



# Astronomy

with your host:

**Lecture 7: The  
Moon and Mercury**



Coop

The

Moon



$$m \sim 7 \times 10^{22} \text{ kg} \sim 1/80 m_e$$

$$r \sim 1738 \text{ km} \sim 1/4 r_e \sim 6 \text{ ms}$$

earth moon distance: 400,000 km  $\sim$  1.3 seconds

NO ATMOSPHERE

# Surface Temperature

Day: 400 K

Night: 100 K

# Why no atmosphere?

## Average Molecular Speed

average molecular speed (in km/s)

$$= 0.157 \sqrt{\frac{\text{gas temperature (K)}}{\text{molecular mass (hydrogen atom masses)}}}.$$

# Escape Speed

escape speed (in km/s)

$$= 11.2 \sqrt{\frac{\text{mass of body (in Earth masses)}}{\text{radius of body (in Earth radii)}}}.$$

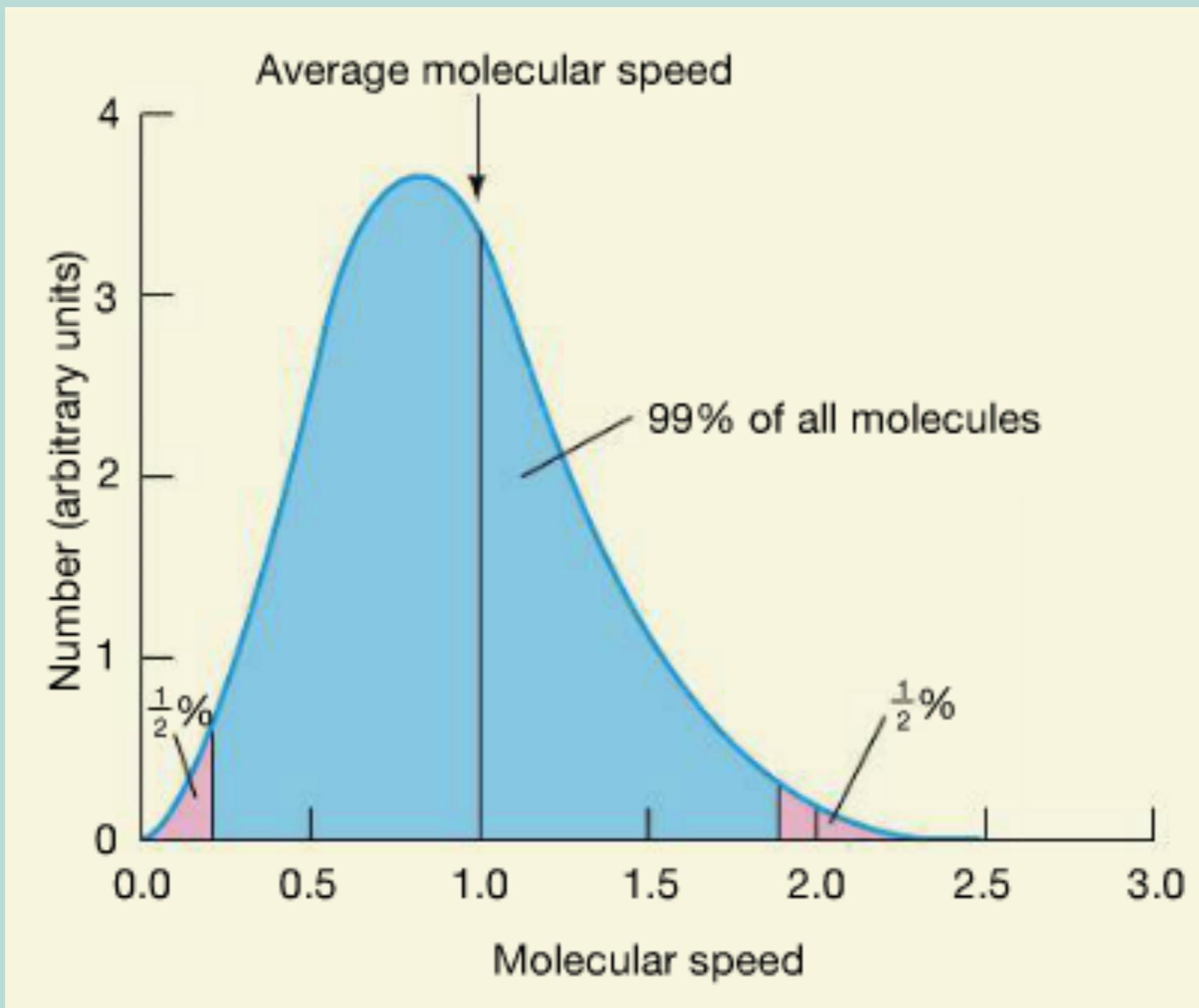
# Escape Velocity

Earth: 11.2 km/s

Mercury: 4.2 km/s

Moon: 2.4 km/s

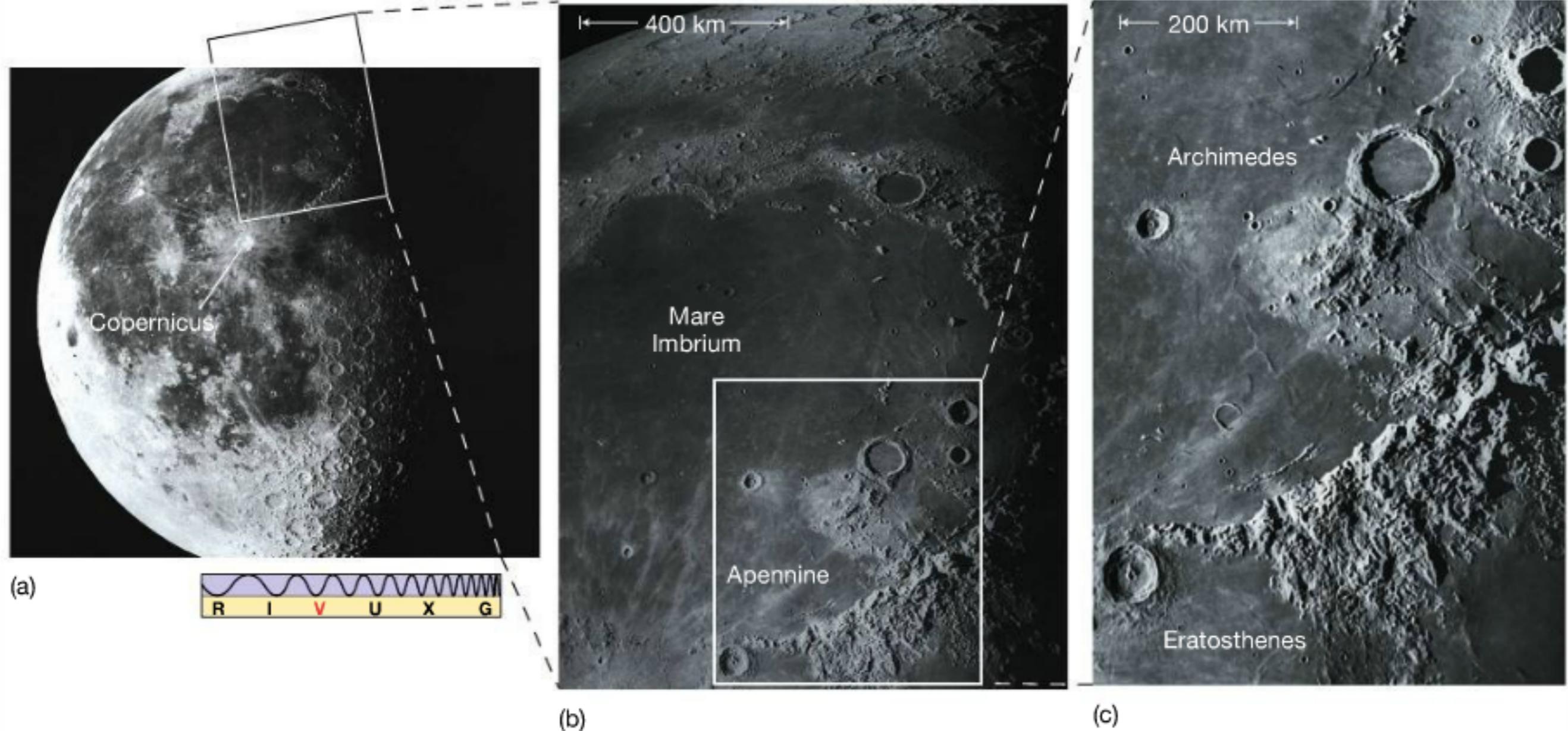
# Maxwell Distribution



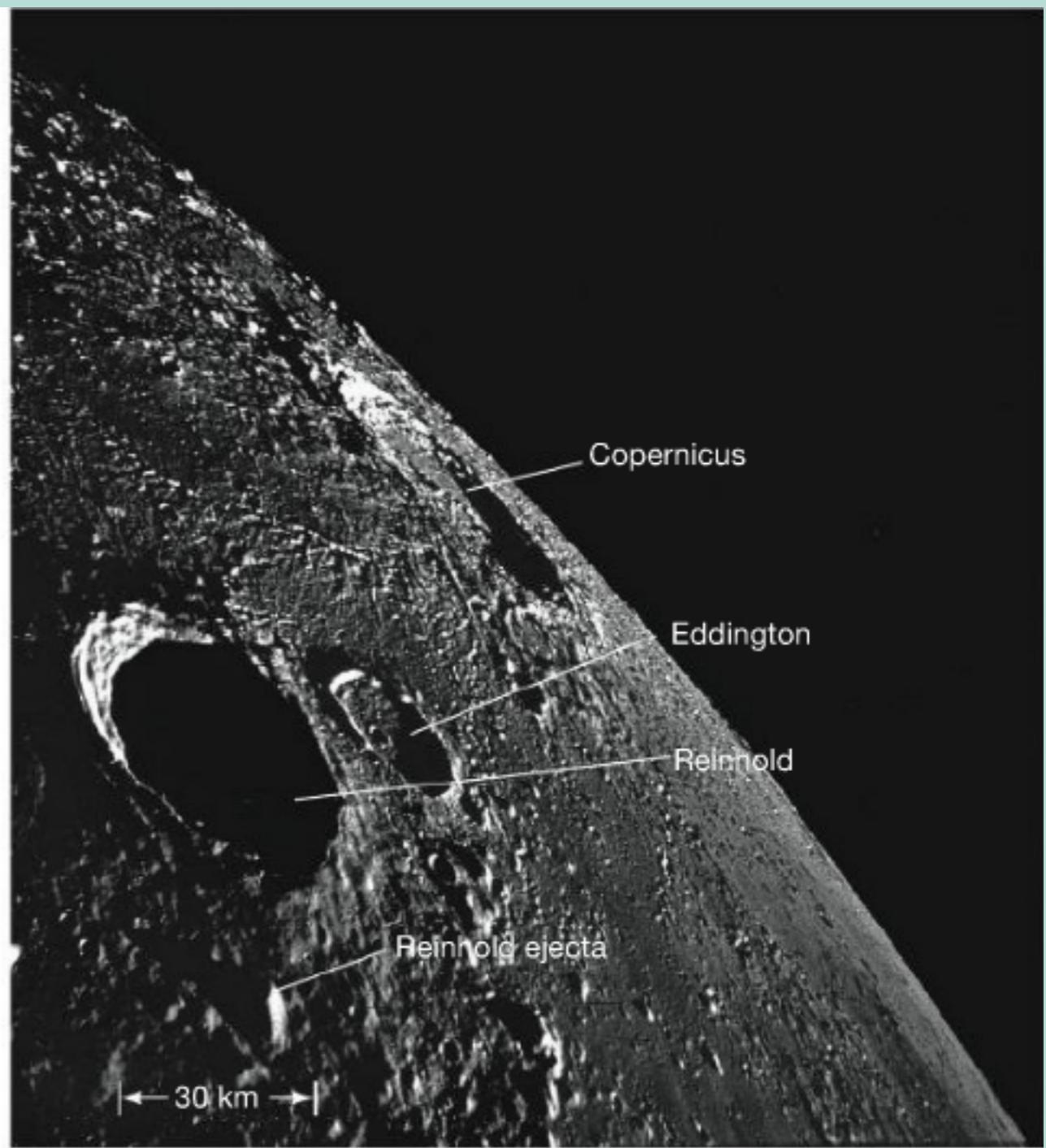
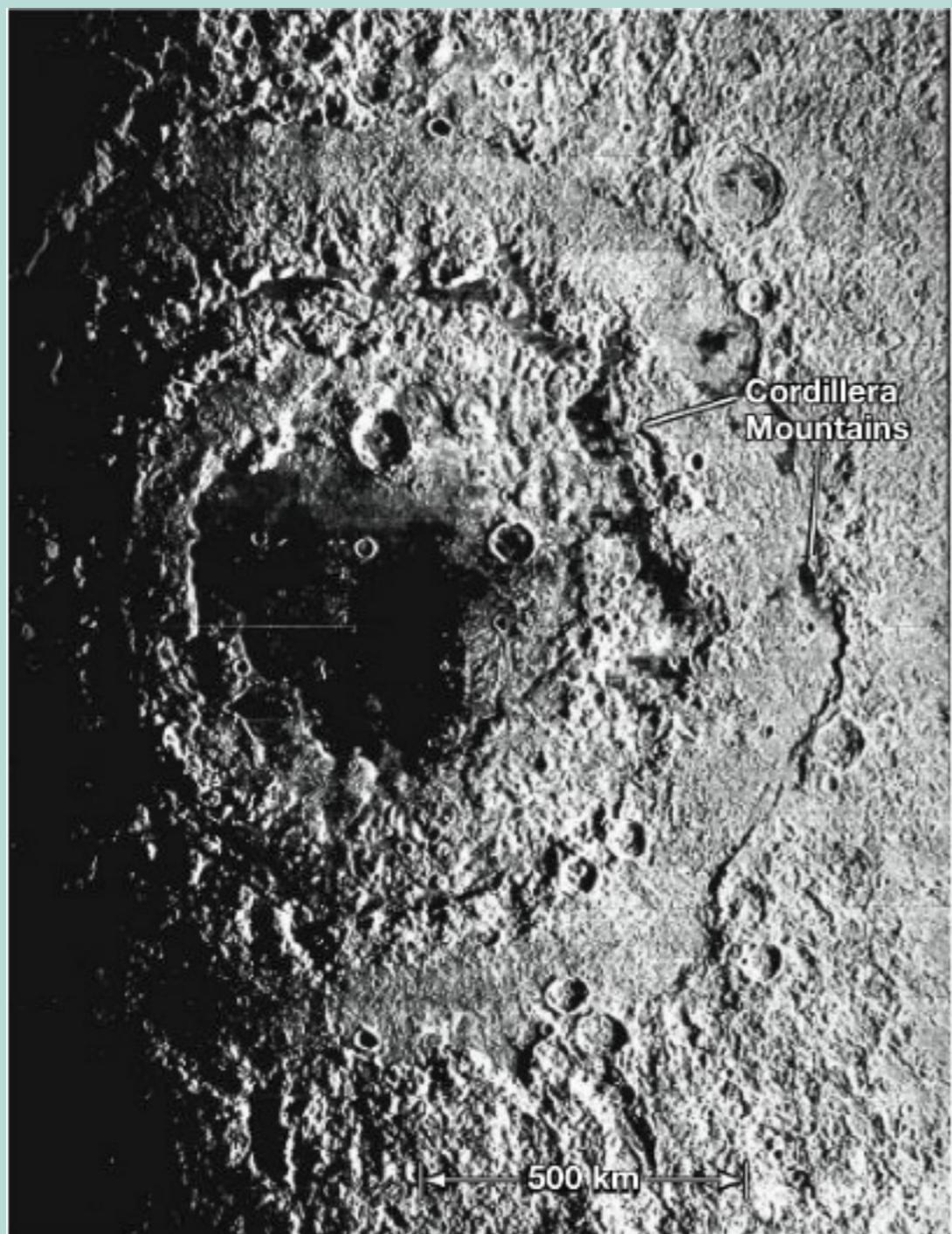
Rule of thumb: 6 times average speed.

