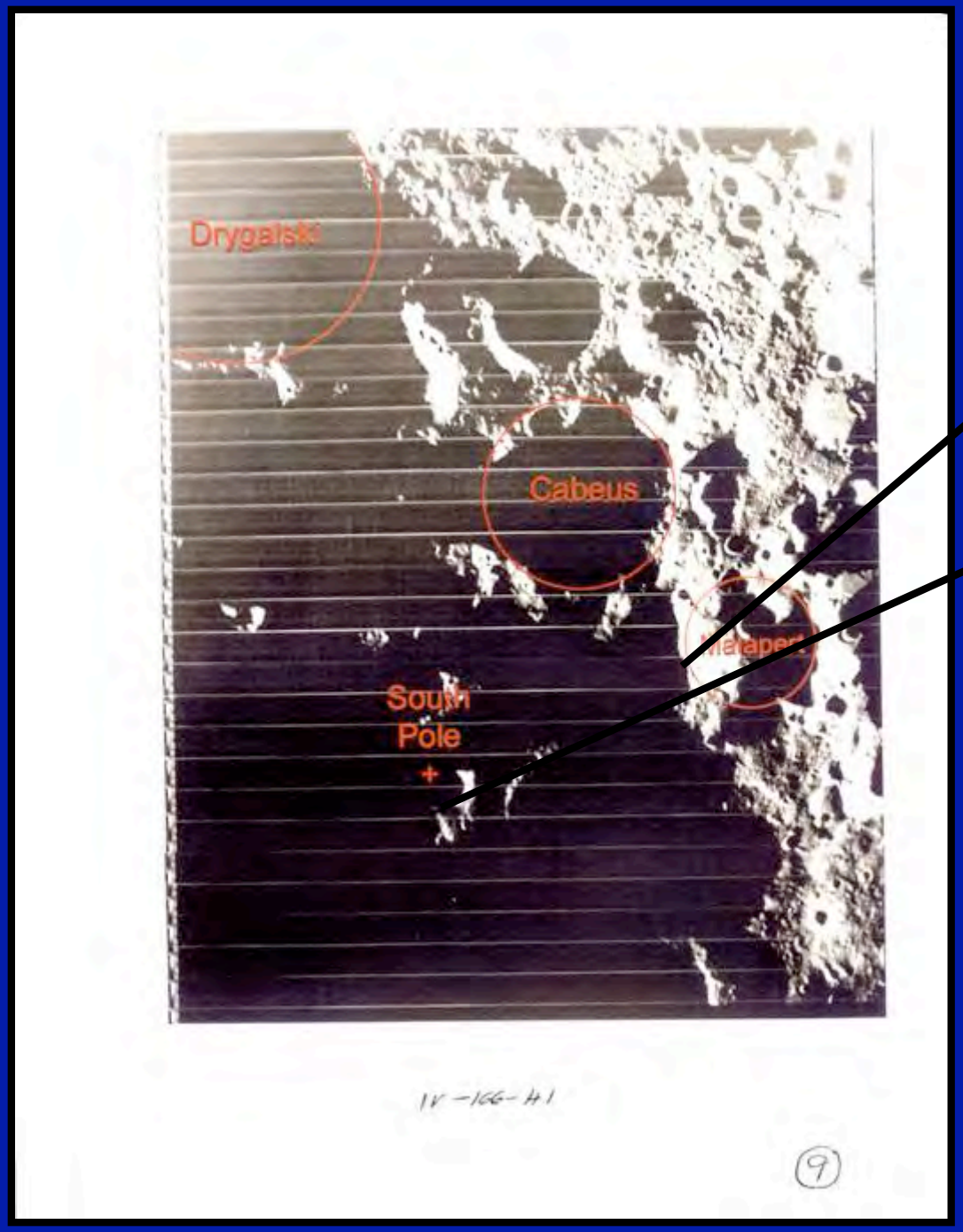


Malapert Mountain

Completely sunlit

Shackleton Crater

Shackleton rim almost all dark



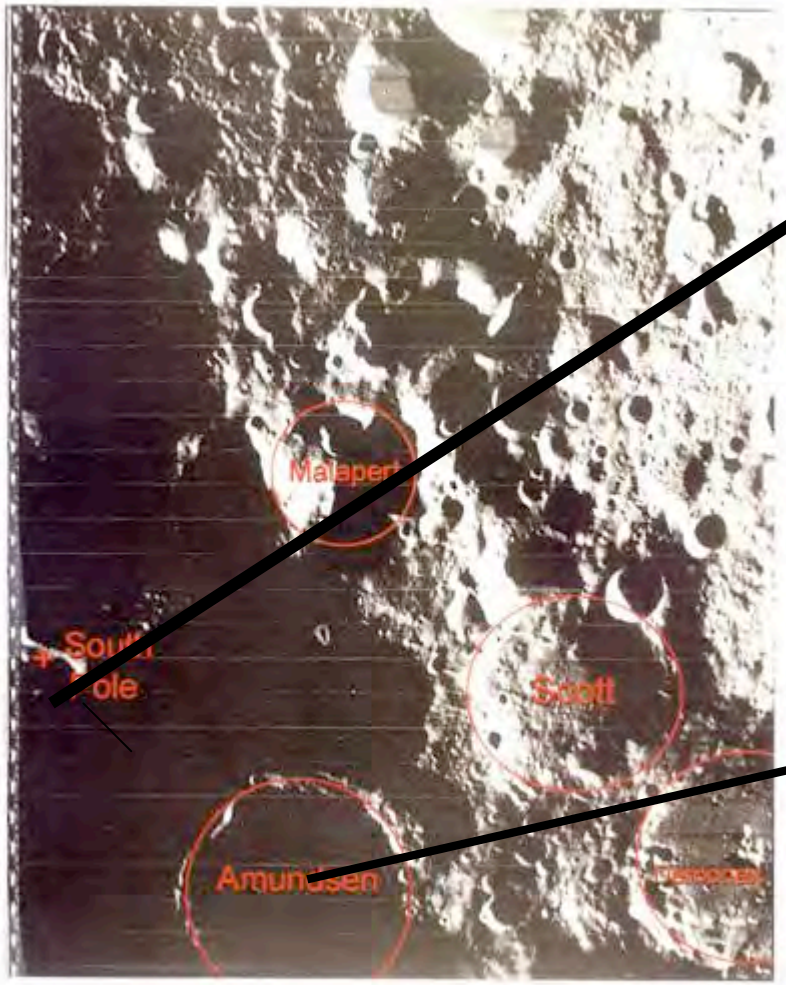
