

Lunar Impact History as Control on the Hadean Eon*

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Abstract

The Moon records impact activity during the Hadean Eon on Earth after a lunar crust formed ~4.52 billion years ago, after which 300 million years of saturation cratering (60-70 km diameter) of the lunar crust occurred. On Earth, the effects of this intense cratering dominated the early Hadean. Development of a terrestrial mega-regolith, rich in glass and pulverized mineral debris, made clays the dominant mineral species in water-rich environments, ideal environments for the development of complex organic precursors. During that same period, a few very large basins formed on the Moon. The far-side basin South Pole-Aitken (~2,500 km in diameter) constitutes the youngest, but evidence exists for at least four other older basins of comparable or greater size, including the ~3,200 km diameter Procellarum Basin. The age of South Pole-Aitken is estimated to be about 4.2 billion years. That age separates two, inner solar system eras of great importance and contrast. Prior to that time, in addition to saturation cratering and clay dominated sedimentary environments, seeds of the first continents may have formed by fractional crystallization of thick, water-rich impact-melt sheets. Crystallization dates for detrital zircon from ancient basin sediments in Australia at 4.4 billion years of age, and evidence of their formation in the presence of water, strongly support this conclusion. After ~4.2 billion years, saturation cratering and formation of very large basins ceased and a second period of large basin impacts began, forming >50 large basins (300-1,000 km diameter) before lunar mare basalts began erupting 3.85 billion years ago.

Lunar Impact History as Control on the Hadean Eon

A black and white photograph of an astronaut on the moon. The astronaut is in the middle ground, walking away from the camera towards the left. The lunar surface is covered in rocks and dust, with a long shadow cast by the astronaut. The background shows the horizon of the moon under a dark sky.