# Lunar Map

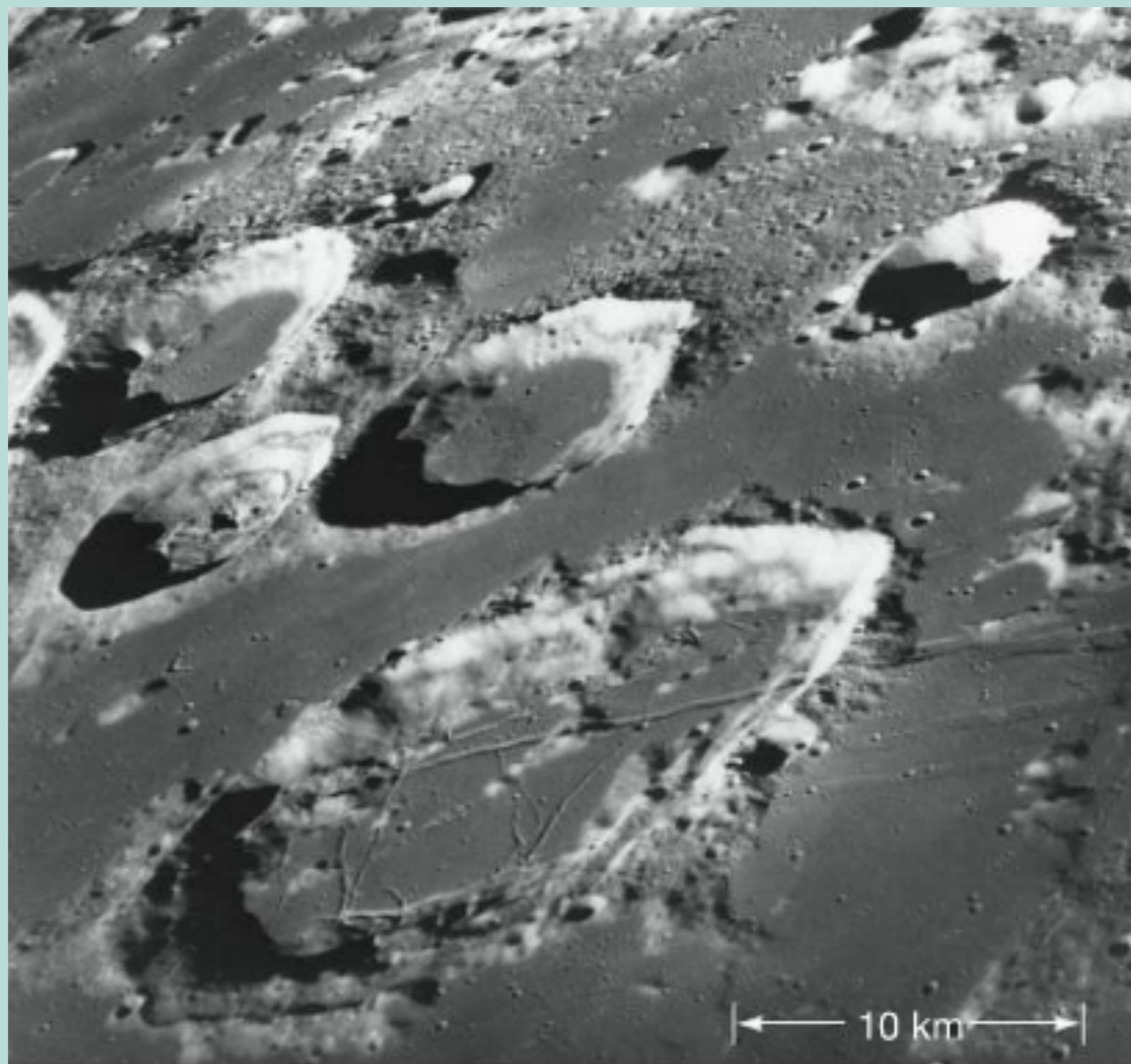




Maria are higher density!



# Lunar fly-by images



# Moon Cruisin'



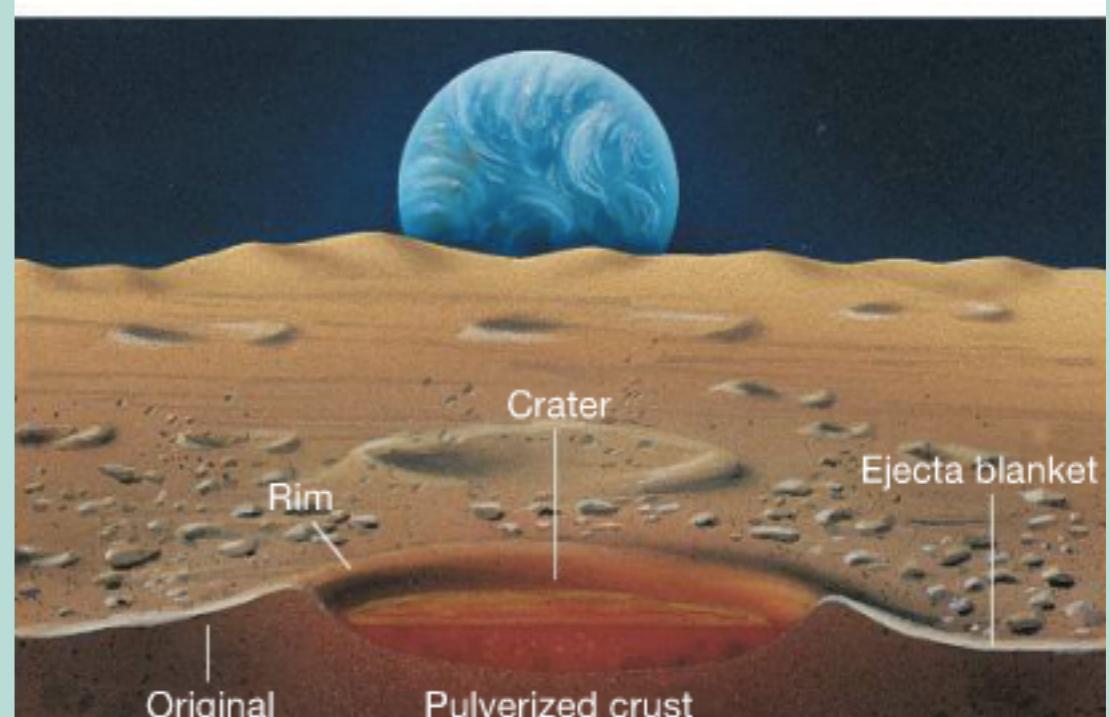
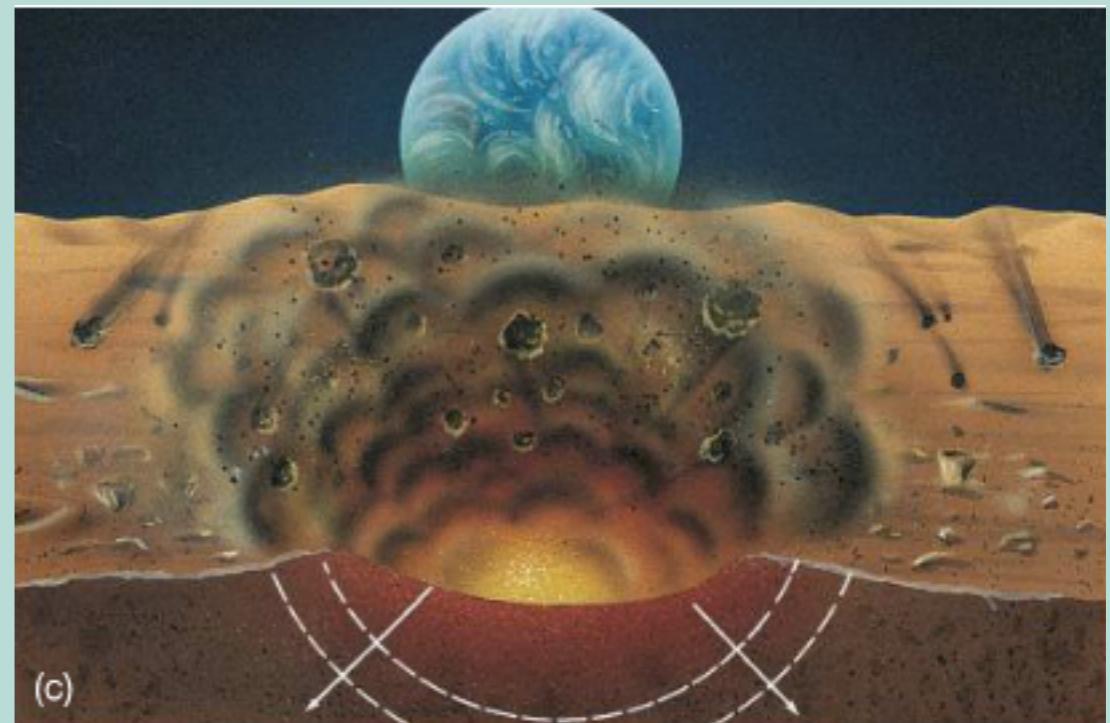
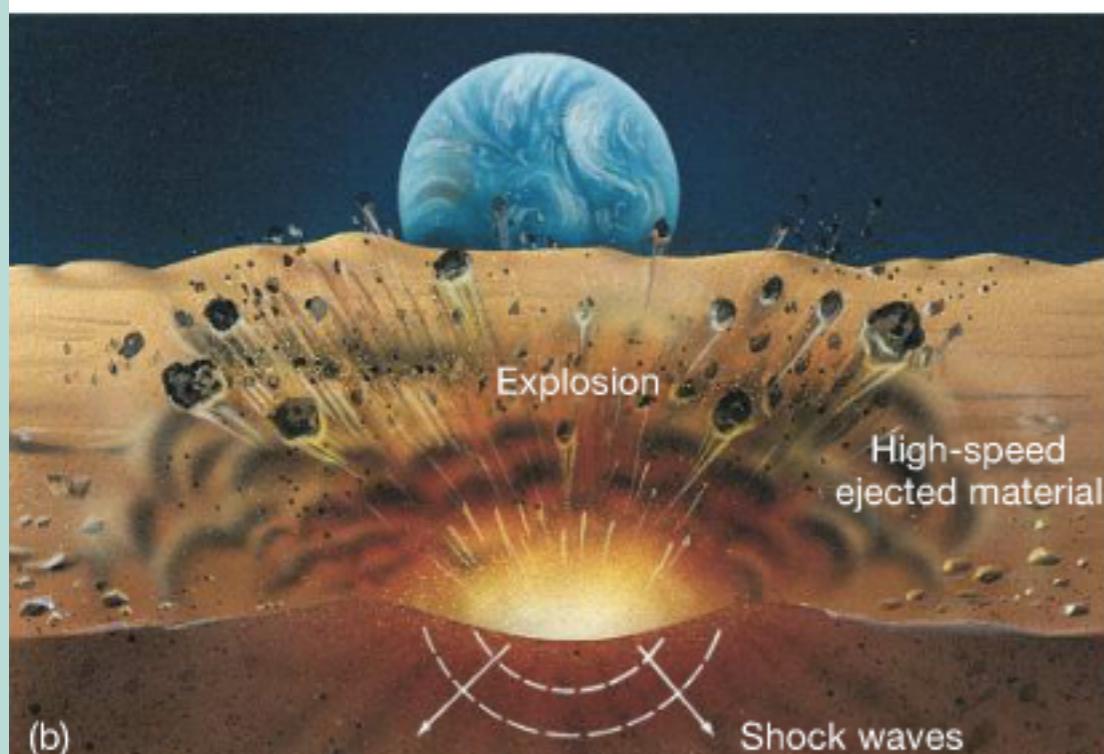
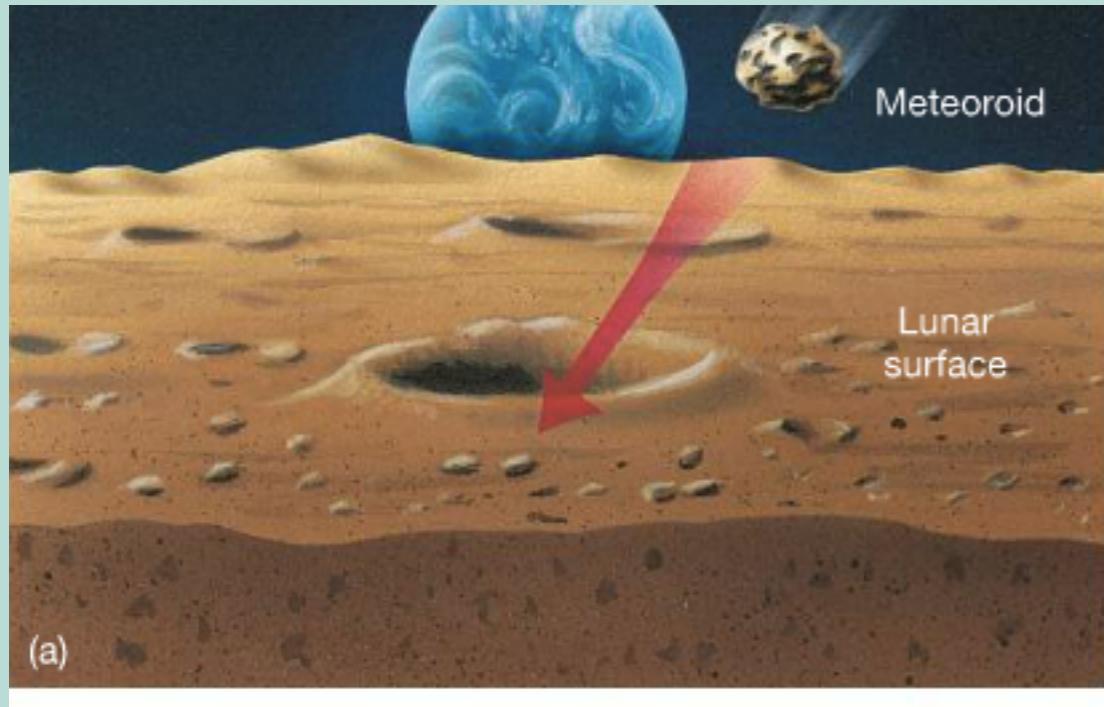
# Regolith



USA! USA! USA!