Lunar Orbiter 4 picture of Shackleton and Malapert Mountain

Malapert

Shackleton

Shackleton rim almost all shaded

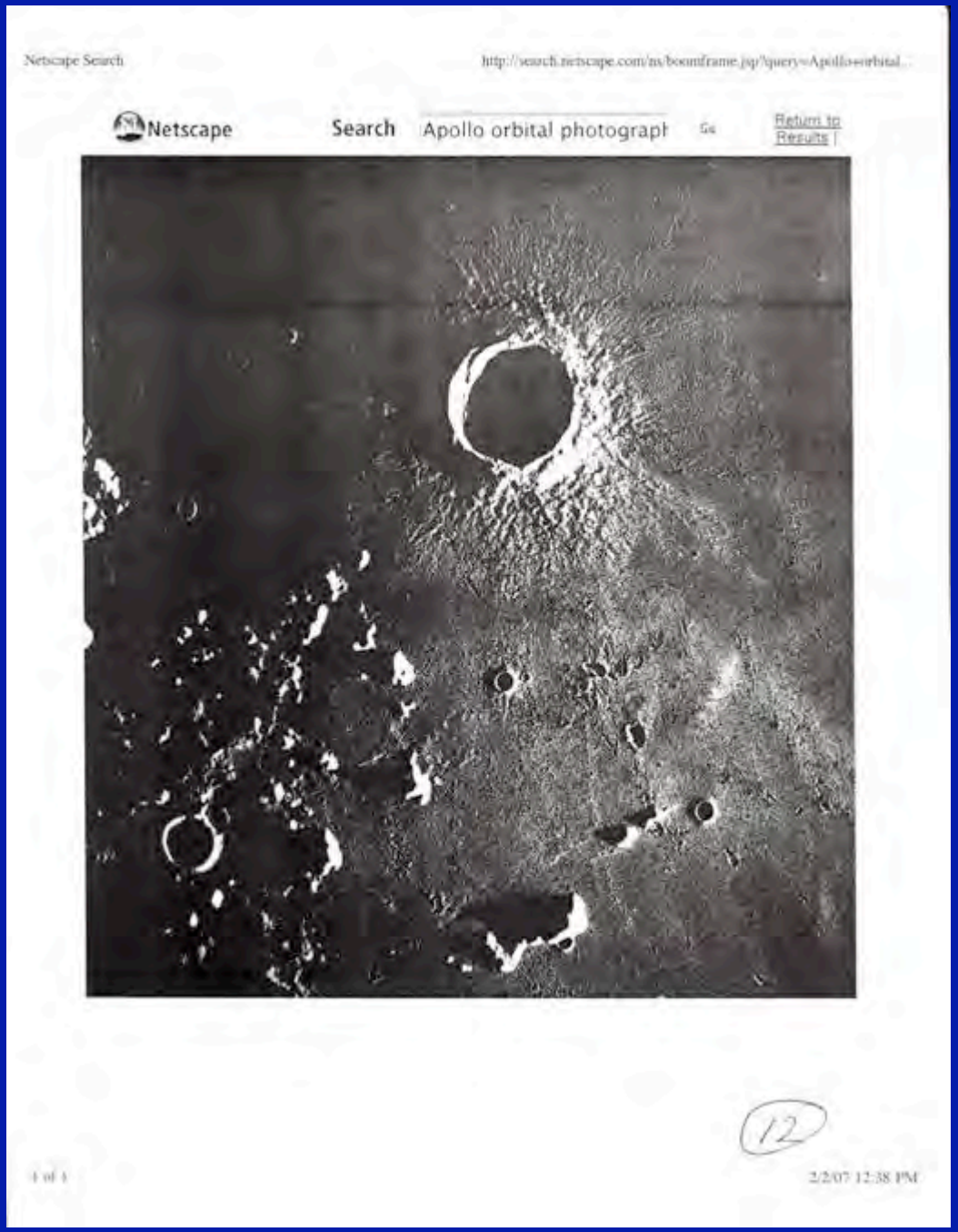
Malapert Mountain in full sunlight on earth side and top.