Harrison H. Schmitt

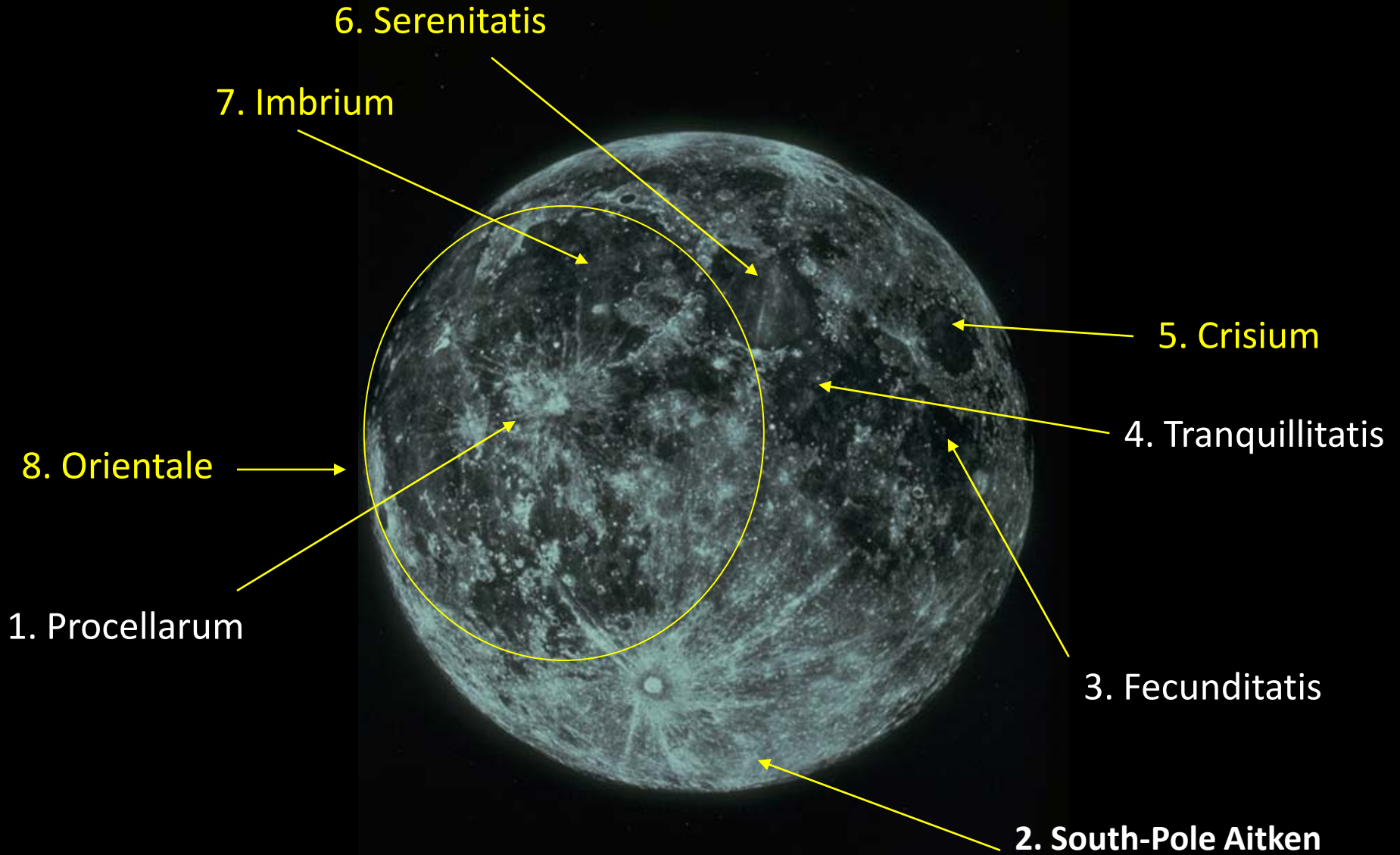
AAPG 2010 Annual Meeting

New Orleans, Louisiana

Issues Defined by Current Knowledge

- **Precise Calibration of the End of Large Impacts in the Hadean**
 - Identify and Date Syn-genetic Samples from Orientale Basin
- **Calibration of Episodes of Large Impacts in the Hadean**
 - Identify and Date Syn-Genetic Samples from South Pole-Aitken and a Range of Younger Basins

