Nearside Megabasin: The Largest Basin from the Moon*

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Abstract

The Nearside Megabasin, 3,200 km wide and centered on the western half of the Lunar nearside, is inferred to have formed from a giant impact ~4.3 billion years ago. Evidence for the basin includes: radial graben, remnant ring structures, aligned igneous features such as domes and dome fields along remnant rings, a thin (<20-km) depressed crust, and anomalous volatile deposits along zones of structural weakness. The Nearside Megabasin is also associated with the Moon's greatest concentration of thorium and KREEP (Potassium, Rare-Earth Elements and Phosphorus) lavas that formed from late-stage partial melts, possibly in response to decompression melting following deep excavation of the lower crust and upper mantle from the Procellarum impact event. These thorium deposits and related volatiles are important resources for sustaining future human settlement on the Moon.

The Nearside Megabasin contains the largest continuous extent of lunar basalts on the Moon and its upper fill is a complex of at least four different flow units, recognized on the basis of albedo and spectral reflectivity. Individually, these flow units are only a few hundreds of meters thick, but may be underlain by 2-4 km thick basin-filling basaltic units. In contrast to many other lunar basins, the Nearside Megabasin lacks a surrounding mountain rim and underlying mascon, features commonly associated with other nearside lunar basins such as Mare Tranquillitatis, Serenitatis, and Crisium. However, the absence of these features may be due to the basin having formed so early that the lunar crust may have not been sufficiently rigid to support rim material and excess masses of thick basin-filling units.

The Nearside Megabasin: The Largest Basin on the Moon

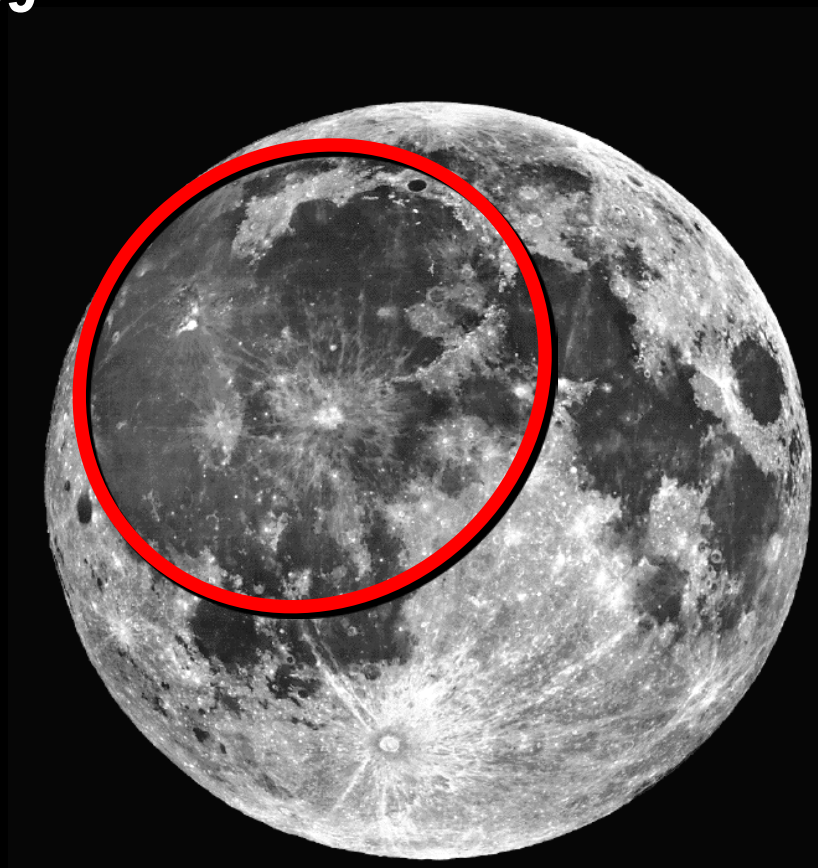
2009 Annual AAPG Convention
Denver, Colorado
June 10, 2009

William A. Ambrose

Bureau of Economic Geology

100 Years of Scientific Impact

1909-2009



Lick Observatory photograph

Outline

Oceanus Procellarum

-Morphology, Crustal Structure, Mare-Fill Units

Nearside Megabasin

-Basin Configuration and Marginal Structures

South Pole–Aitken Basin

-Antipodal Basin Structure

Significance

Publication was authorized by the Director, Bureau of Economic Geology, The University of Texas at Austin