Lunar Orbiter 4 Picture of Shackleton Crater

Rim of Shackleton almost entirely shaded; note decreasing visibility of Amundsen Crater

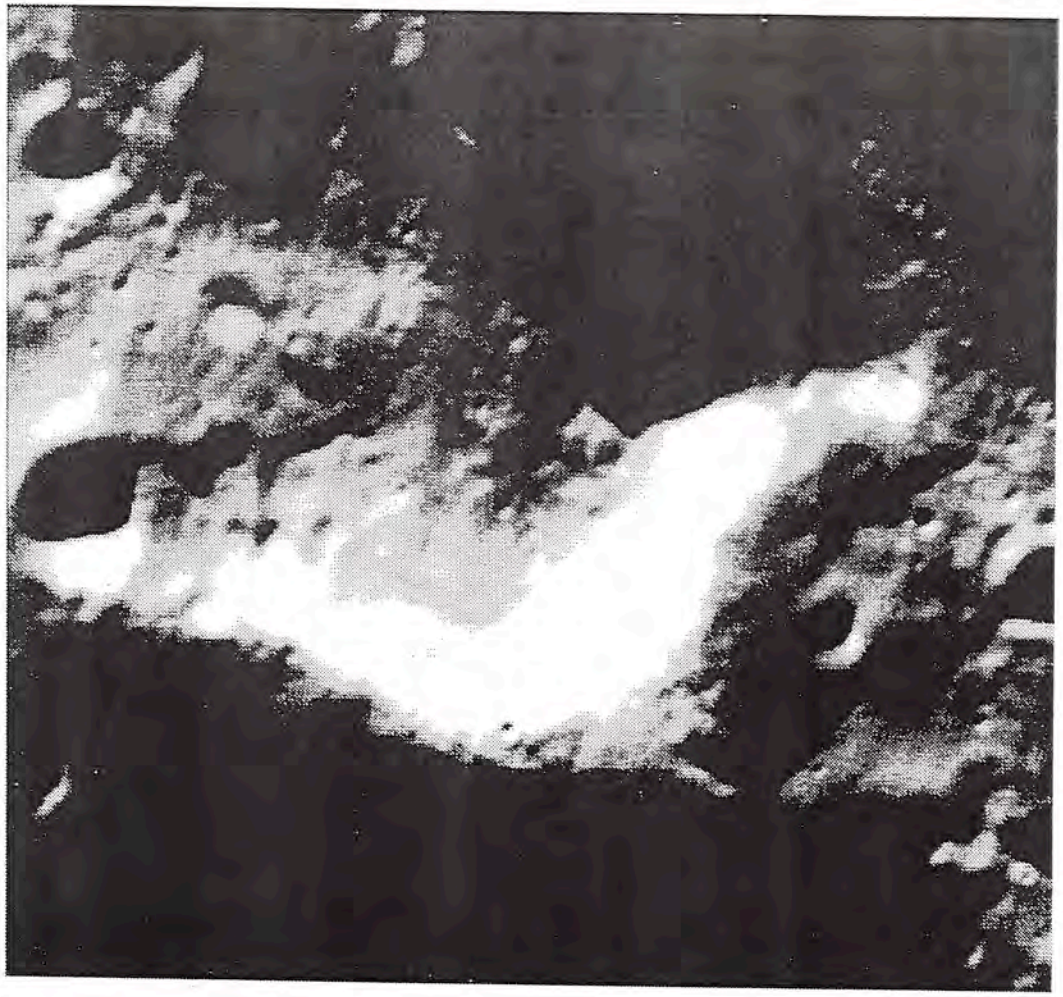
Amundsen Crater



Apollo Picture of Euler (29 km diameter)

Topography probably similar to Shackleton; note rough flanks and narrow rim

Lunar Orbiter 4 Close-up of Malapert Mountain



MM about 50 km left to right

Top of MM relatively smooth; note only one crater

North face and top continually sunlit on all available Lunar Orbiter photos

Slopes probably smooth, similar to Apennines at Apollo 15 landing site