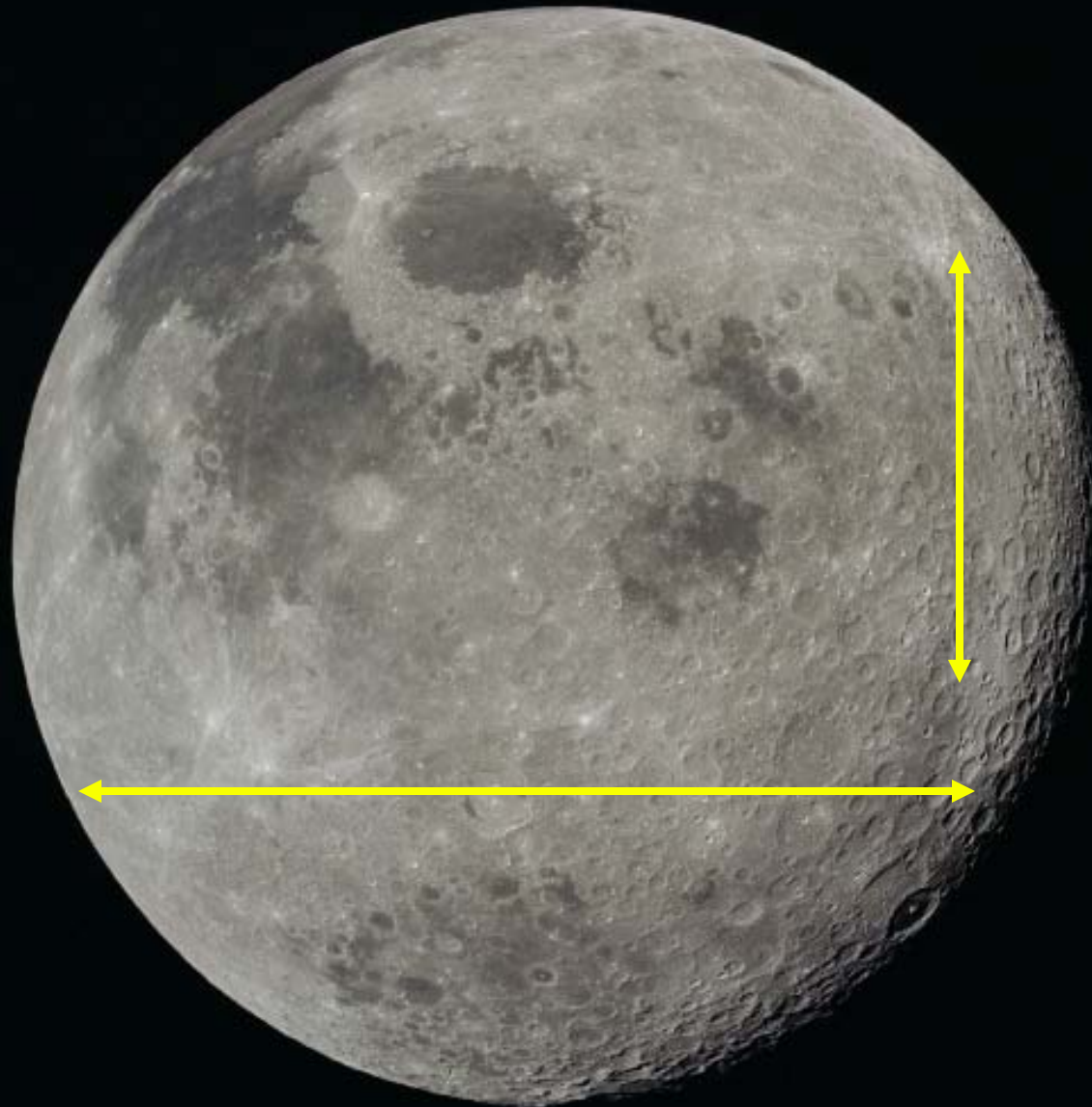




Major Impact Basins

Cataclysm “Shoehorn” Effect: A Lot to Happen in <100 My

- Saturation Cratering Before SPA
- Possibly 5 Very Large Basin Events Before SPA (>1000km Diameter)
- “Old” Mg-suite Parent Intrusions in Crust
- SPA and >35 Large Basin Events Before ~3.9 Gyr
- Young” Mg-suite Parent Intrusions in Crust Before ~3.9 Gyr
- Crypto-Maria Eruptions Before Young Large Basins
- Crustal Strengthening Before ~3.9 Gyr
- 14 Large, Mascon Basins



Clay!

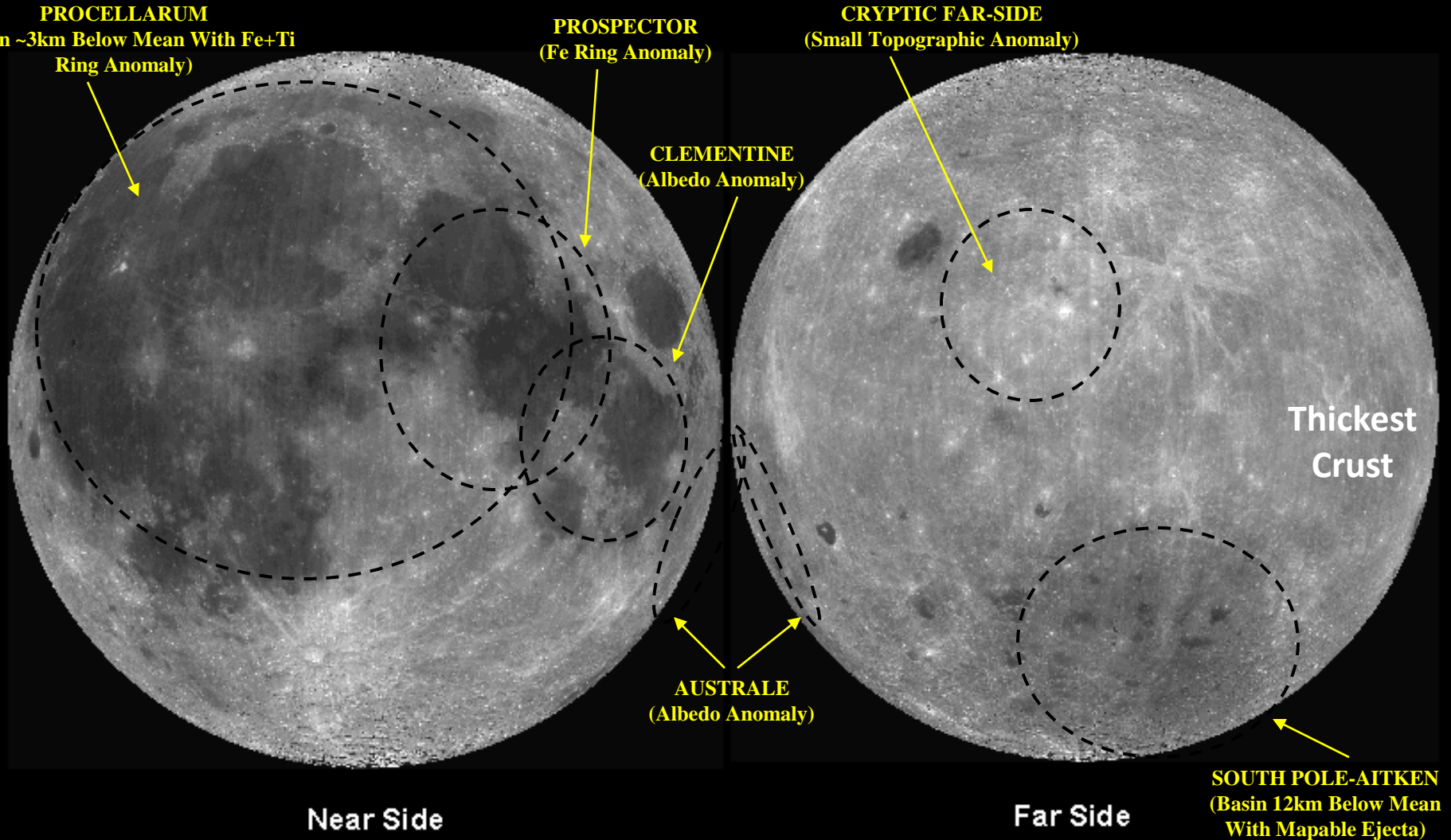
**Highlands Saturated with 60-70km Diameter
Craters - Underlain by 25km Thick,
Highly Insulating Mega-Regolith**

Clay!!