Oceanus Procellarum

Facts and highlights

Largest mare area

Poorly developed mascons

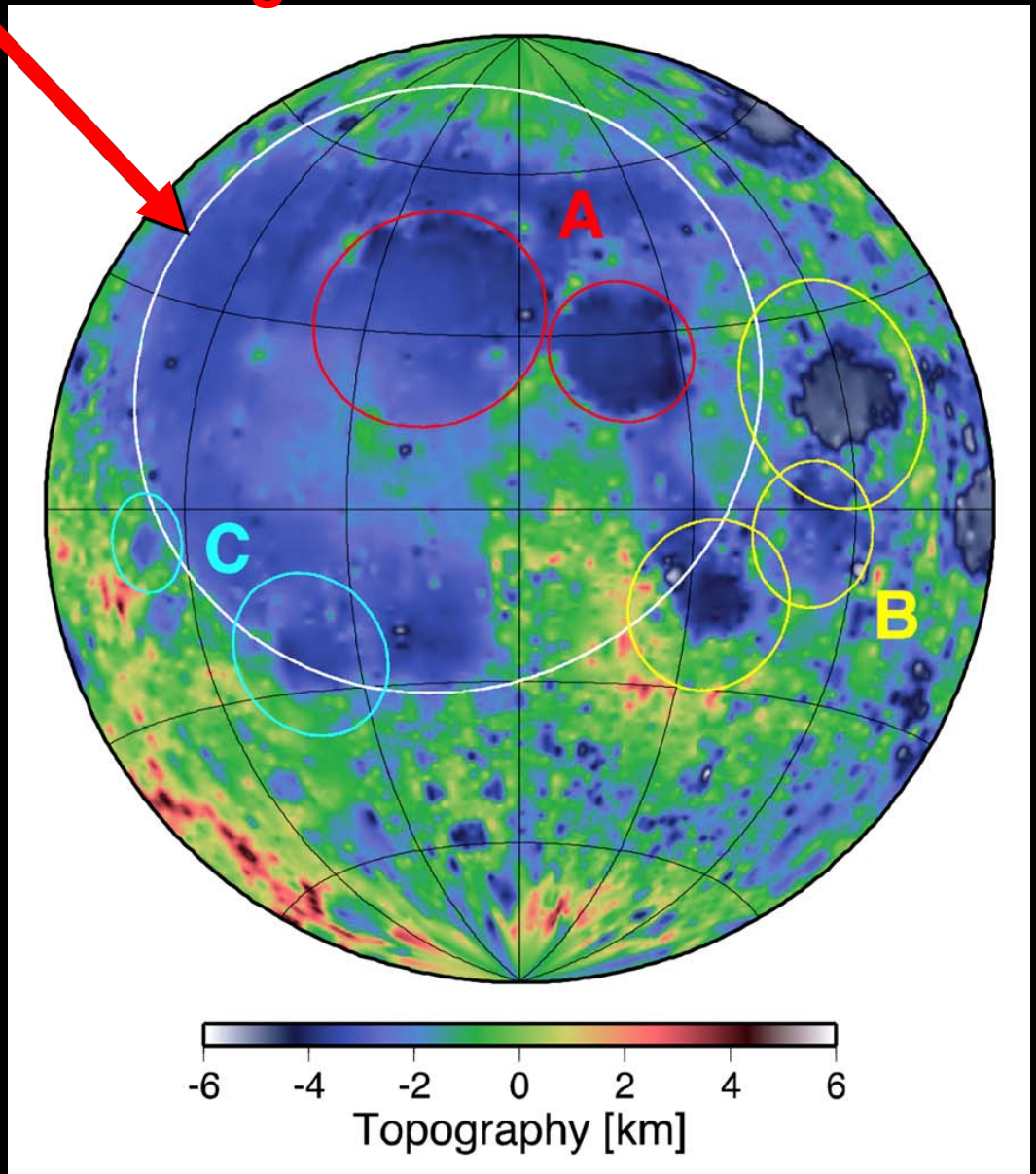
Th, KREEP-rich fill

3,200-km diameter

Lick Observatory photograph

Mascons and Non-Mascon Basins

Nearside megabasin



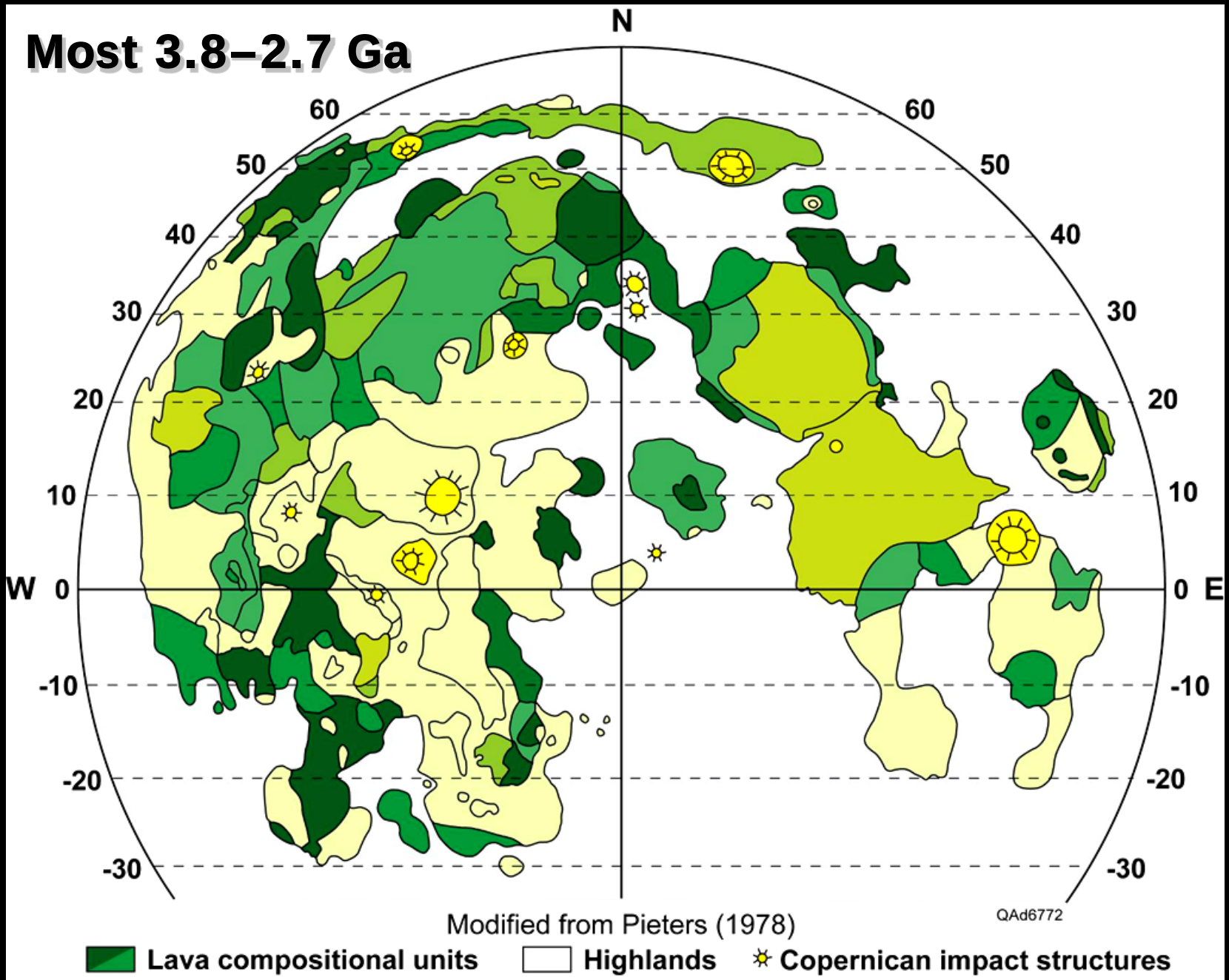
A
Imbrium
Serenitatis

B
Crisium
Fecunditatis
Nectaris

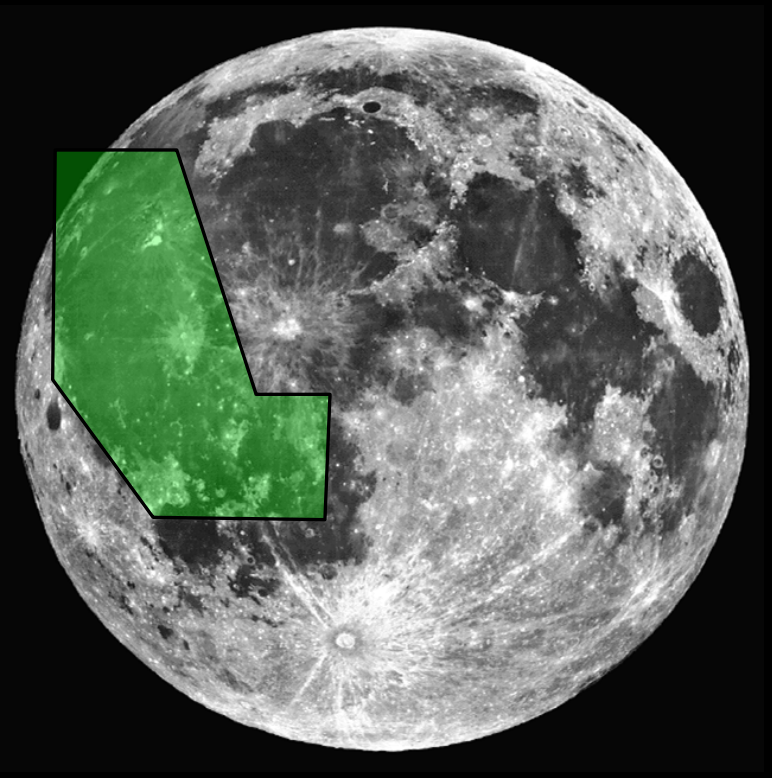
C
Grimaldi
Humorum

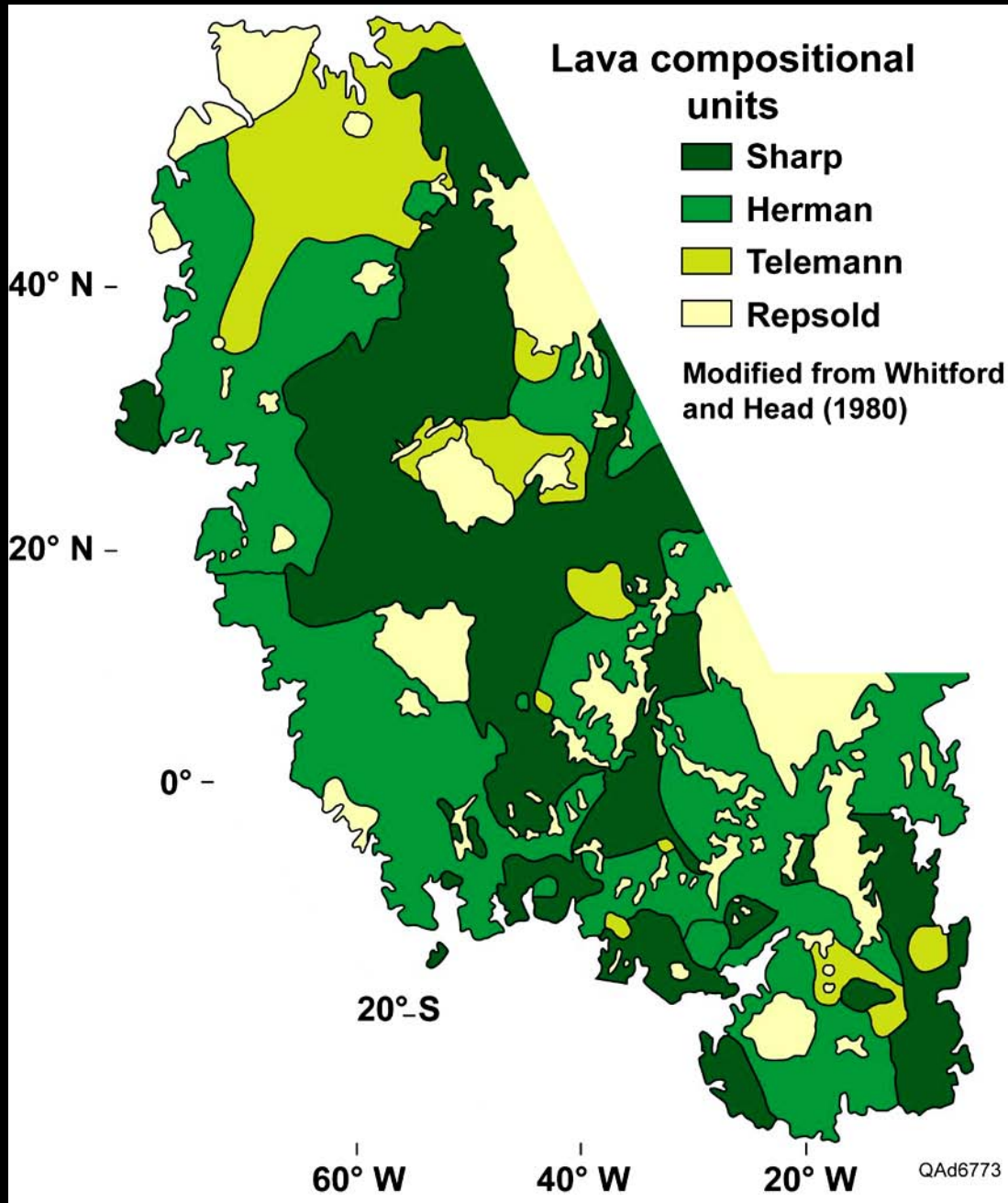
Sugano and Heki (2004)