Surveyor VII View of North Flank of Tycho Crater

Note thin regolith, rough terrain. probably similar to flank of Shackleton Crater

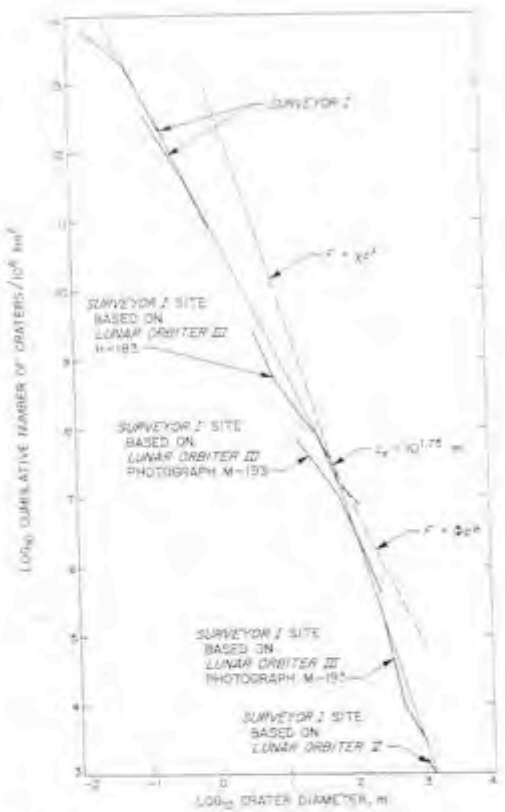


FIGURE 3–39.—Cumulative size-frequency distribution of small craters on the lunar surface in the vicinity of Surveyor I, determined from Surveyor I pictures and Lunar Orbiter III and V photographs.

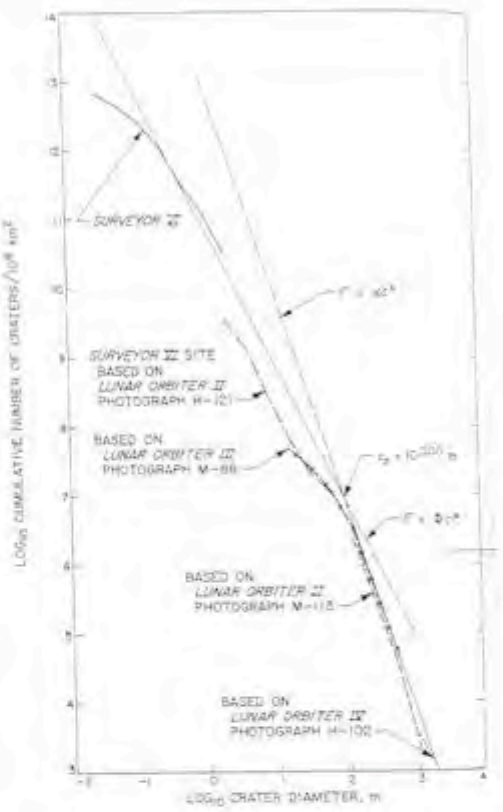


FIGURE 3–40.—Cumulative size-frequency distribution of small craters on the lunar surface in the vicinity of Surveyor VI, determined from Surveyor VI pictures and photographs from Lunar Orbiter II, III, and IV.