# Crater Formation



1 kg moving at 10 km/s = 10 kg TNT

# Barringer Crater

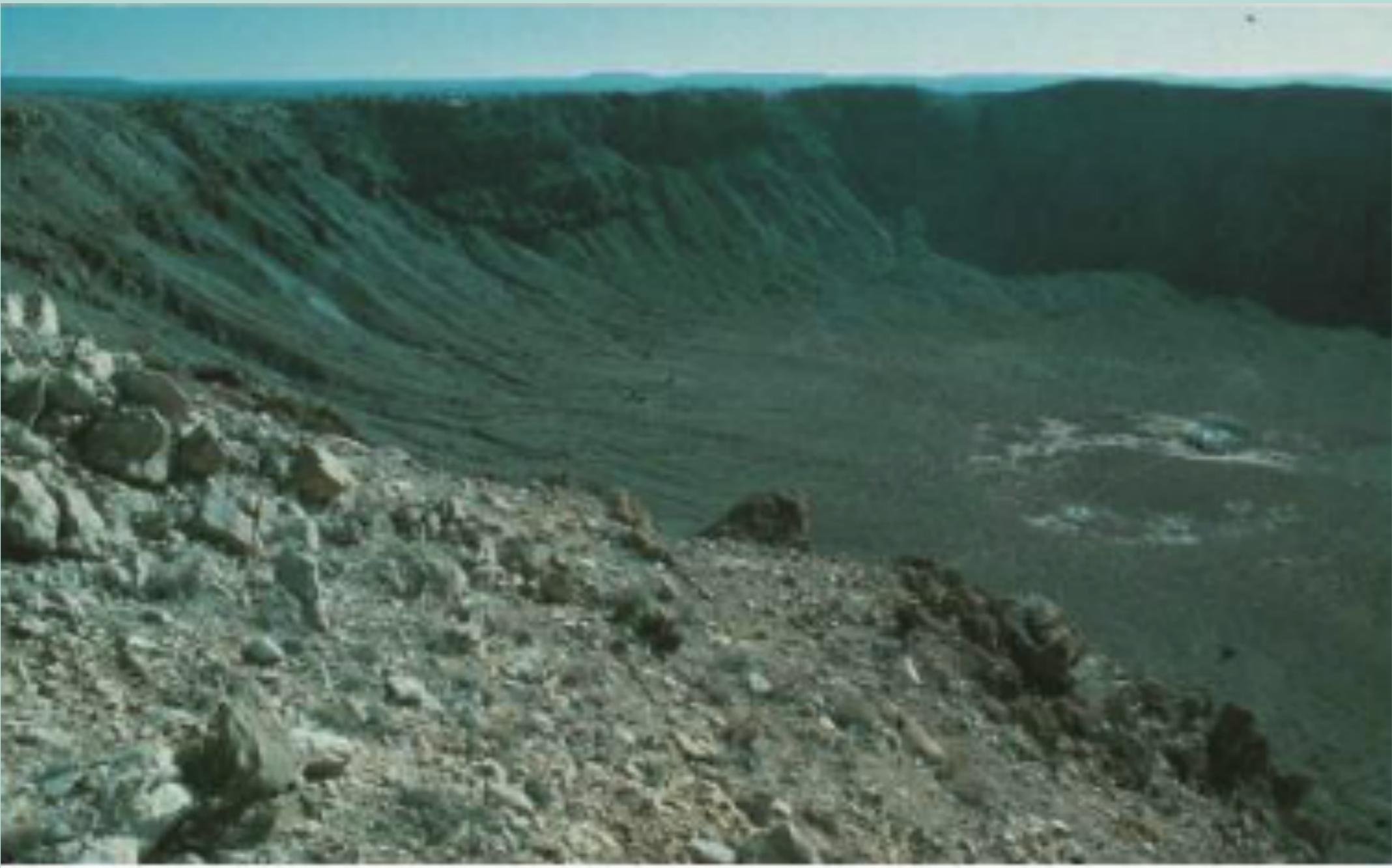


45 meter rock

**For the sake of perspective...**

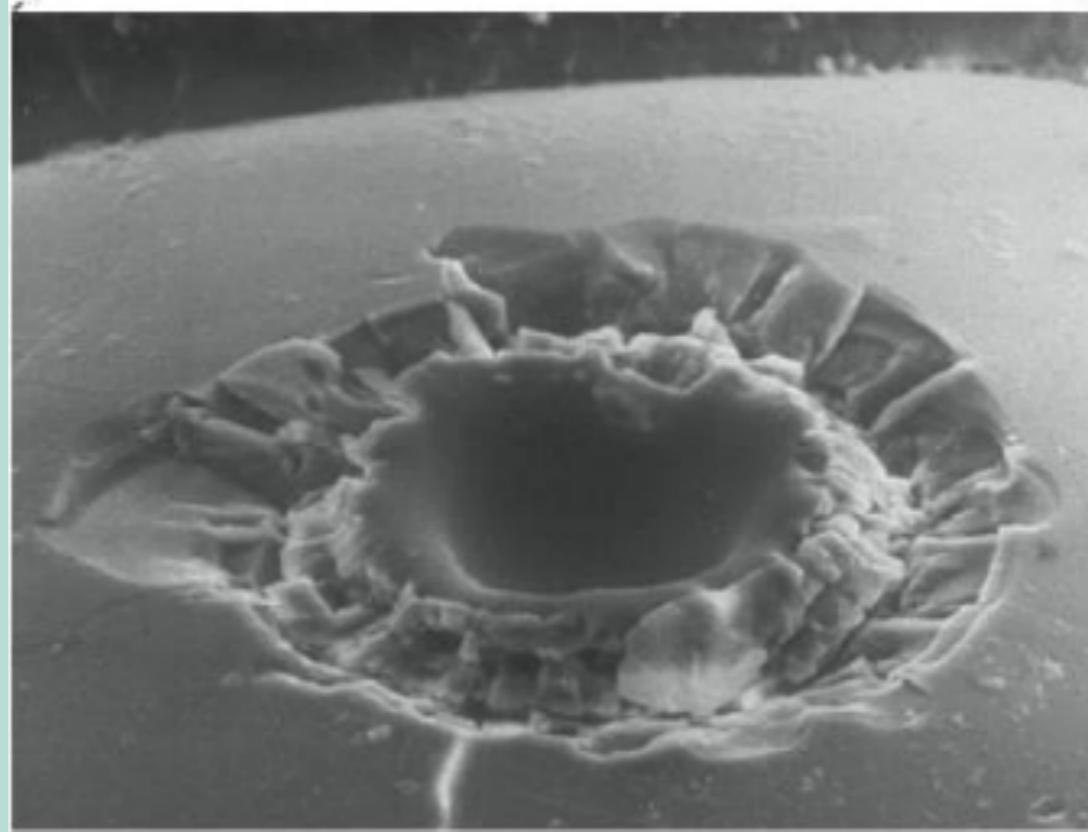
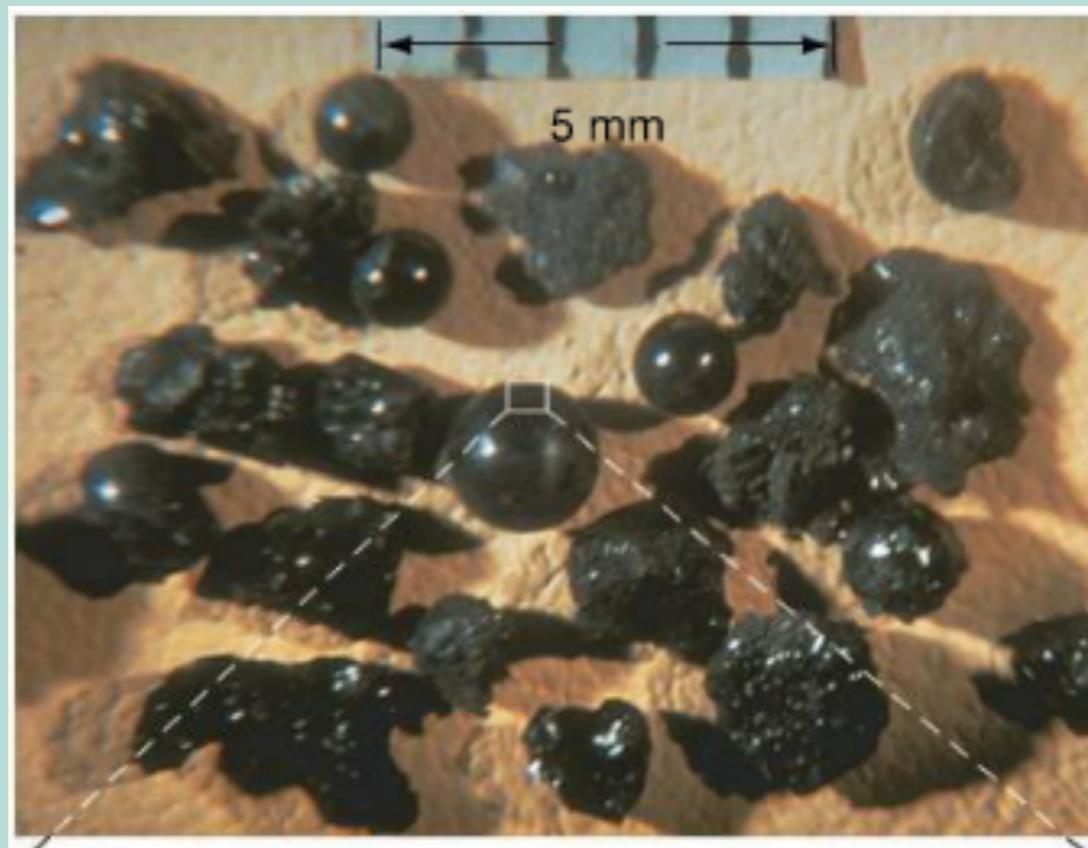


# Barringer Erosion

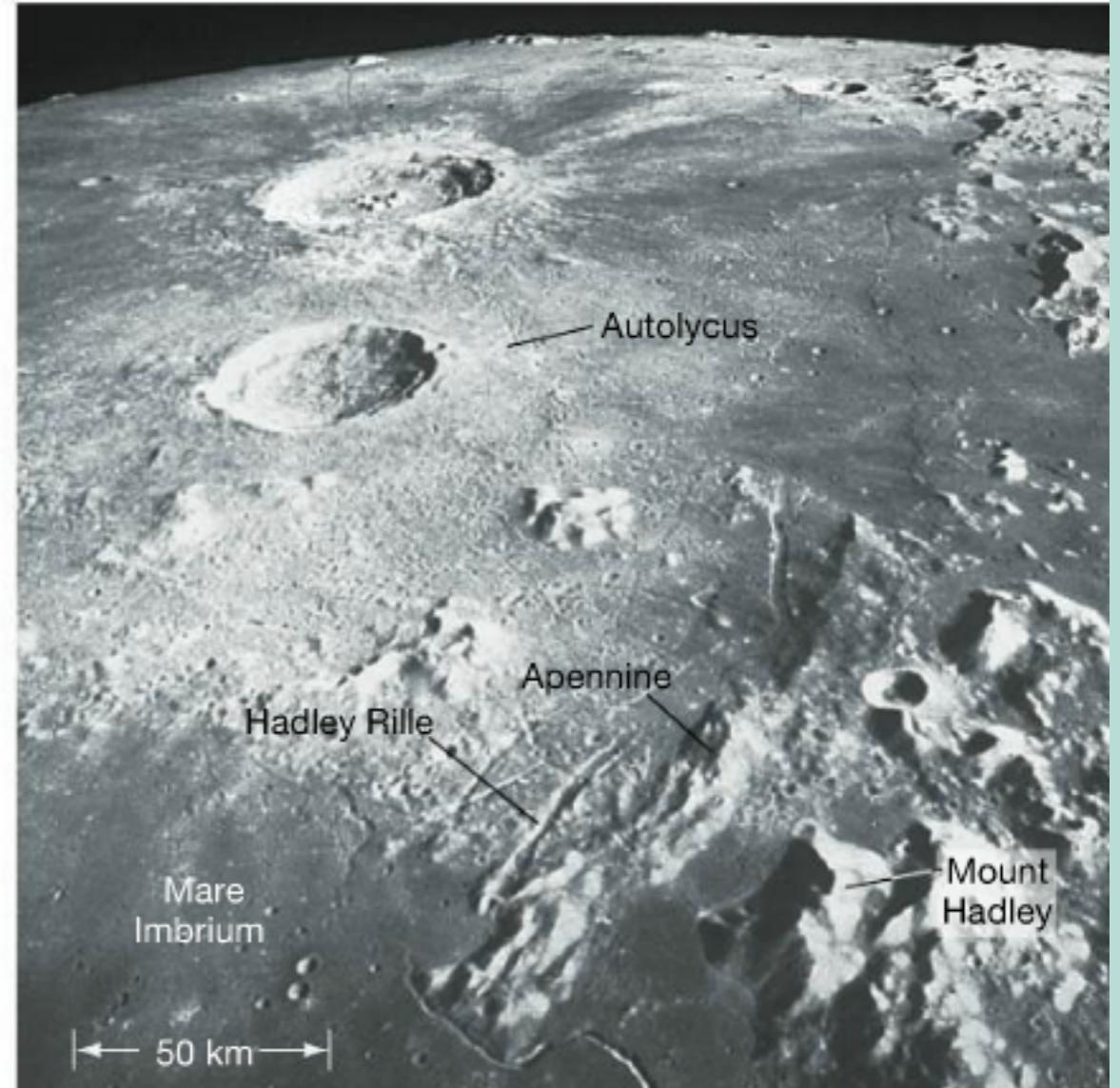
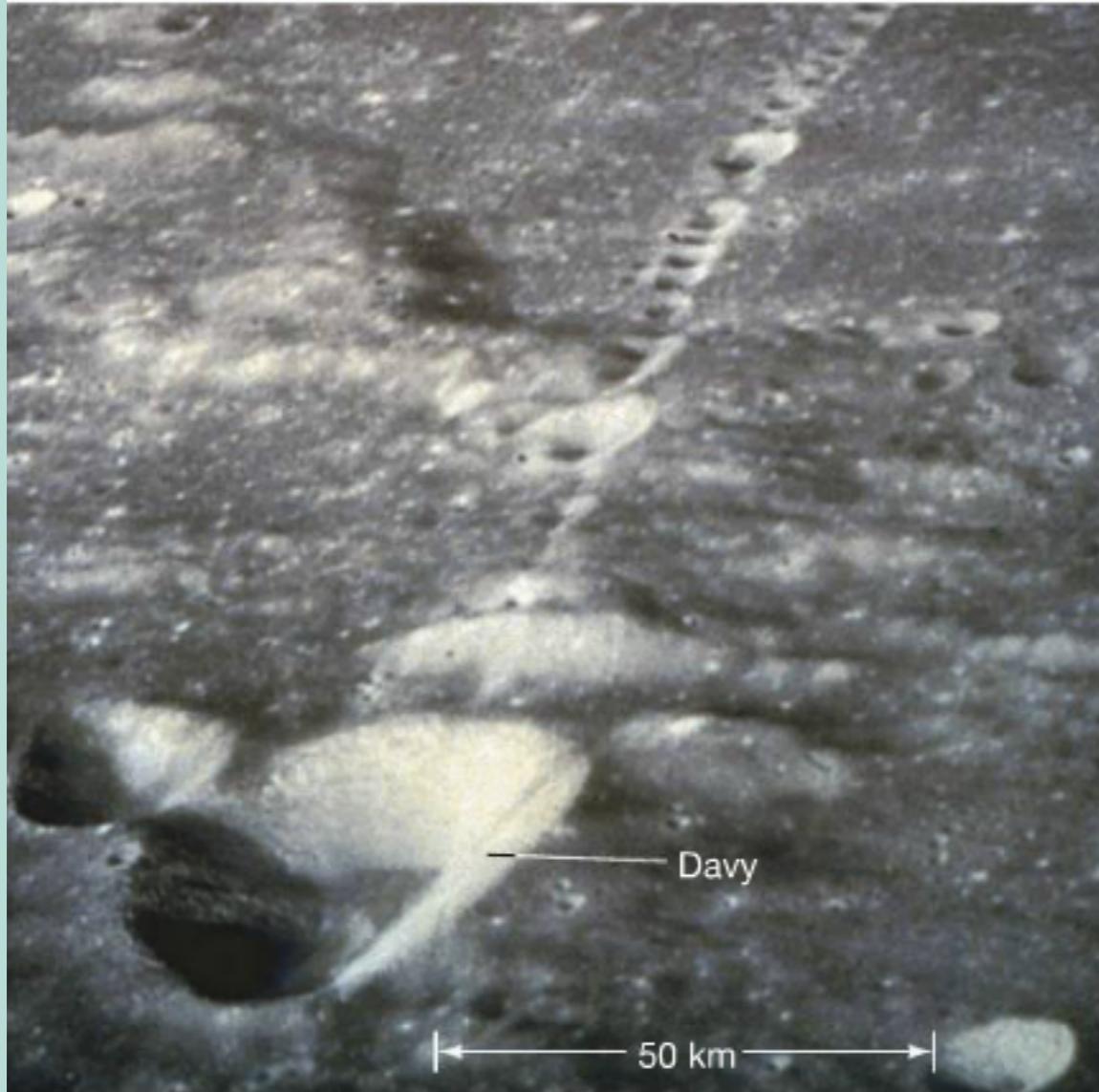