Nearside Compositional Units



Oceanus Procellarum Compositional Units





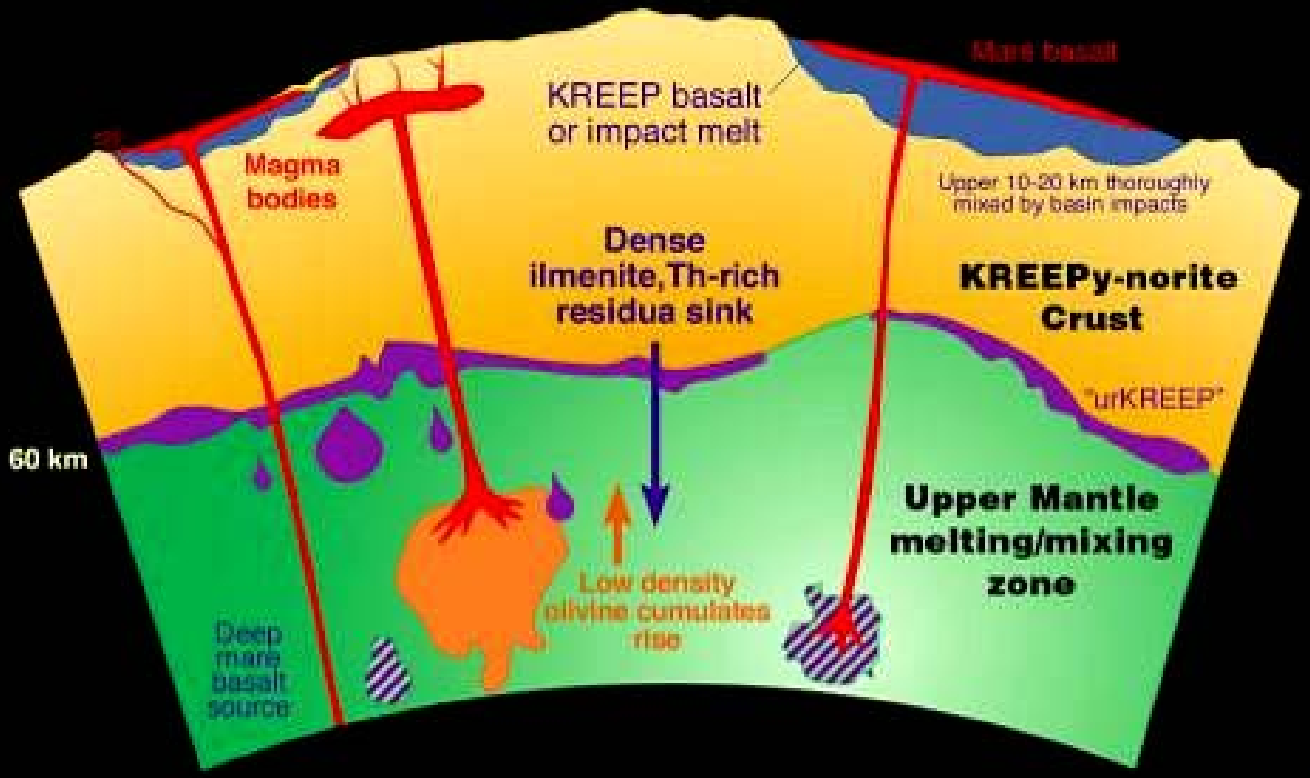
Bureau of Economic Geology

Oceanus Procellarum Compositional Units

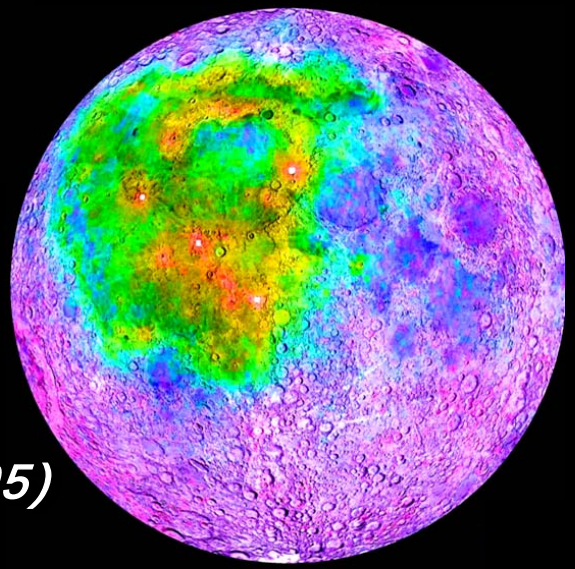
Attribute	Sharp	Hermann	Telemann	Repsold
Brightness	dark	darkish	bright	bright
Craters	few	intermediate	many	?
Titanium content %	3-11	1-6	<2	?
Thickness (meters)	25	150	250	125
Area (percent)	43	45	11	1
Age (billion years)	2.7±0.7	3.3±0.3	3.6±0.2	3.75?

QAd6771

Procellarum KREEP Terrane



Jolliff et al. (2000)



Spudis (2005)

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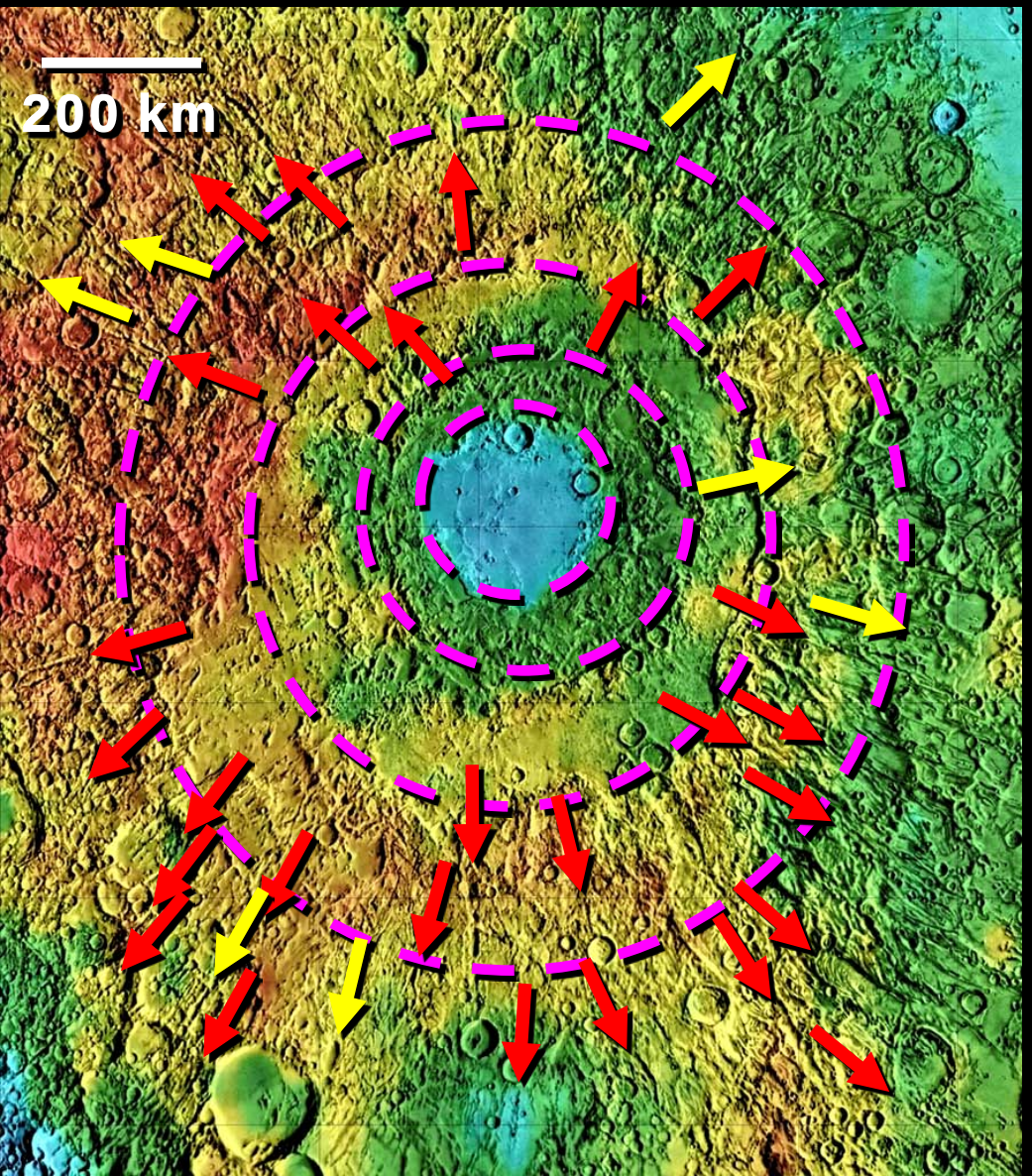
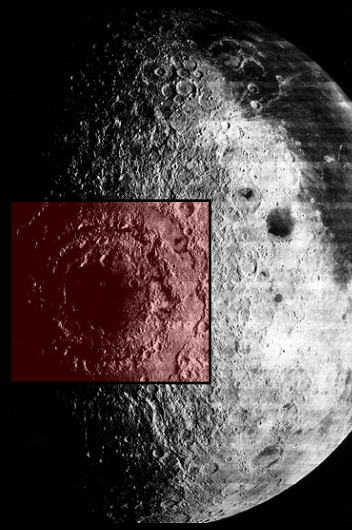
Orientale—Multiringed Basin