PROBABLE VERY LARGE BASINS ON THE MOON

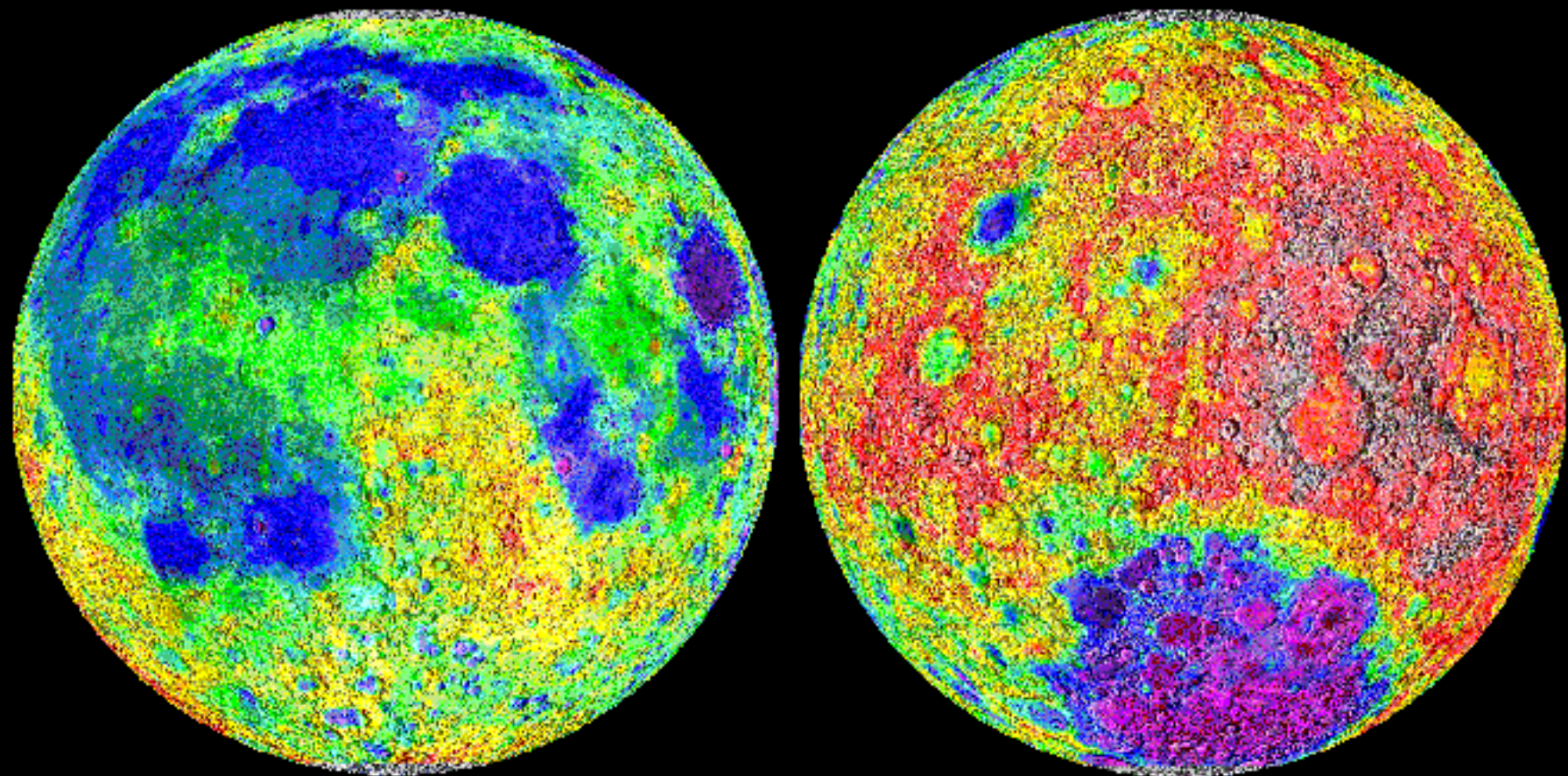
Procellarum and South-Pole Aitken Continental in Scale



CLEMENTINE GLOBAL ALBEDO IMAGES (750 nm filter)

Clementine Topographic Map of the Moon

Contour Interval - 500 m



Near Side

Far Side

-8 -6 -4 -2 0 2 4 6 8



Kilometers

We Need More Dates of Syn-Genetic Impact Melt Rocks!!

Boundaries in the Hadean:

3.8 Gyr – End of Hadean

~4.1 Gyr – End of Clay Domination

~4.3 Gyr – End of Very Large Basin Formation