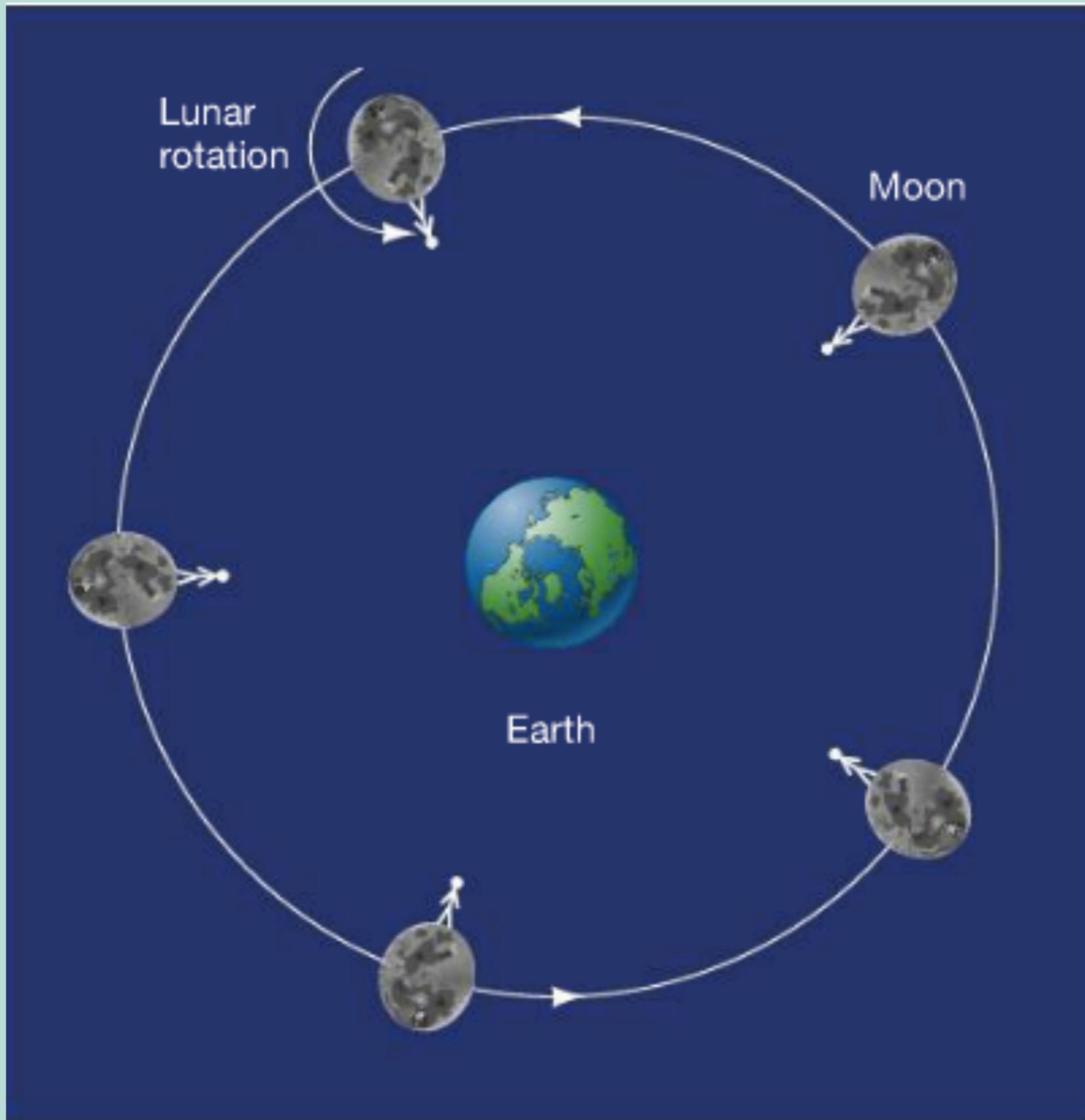
# Mini-meteors



# Chain Volcanic Activity



# Tidal Lock

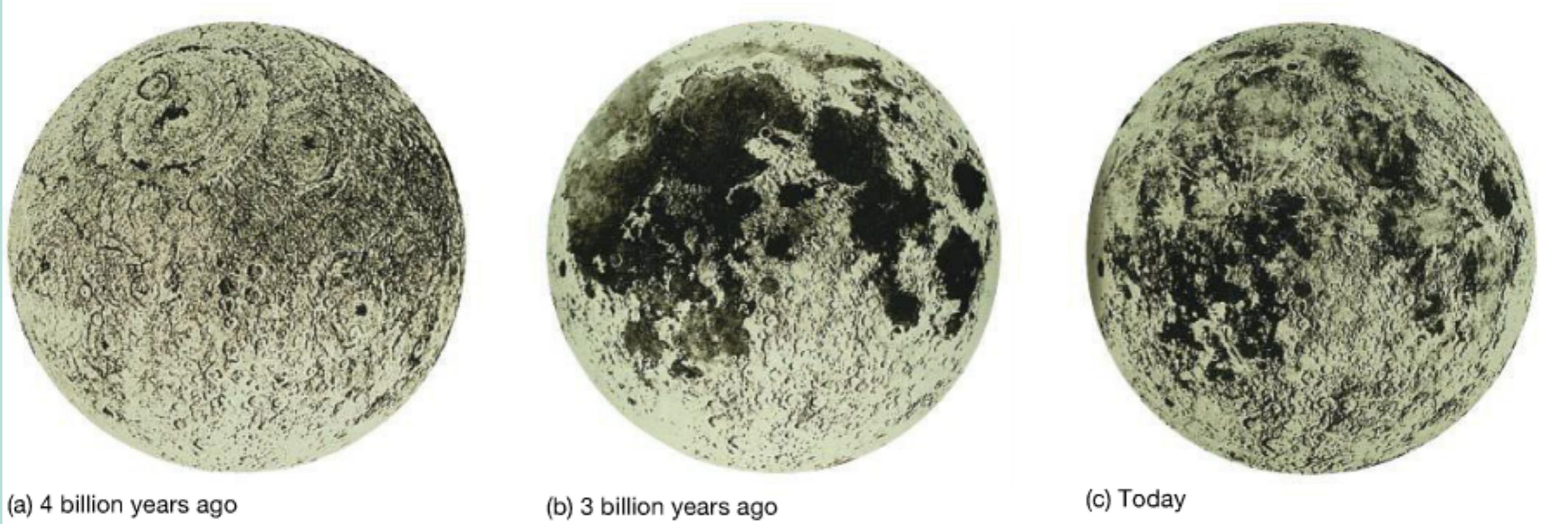




# Dark Side of the Moon



# Lunar Evolution

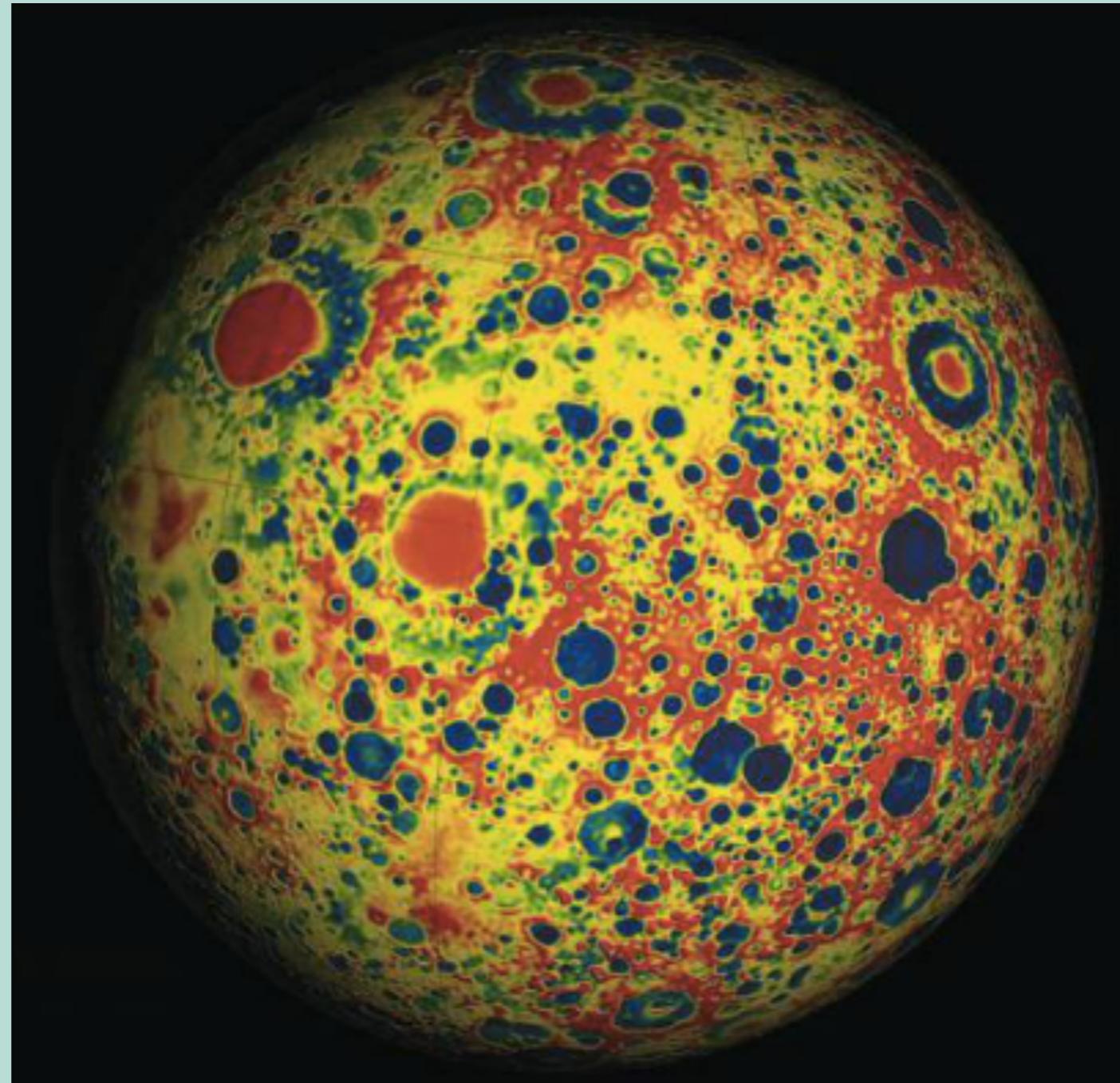


(a) 4 billion years ago