USGS lidar map



Lunar Orbiter 4

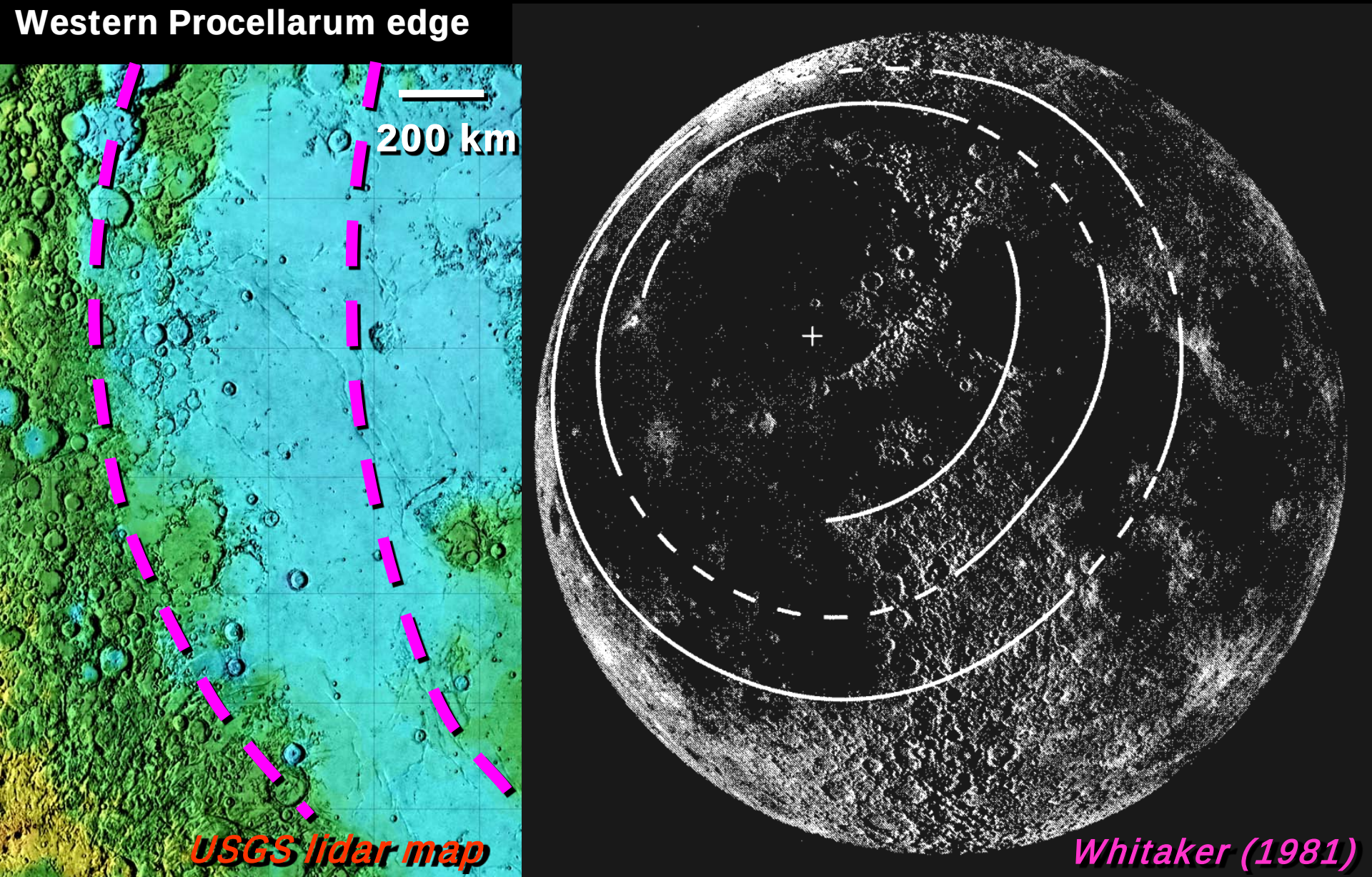


Basin rings

Secondary crater

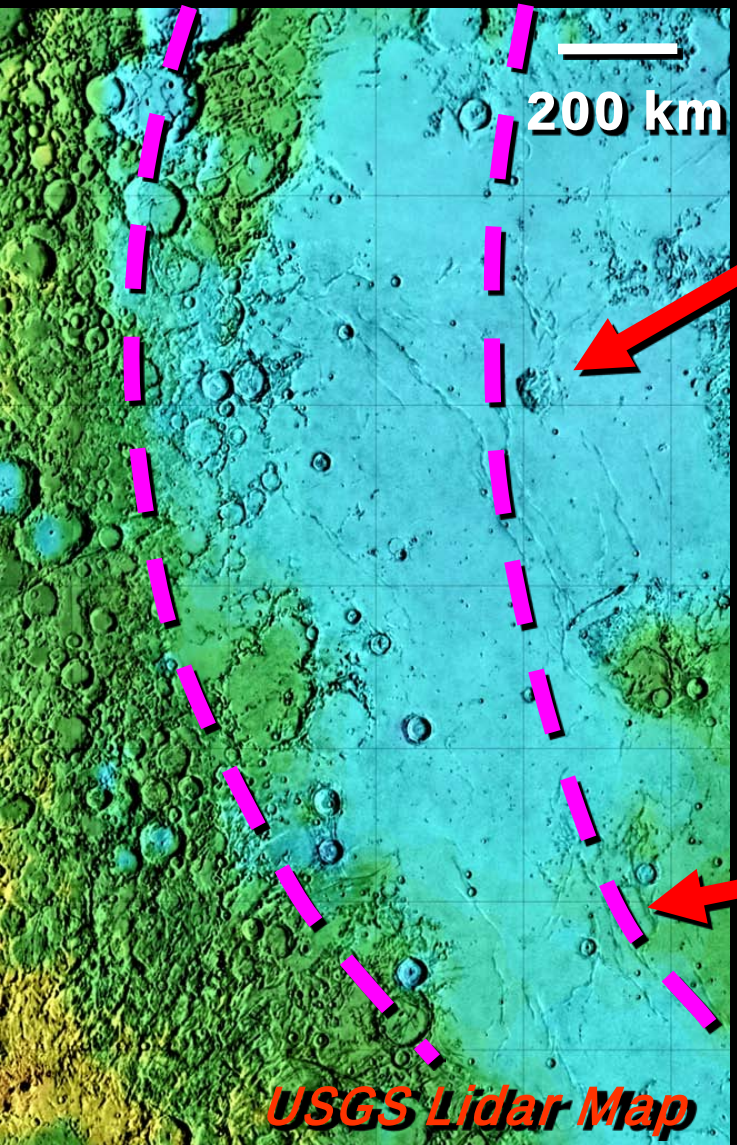
Scours, crater chains, and valleys

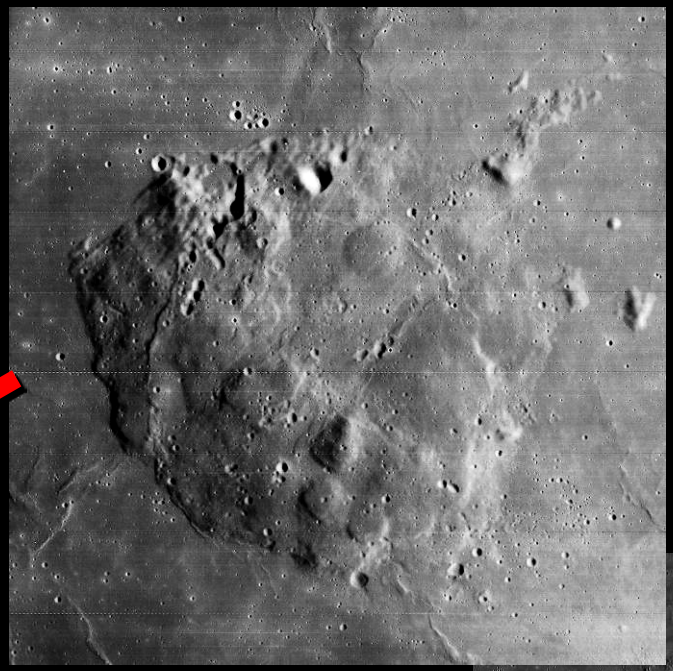
Nearside Megabasin—Ring Structures



Nearside Megabasin – Volcanic Domes

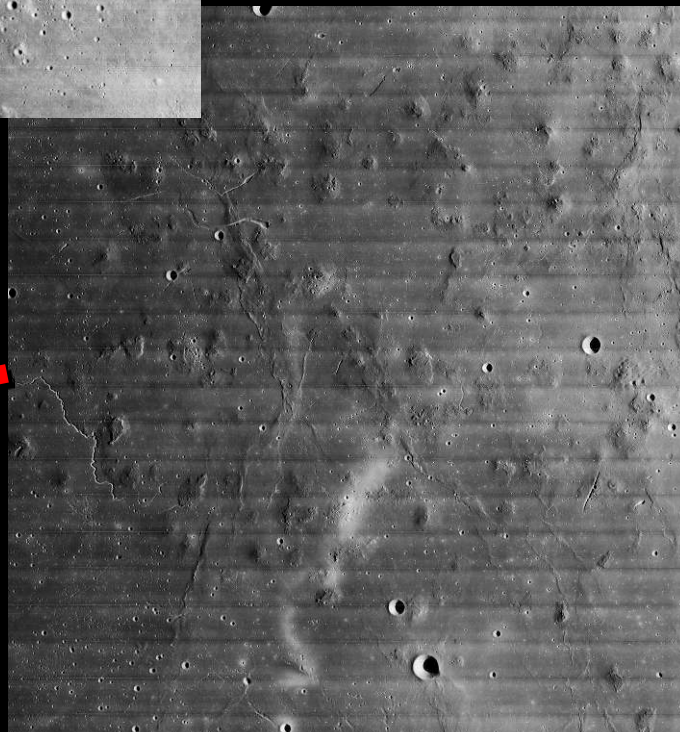
Western Procellarum Edge