Fig. 14 Small crater populations, Surveyor I and VI sites. (Morris and Shoemaker, 1969).

14

Small Crater Populations, Surveyor I and VI Sites

Similar slopes and intercepts imply steady-state small crater population, similar on all mare sites

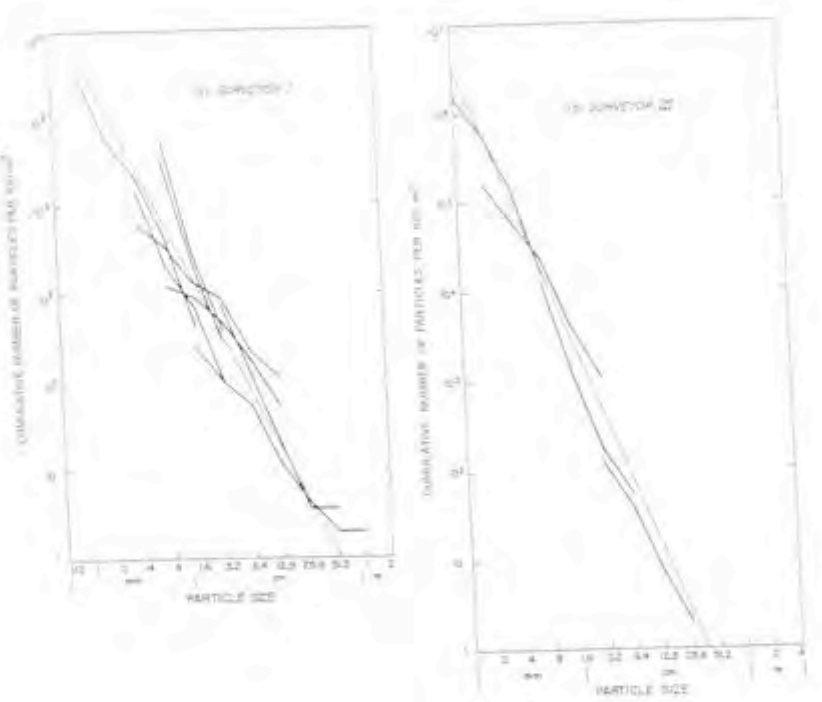
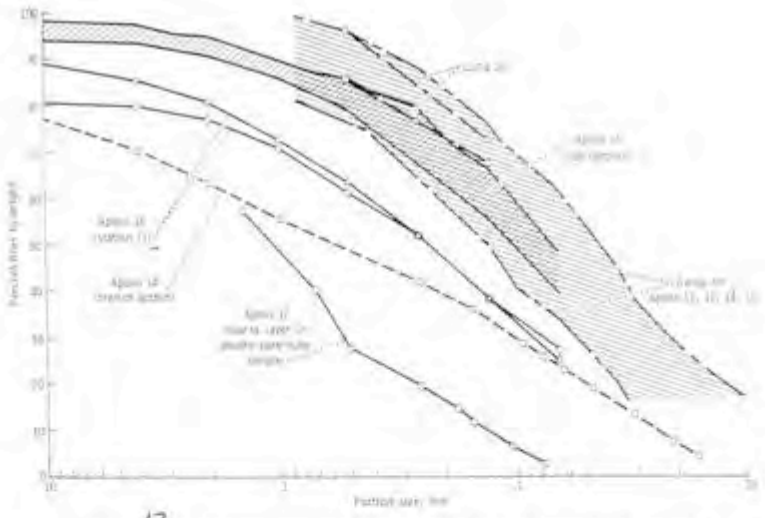


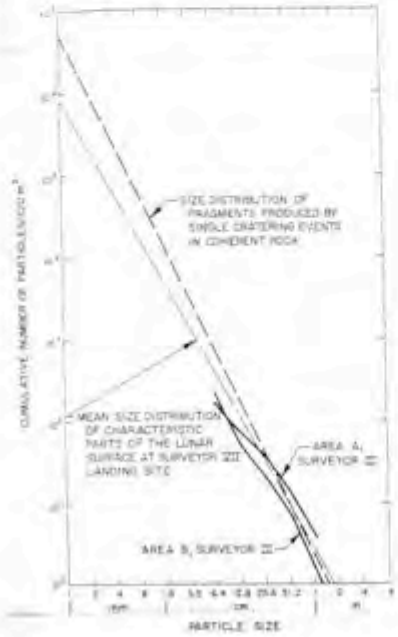
Fig. 15 Surface particle size distribution, from Surveyor I and III (Morris and Shoemaker, 1969.)