(b) 3 billion years ago

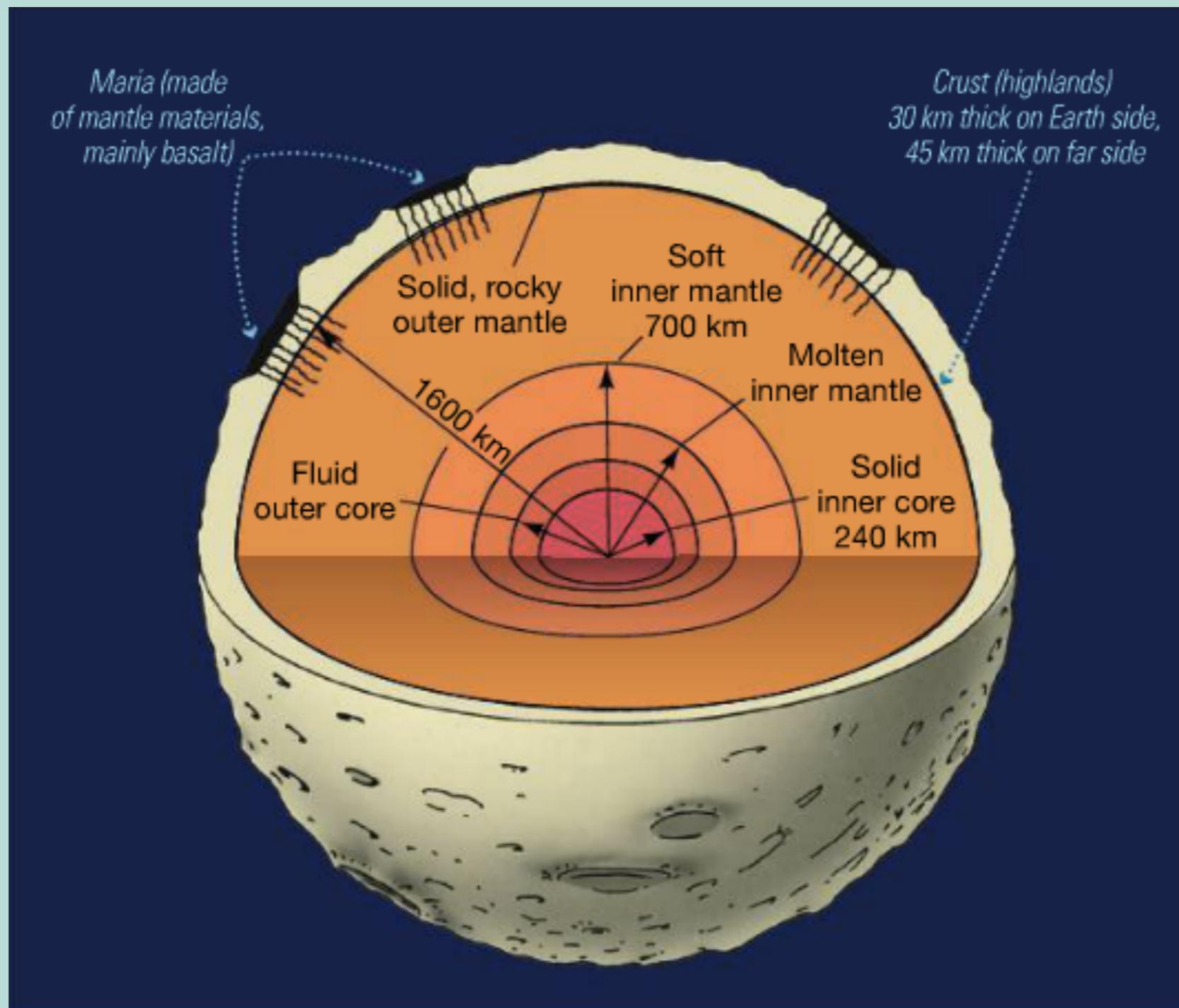
(c) Today

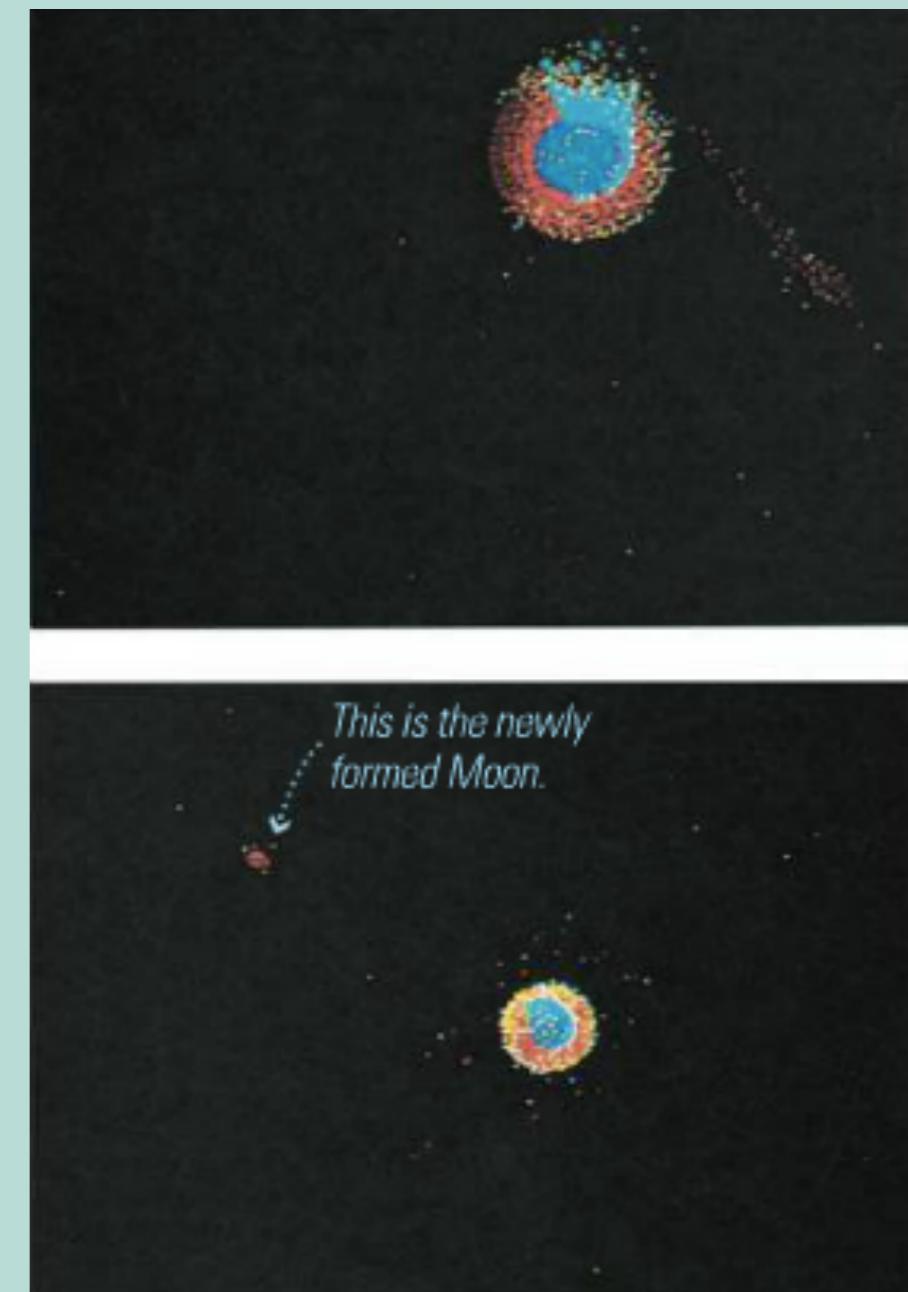
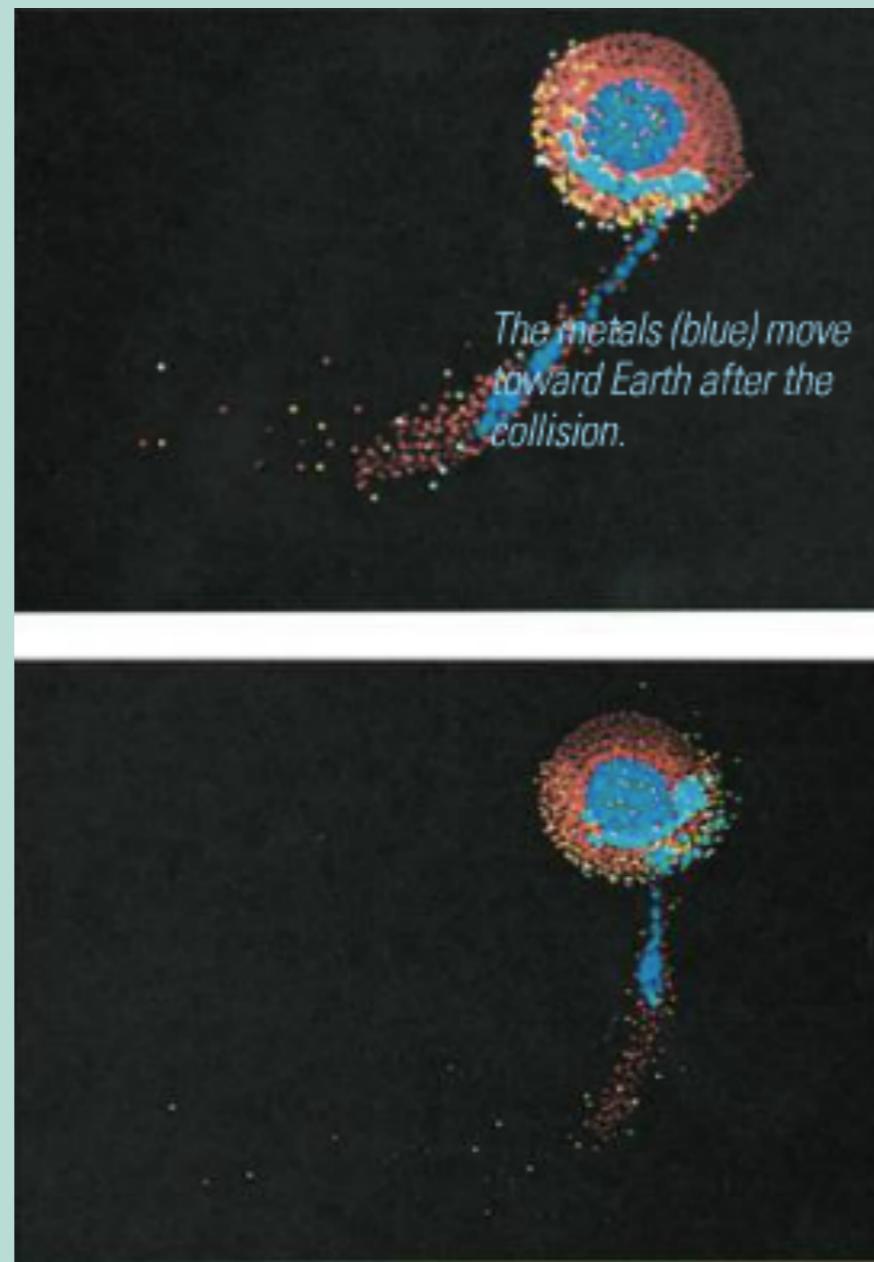
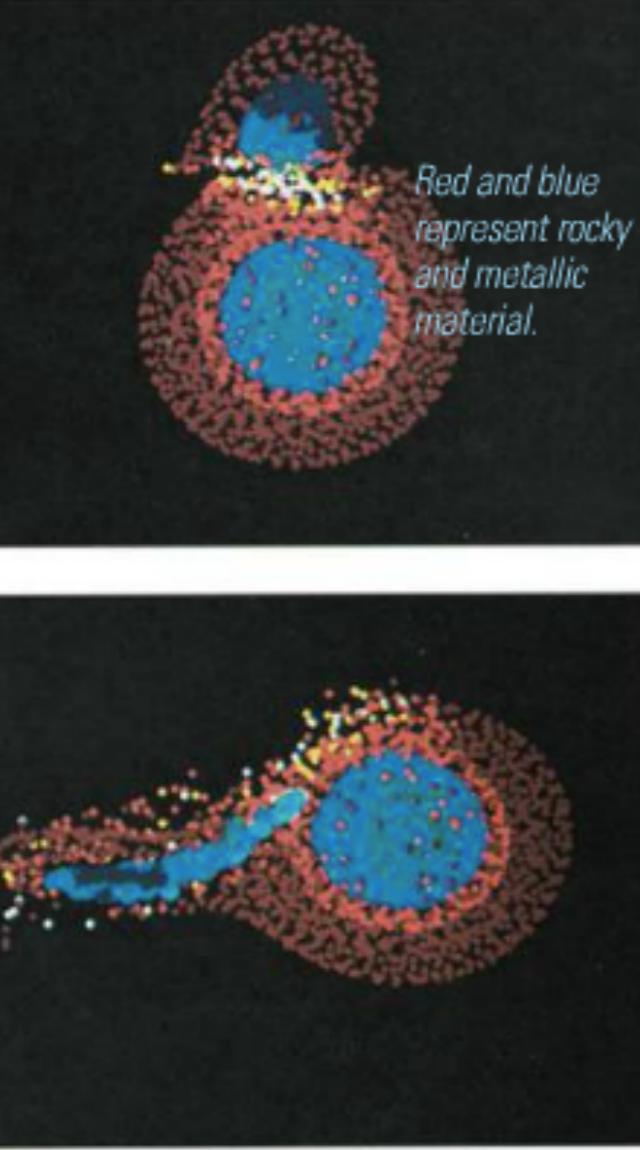
# GRAIL



(Gravity Recovery and Interior Laboratory)