Mons Rümker

LO-IV-163-H2

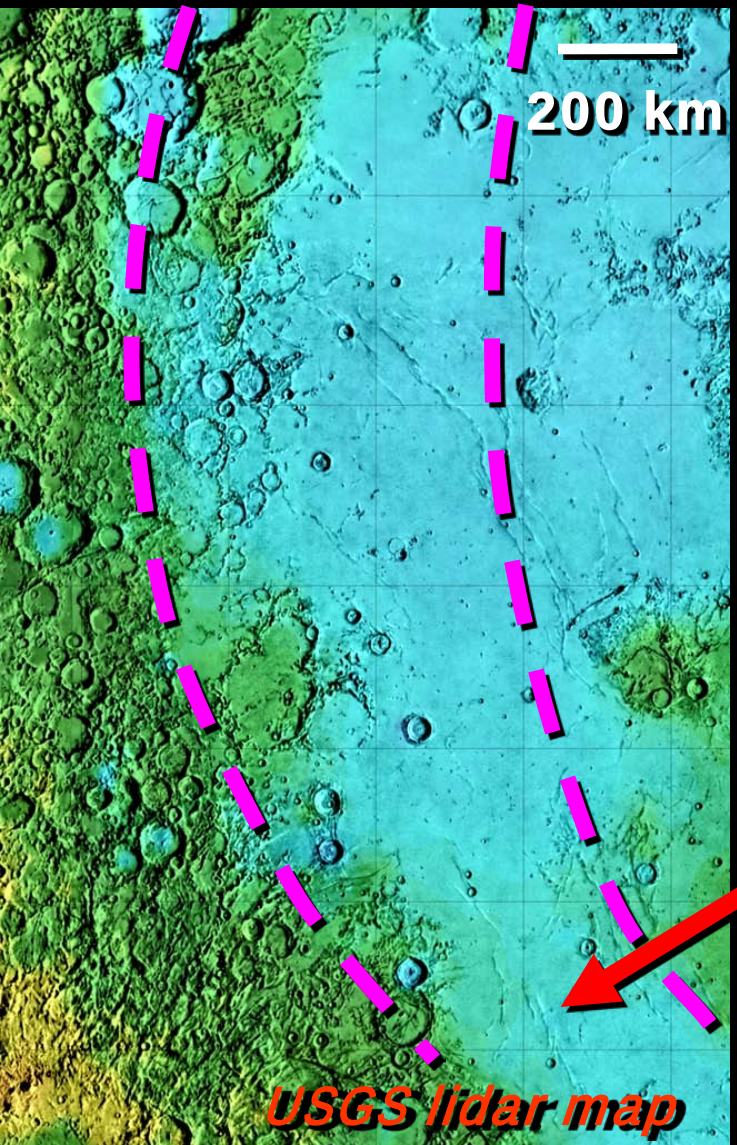


Marius Hills

LO-IV-157-H2

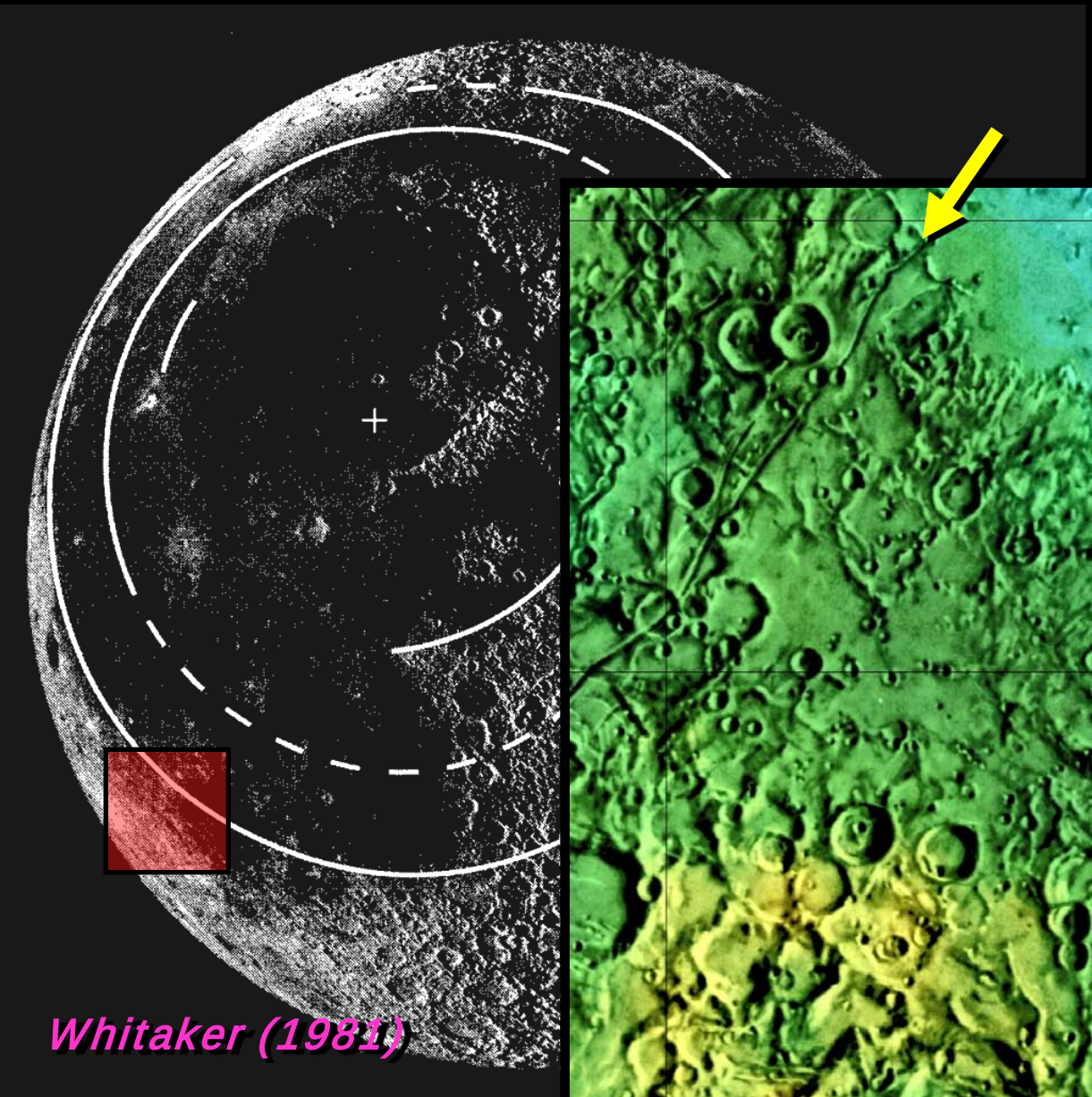
Nearside Megabasin—Wrinkle Ridges

Western Procellarum edge



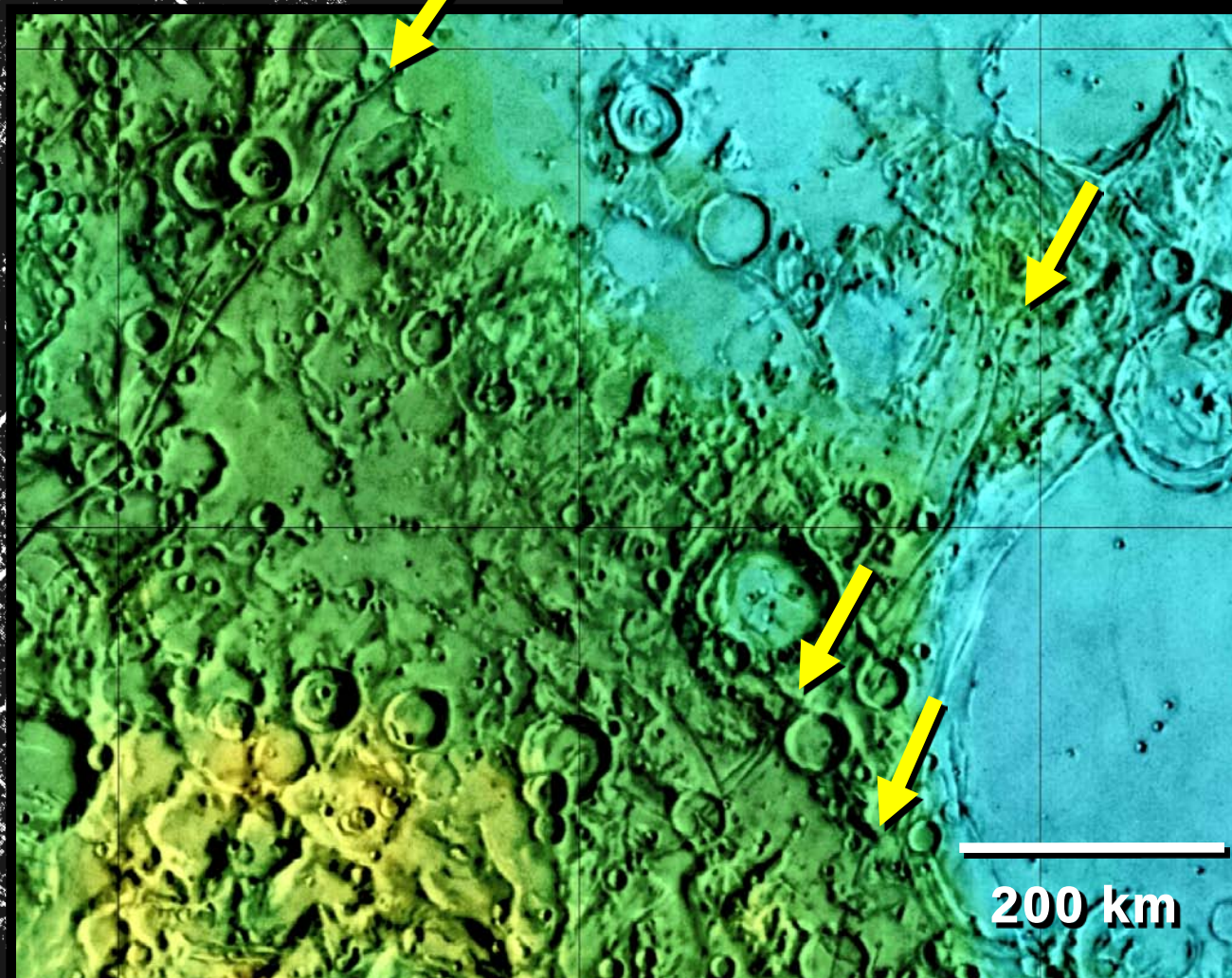
Lunar aeronautical chart 56

Nearside Megabasin—Radial Graben



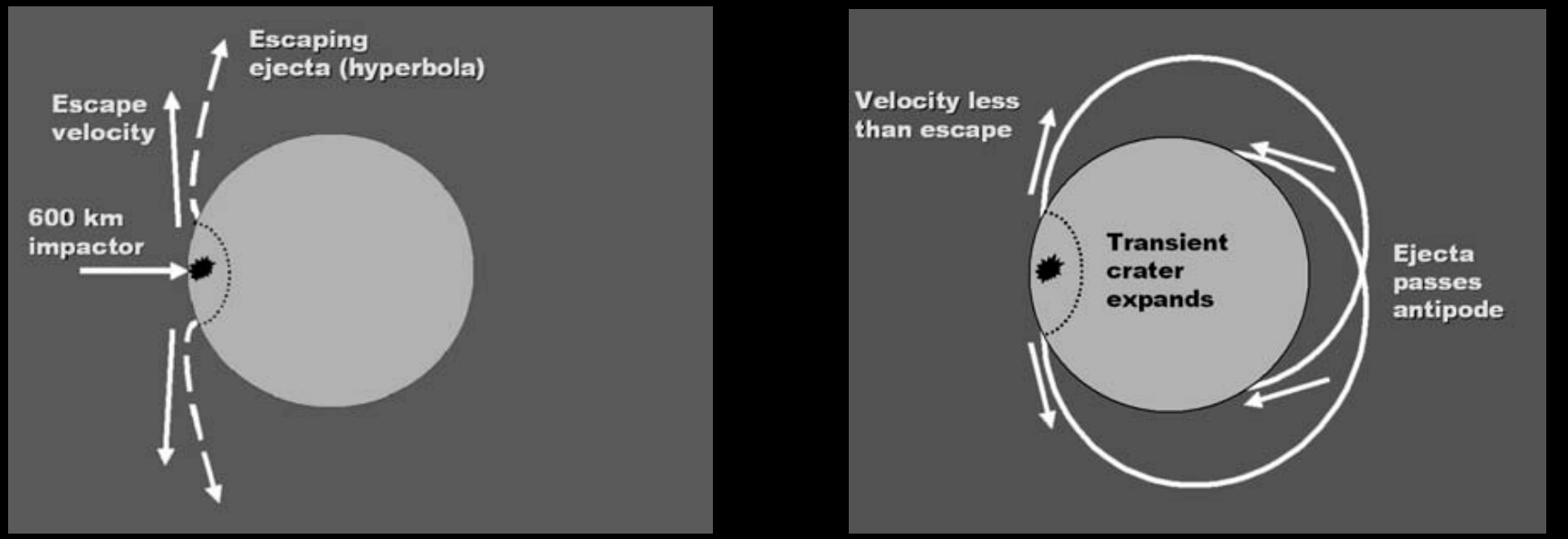
Whitaker (1981)