Surface Particle Size Distribution, Surveyor I and III Sites

Similar slopes and intercepts imply similar regolith properties at all mare sites; steady state feature



17



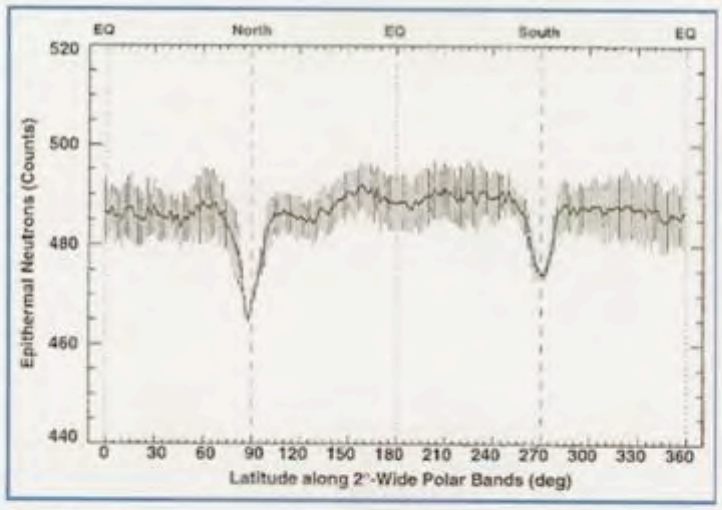
16

Particle Size Distribution, Returned Lunar Soil Samples

Similar slopes of regolith returned samples shows similarity of mature regolith at mare and highland sites. Implies similar regolith on Malapert Mountain.

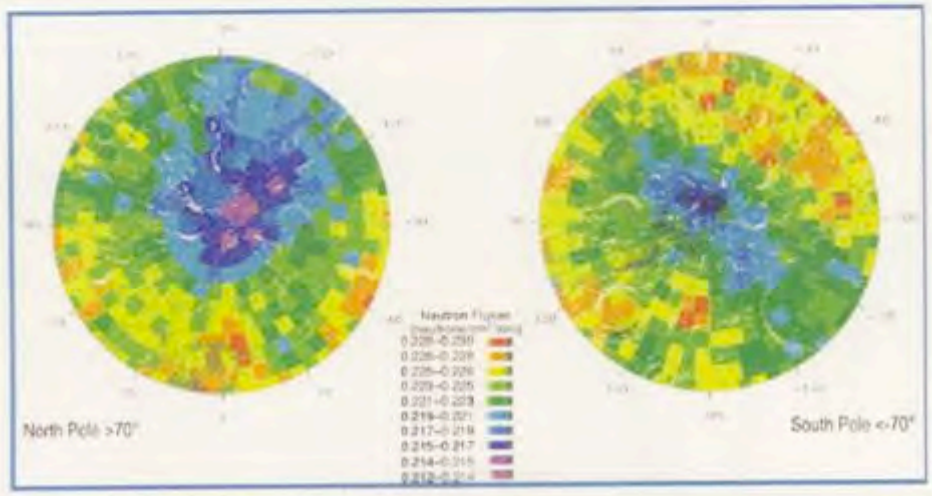
Particle Size Distribution, Surveyor VII Site, vs. Single Cratering Event in Solid Rock

Diagram explains regolith at Tycho: immature, thin



Epithermal Neutron Counts, Lunar Prospector Orbits

Low neutron counts indicate high
hydrogen content; note sharp drops over both poles.



Epithermal Neutron Count Maps, North Pole (left) and South Pole (right)

South pole map shows closeness of Malapert Mountain to high-hydrogen areas; compare with Clementine mosaic showing shaded areas.

Advantages of Malapert Mountain as an Outpost Site

- Long-term continuous sunlight on top and north side
- Large relatively smooth area for landing and surface operations
- Probable thick, workable regolith
- Close to shaded areas, high hydrogen content
- Dynamic accessibility; zero longitude; LOR mode with no plane changes; anytime return
- Uninterrupted microwave visibility from Earth