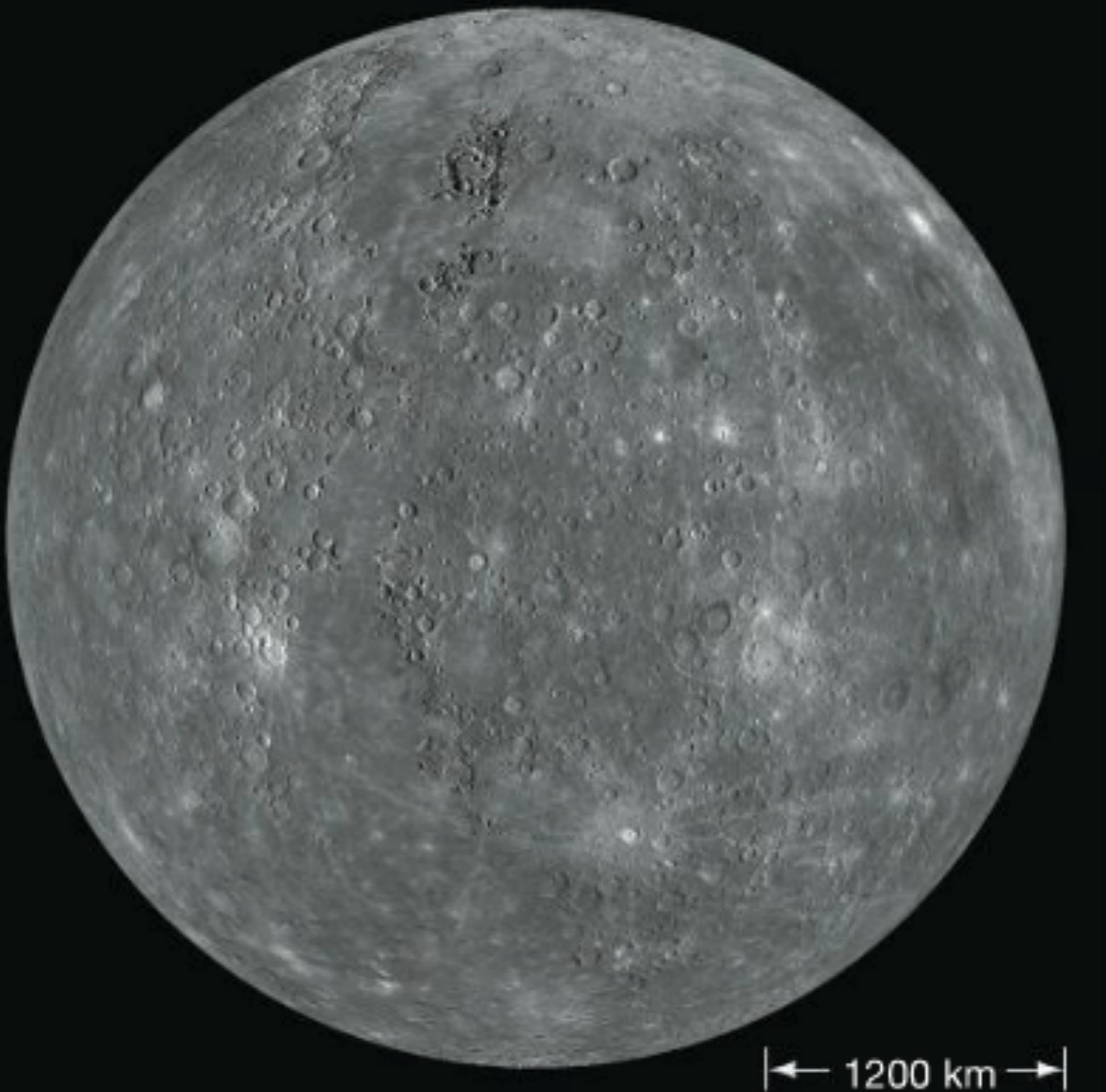
# Chomp





# Moon Origins Coformation? Capture? Fission?

## Impact Theory



Mercury

$m \sim 3.3 \times 10^{23}$   
 $\sim 1/18 M_e$

$r \sim 2.4 \times 10^6$   
 $\sim 8 \text{ ms}$   
 $\sim .38 M_e$

$d_{\text{sun}} \sim$   
.3 AU  
 $\sim 2.5 \text{ min}$

$e = .2$   
 $\sim .08 e_{\text{earth}}$

| ← 1200 km → |

# Surface Temperature

Day: 700 K

Night: 100 K

# MESSENGER: 10 Years in Space

BY THE NUMBERS\*

**8 BILLION**  
miles traveled

**29** TRIPS  
around  
the Sun

**255,858**  
IMAGES  
returned to Earth

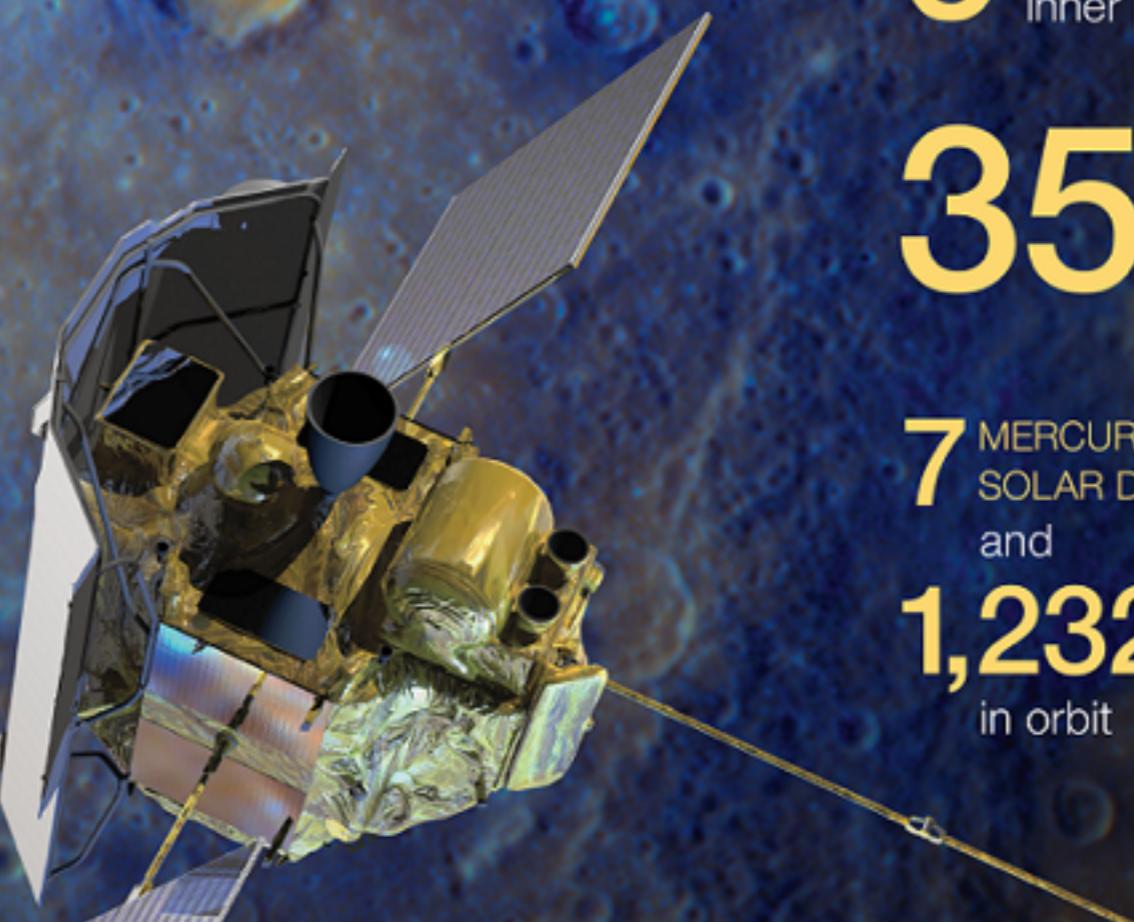
**91,730 MPH**  
average speed  
(relative to the Sun)

**6** FLYBYS  
of the  
inner planets

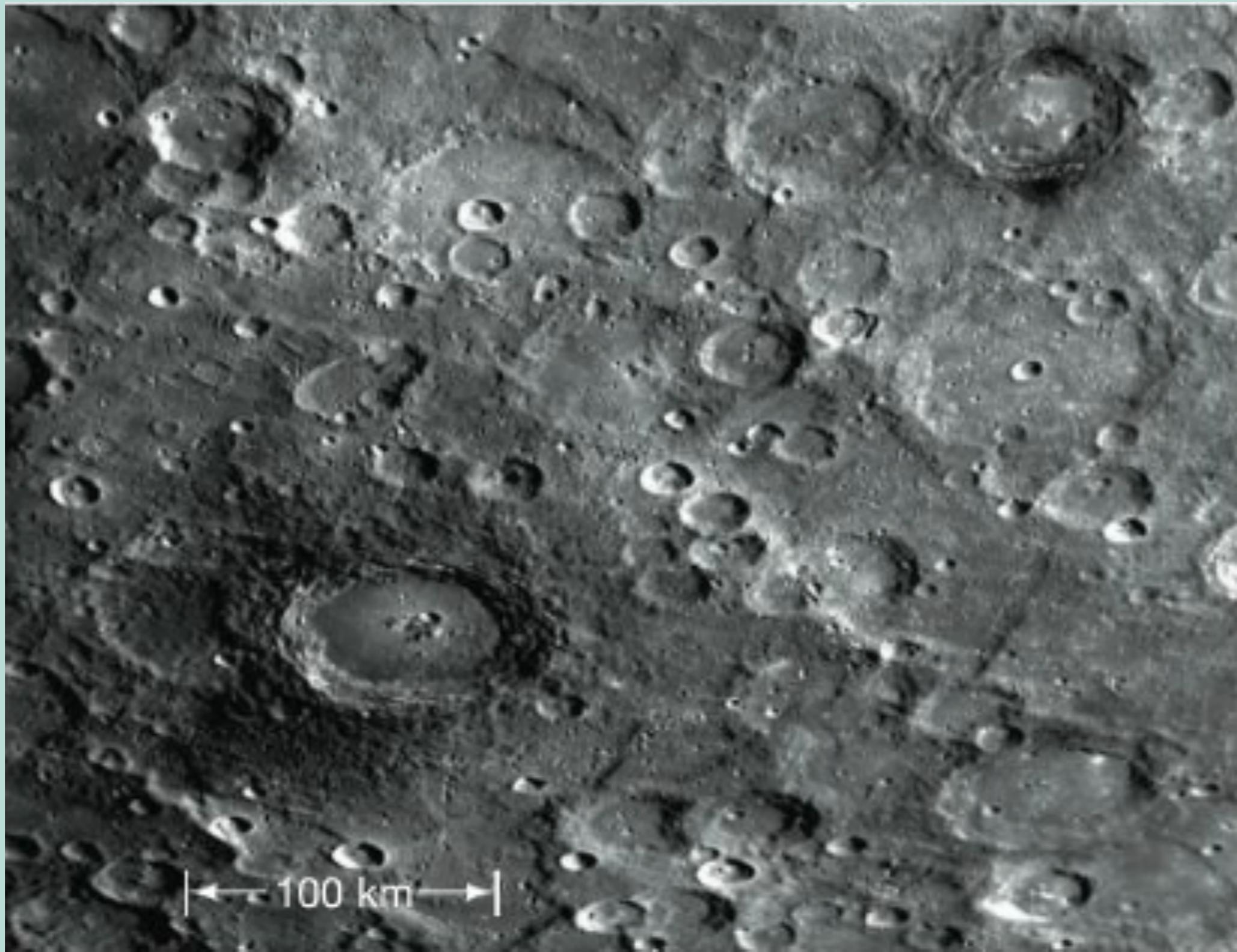
**35** MILLION  
SHOTS  
by the Mercury  
Laser Altimeter