USGS lidar map



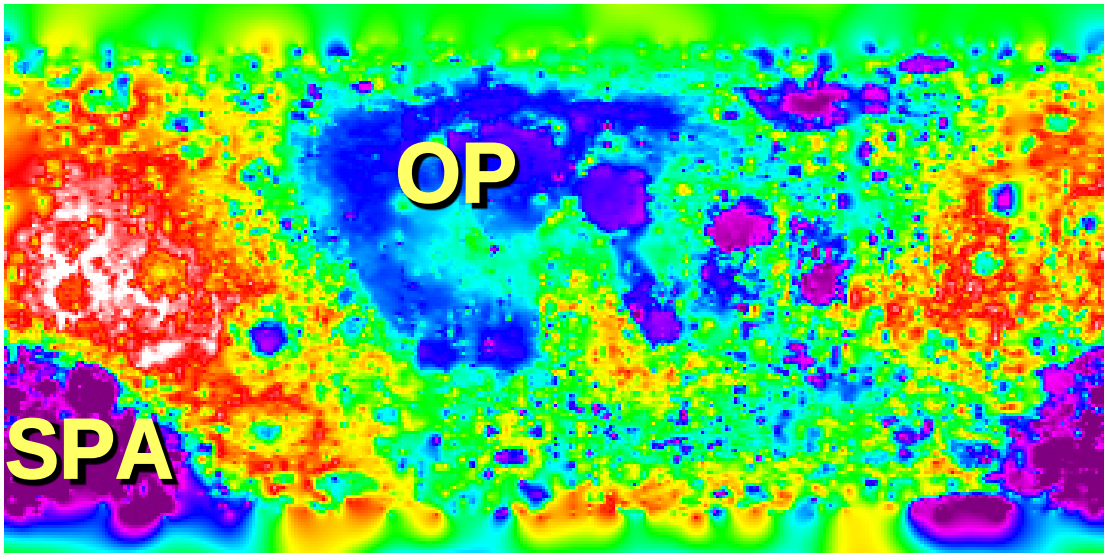
Nearside Megabasin – Model

Byrne (2007)



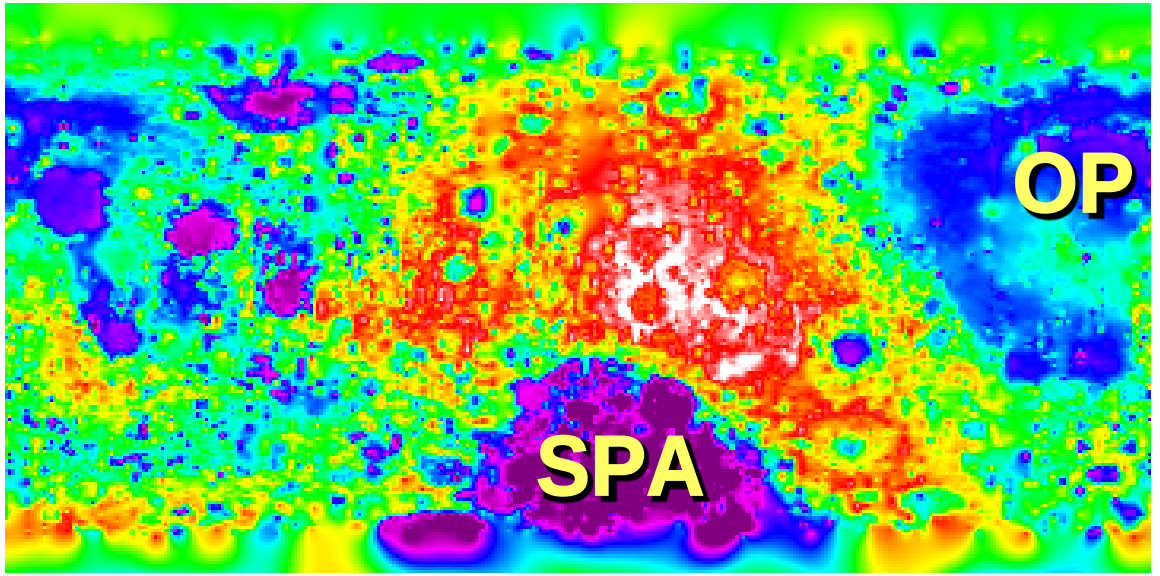
Nearside Megabasin – Elevation

Clementine digital elevation



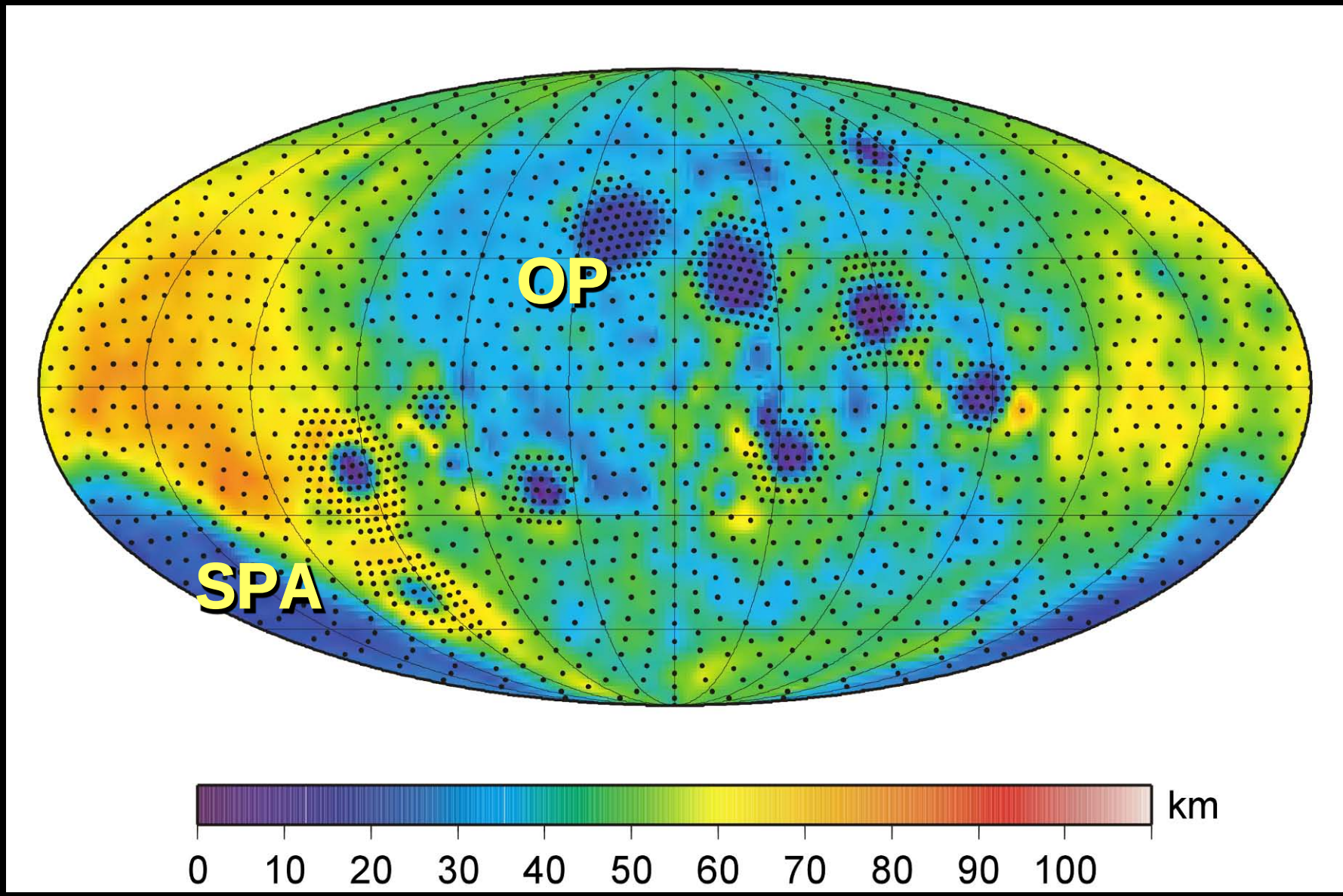
Near side

Far side



Byrne (2007)
From Zuber (2003)

Nearside Megabasin – Crustal Thickness



Wieczorek (2007)

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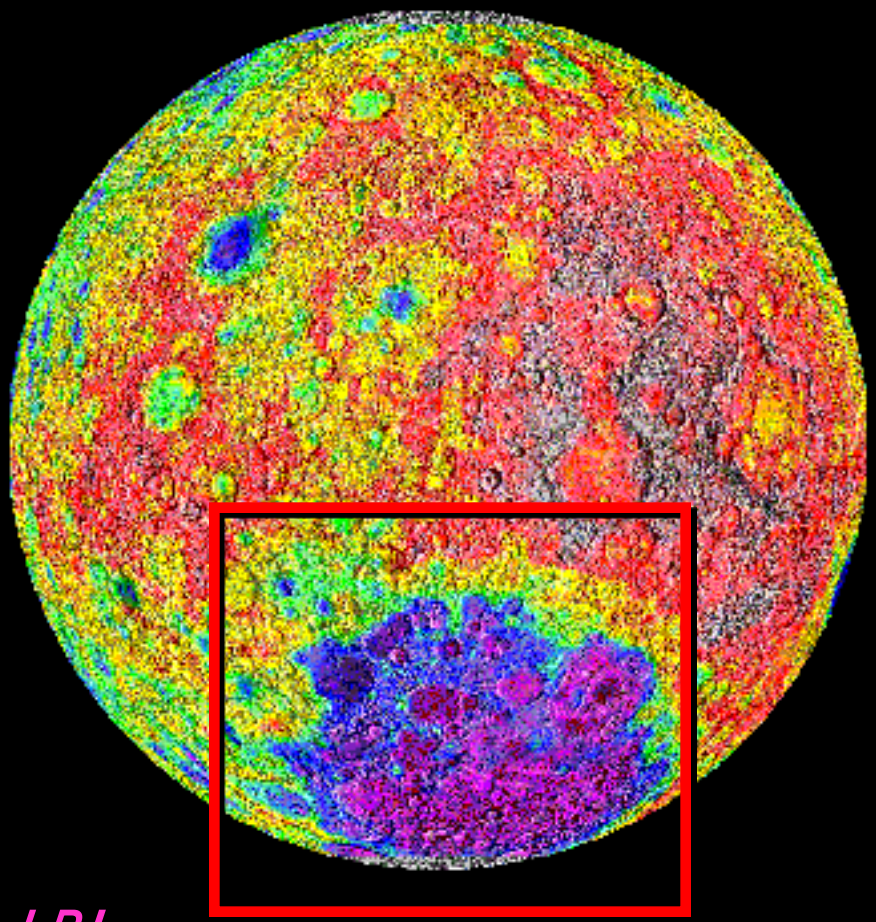
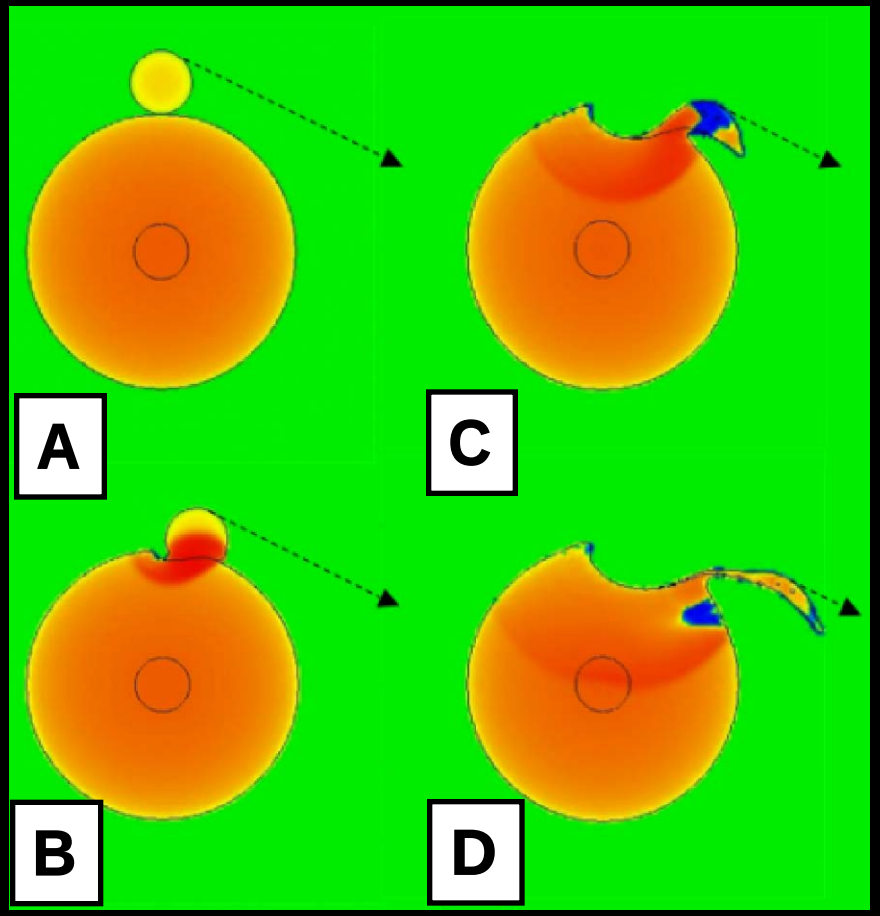
Significance

South Pole–Aitken Basin

Laser altimetry



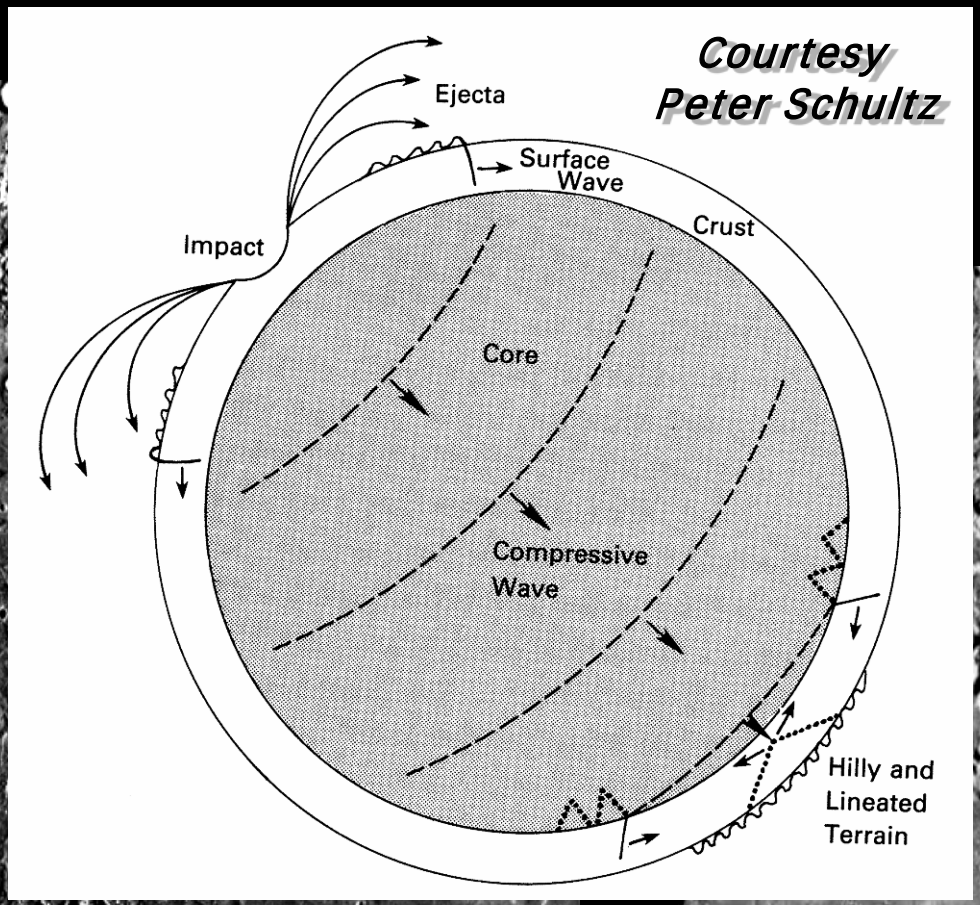
Collision model



LPI

Modified from Schultz and Crawford (2008)