**7** MERCURY  
SOLAR DAYS  
and

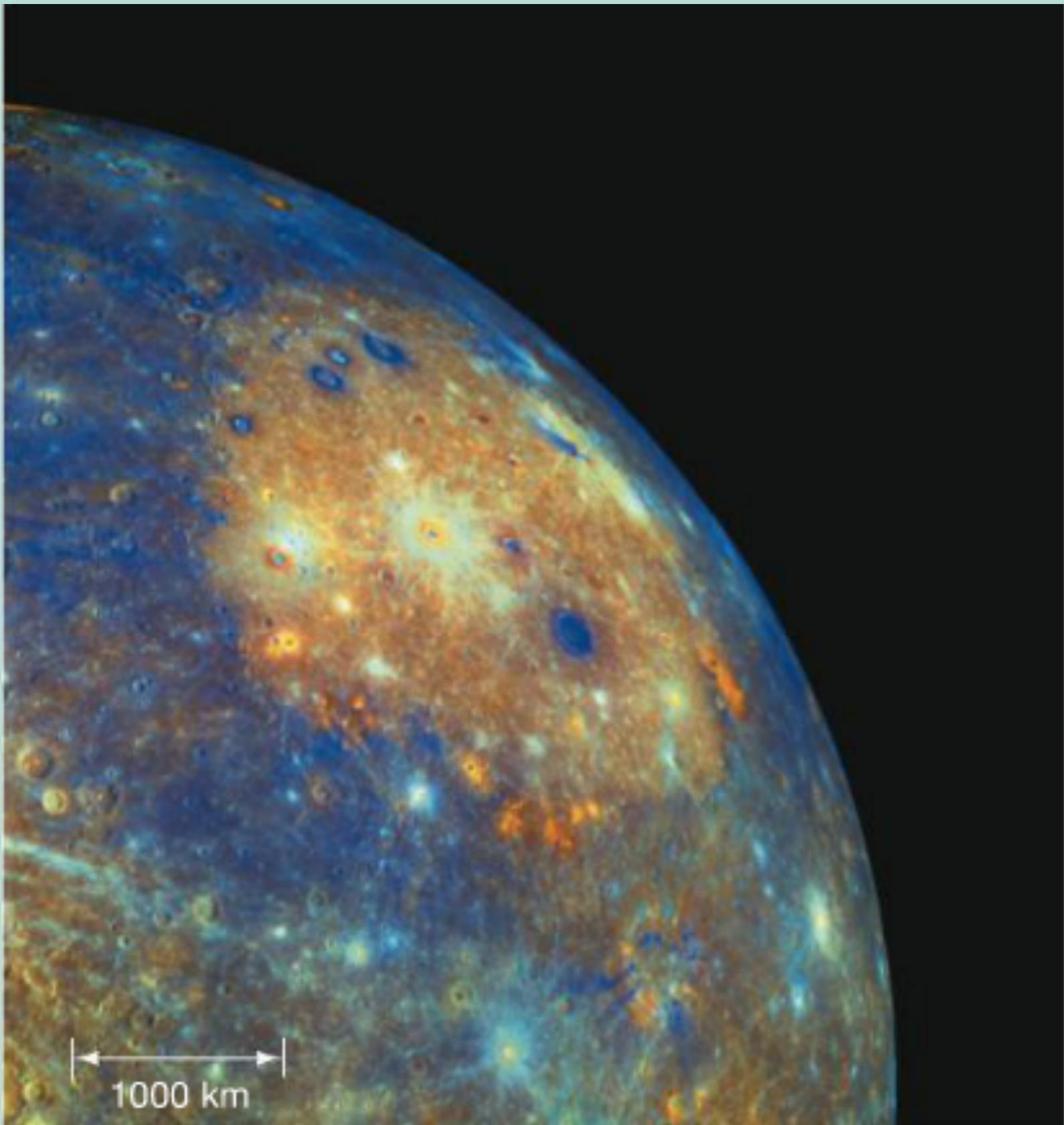
**1,232** EARTH  
DAYS  
in orbit



# Mercury Up Close

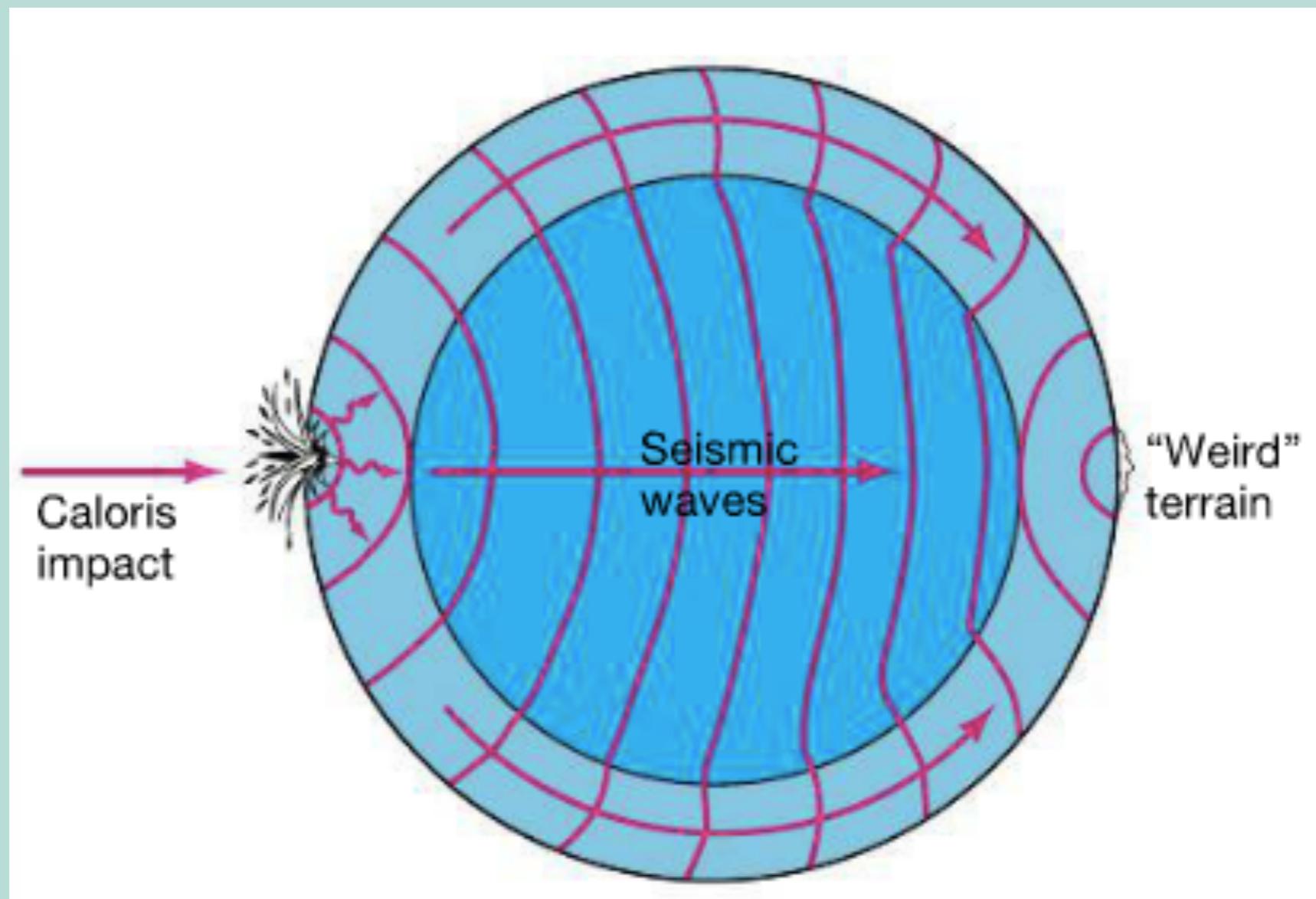


# Caloris Basin

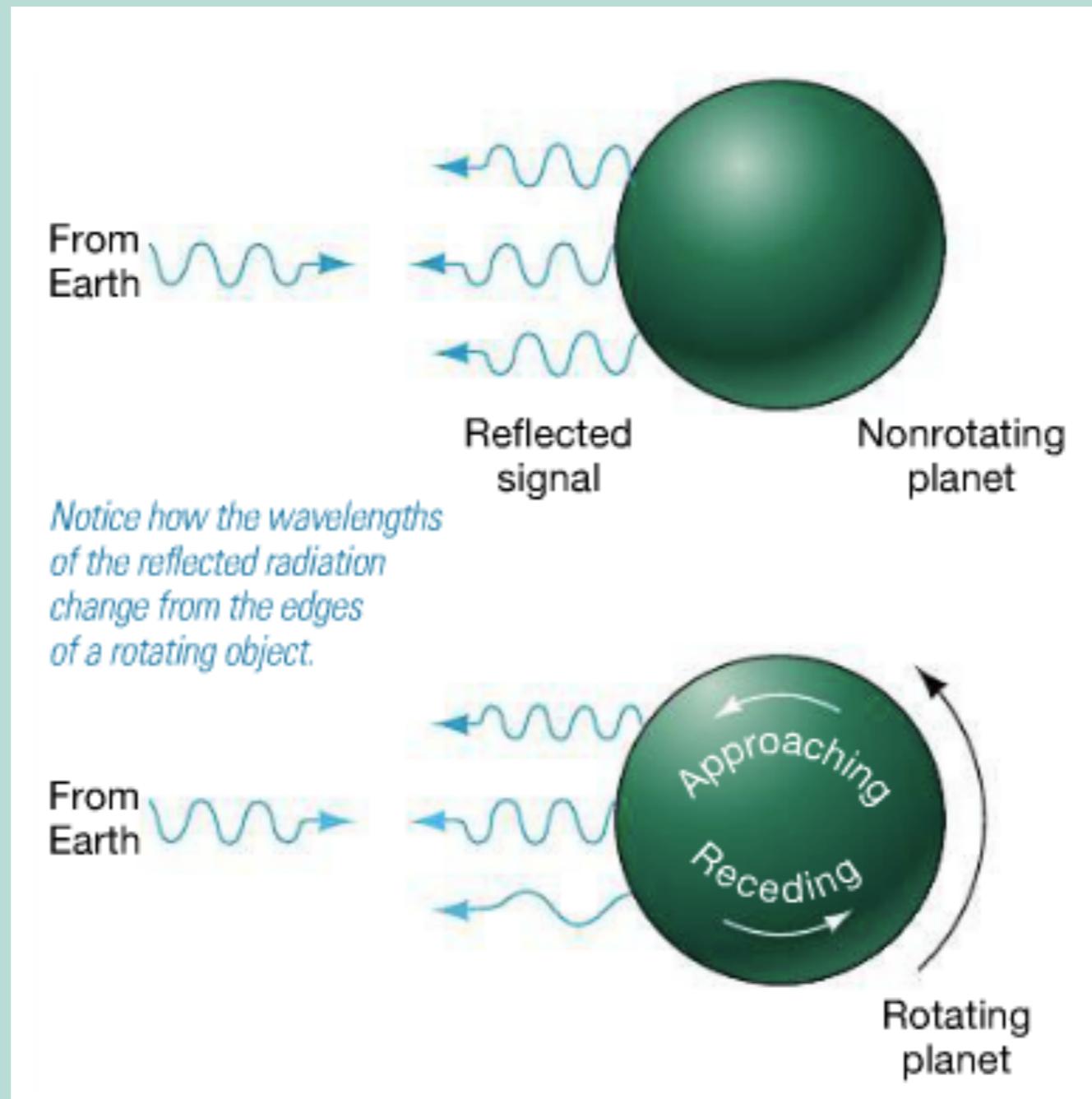


1500 km across

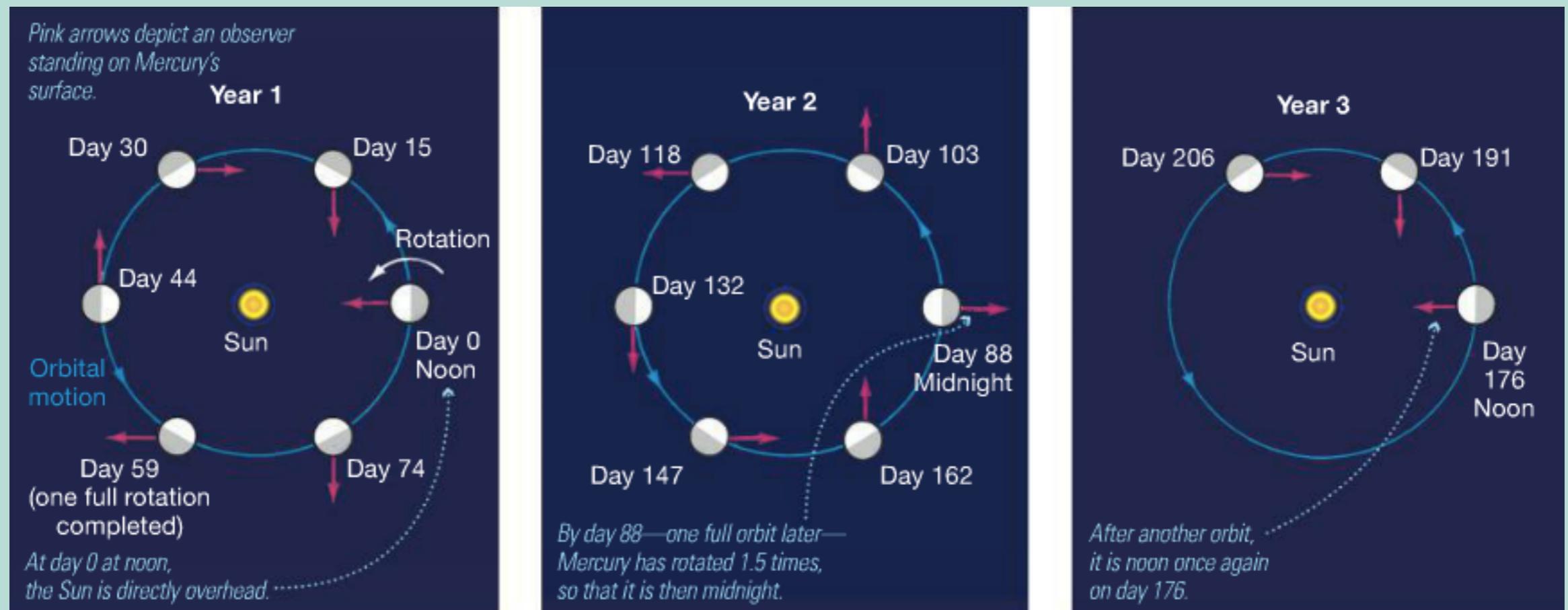
100 km meteor



# Mercury is rotating!

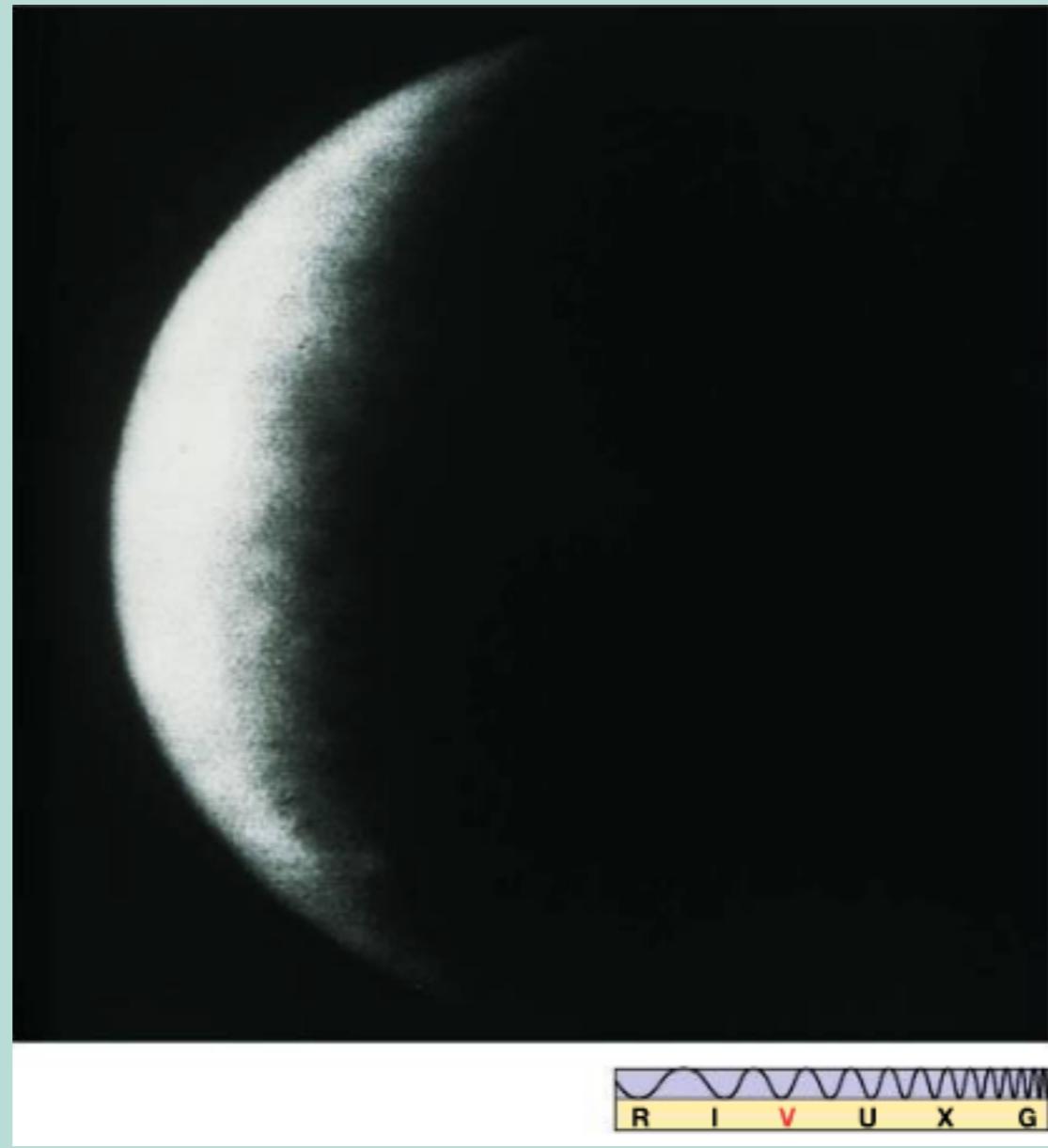