Mercury: Caloris Basin



Mariner 10 photographs

Antipodal point

650 km

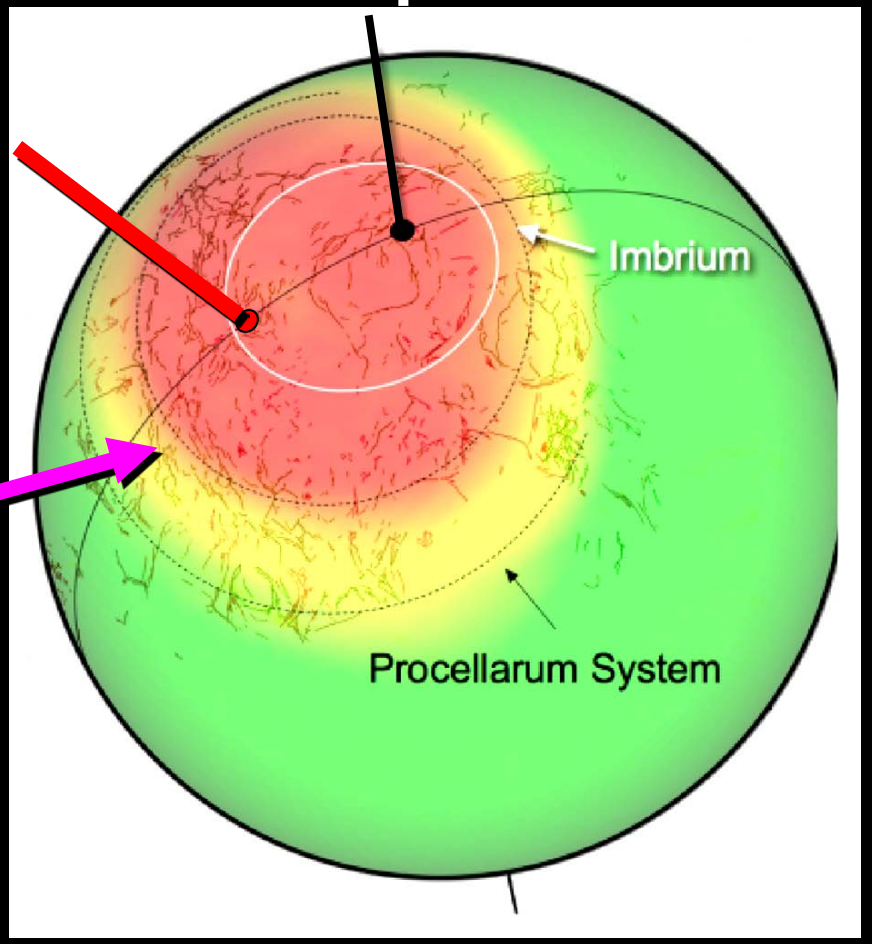
~50 km

Antipodal Effects from SPA Basin

SPA antipode

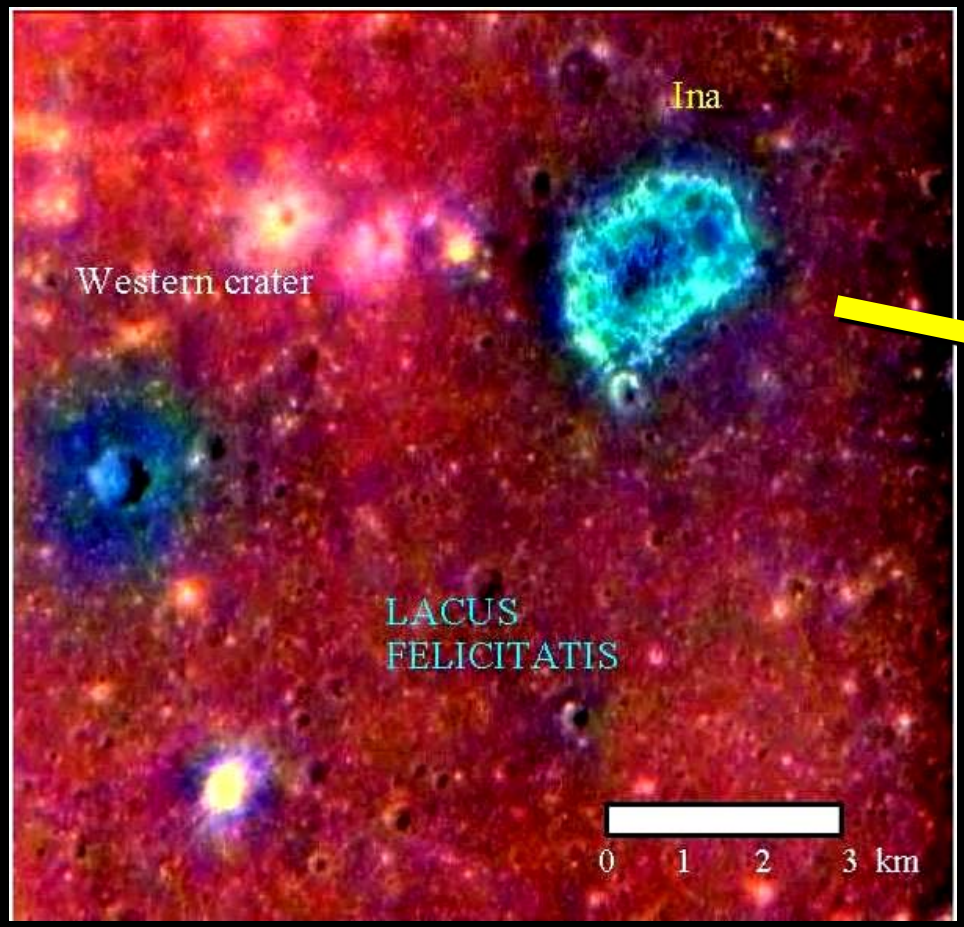
Oceanus Procellarum center

Arcuate and radial graben and ridges

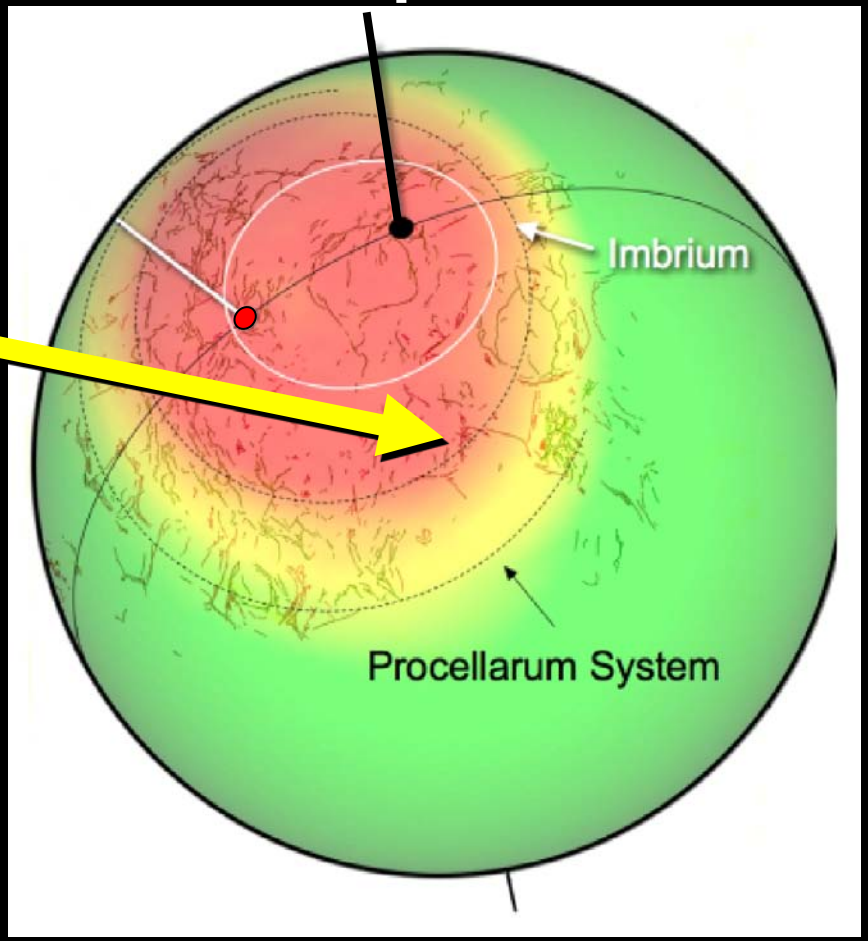


Modified from Schultz and Crawford (2008)

Ina–Recent Volatile-Rich Deposits



SPA antipode

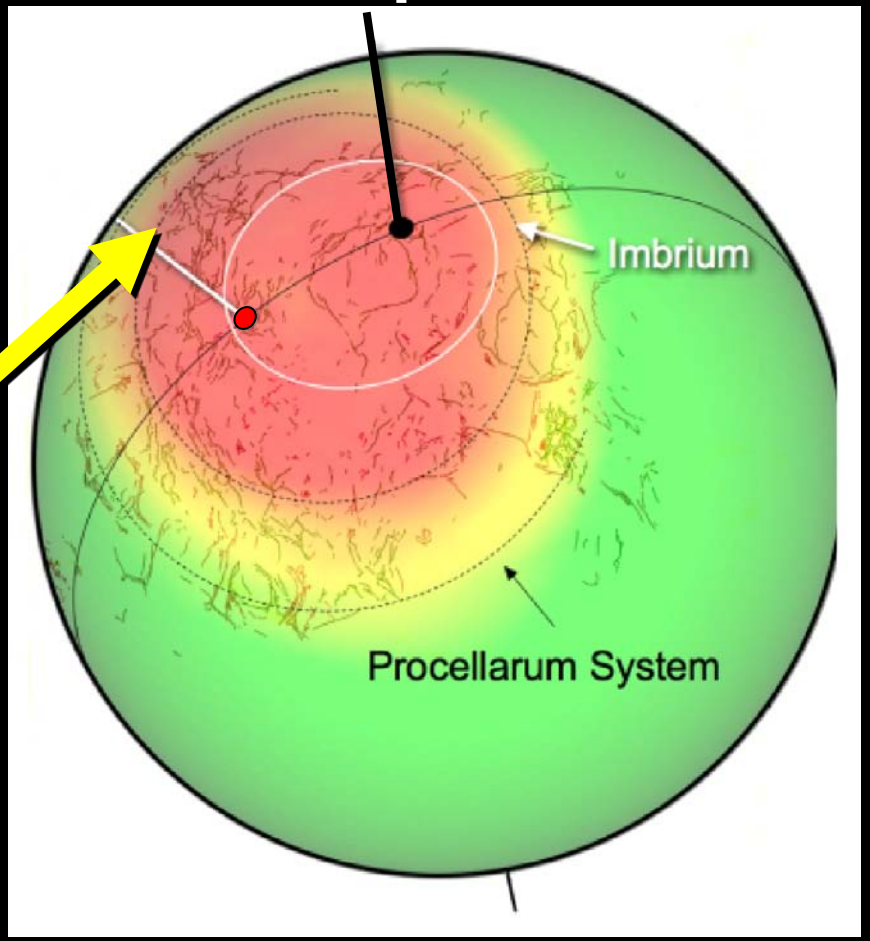


Schultz et al. (2006)
Schultz and Crawford (2008)

Lichtenberg–Possible Young Volcanism

McAlpin et al. (2008)
Clementine UV/VIS

SPA antipode



Clementine photograph

Summary

Nearside megabasin

-Thin, depressed crust
-Thorium, KREEP enrichment
-Elevation profile basinlike
-Radial graben
-Aligned volcanogenic features

Nonbasin attributes

-No mascons (isostatic equilibrium)
-Ring structure incomplete
-Secondary craters poorly documented

South Pole – Aitken Basin

-Antipodal structures in Procellarum area
-Procellarum volatile-rich deposits—Ina

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