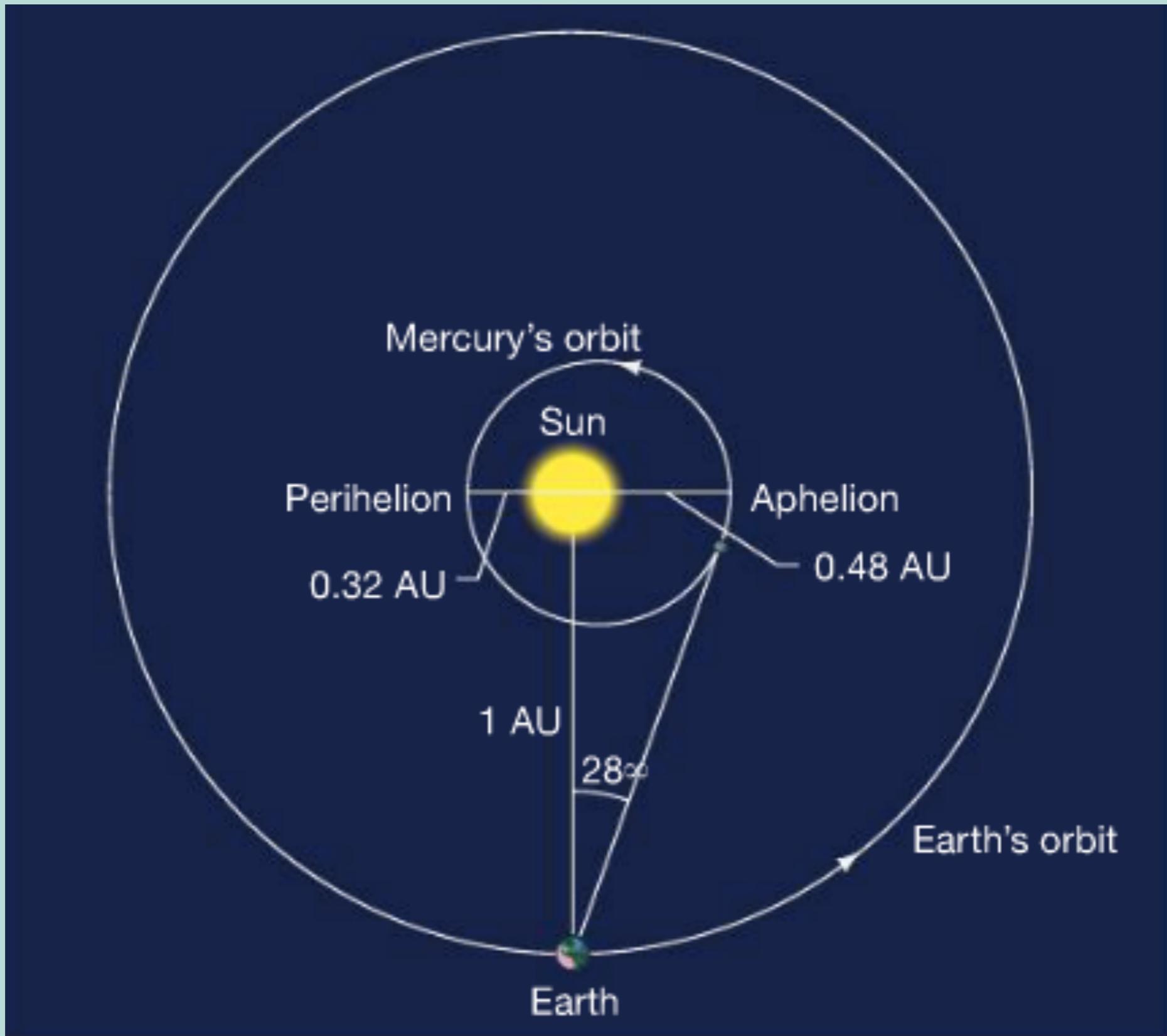
# 3:2 resonance



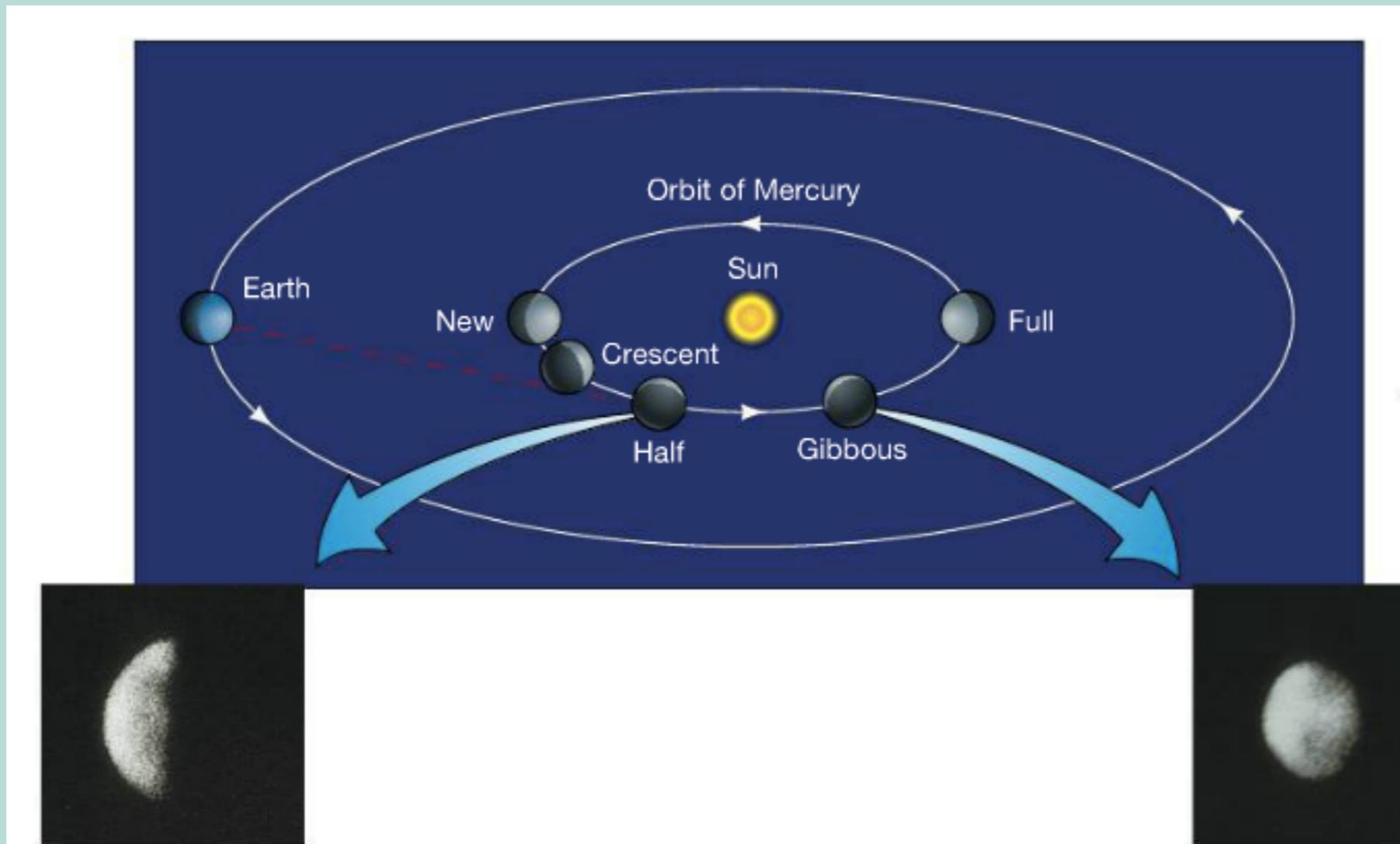
1 “day” is 2 “years” long!

# Mercury from Earth

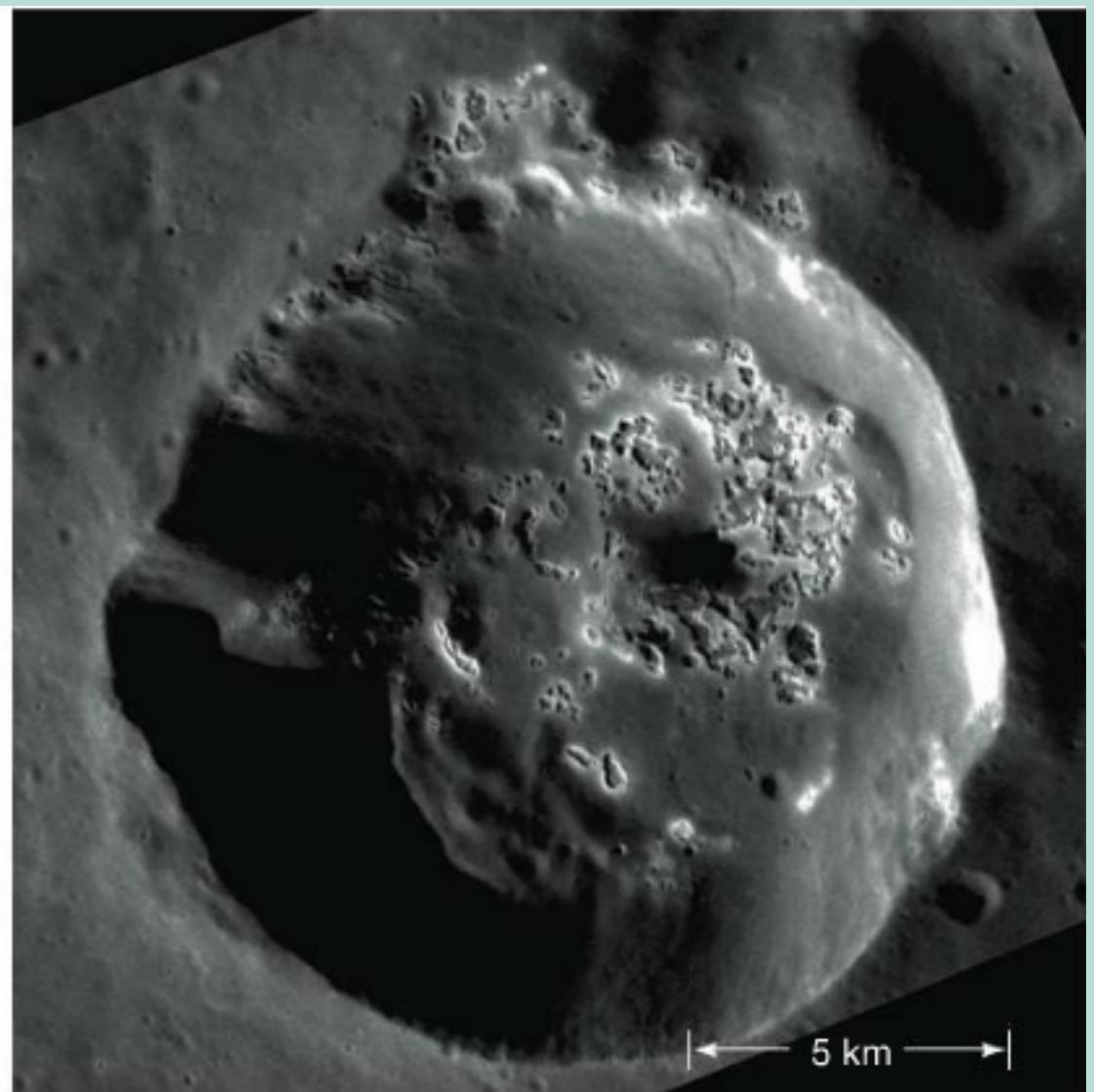




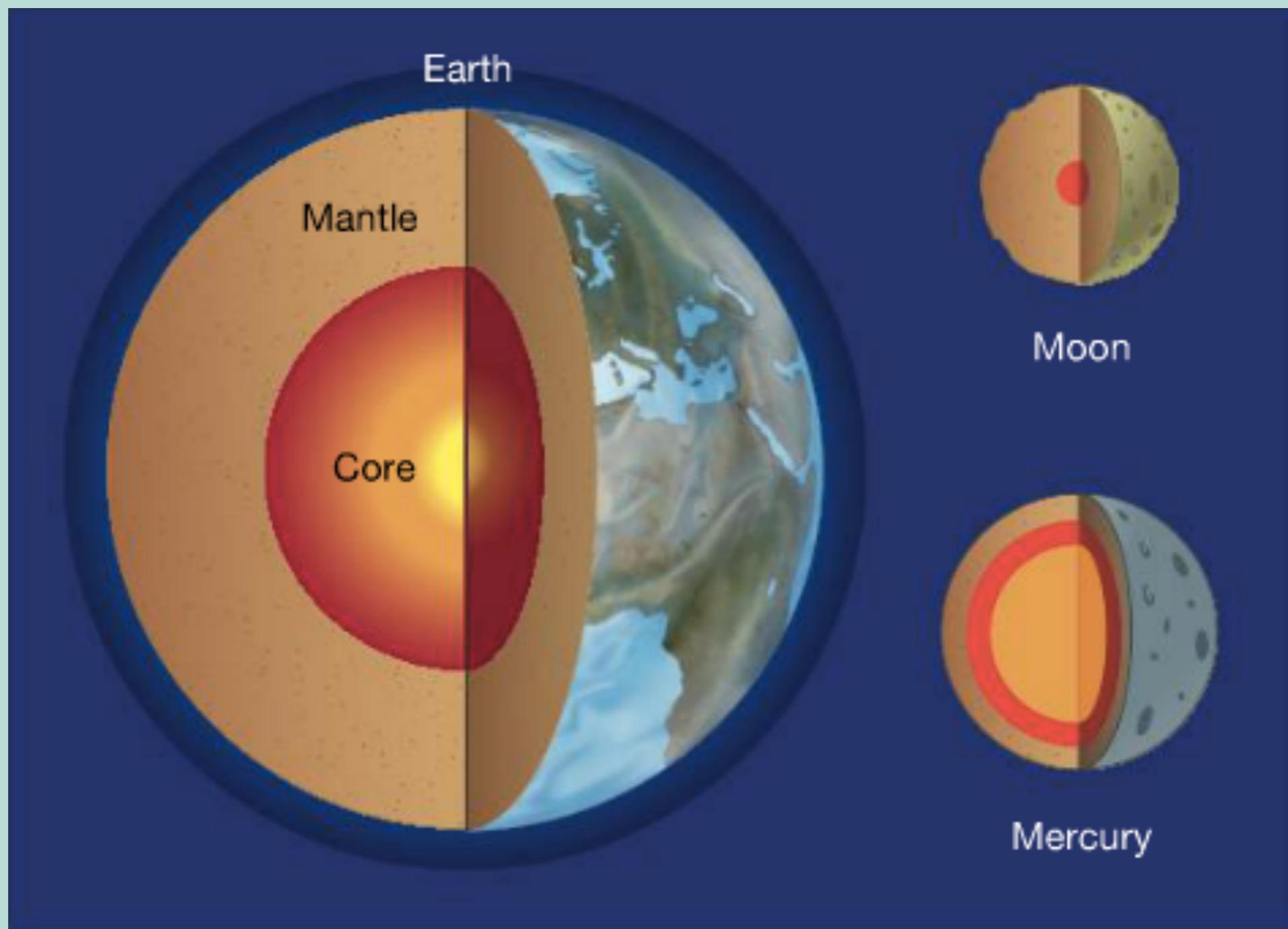
# Half Mercury



# Hollows and Scapes



# Interior Comparison



Mercury has an active magnetic field! (unlike the moon)