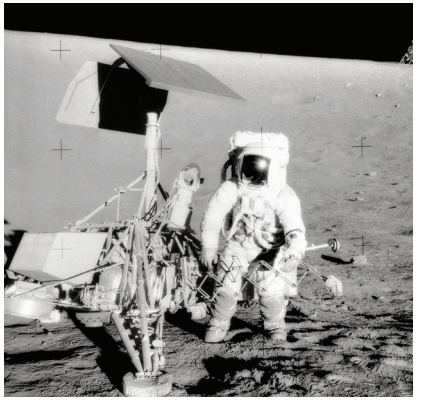
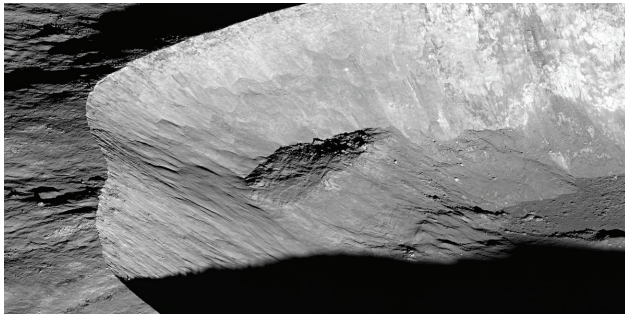
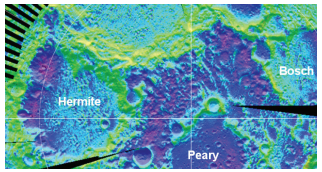
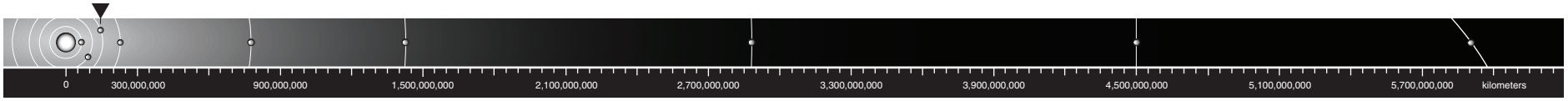





Bosch
Hermite
Peary


0
300,000,000
900,000,000
1,500,000,000
2,100,000,000
2,700,000,000
3,300,000,000
3,900,000,000
4,500,000,000
5,100,000,000
5,700,000,000
kilometers

Earth's Moon

The regular daily and monthly rhythms of Earth's only natural satellite, the Moon, have guided timekeepers for thousands of years. Its influence on Earth's cycles, notably tides, has been charted by many cultures in many ages. The Moon moderates Earth's wobble on its axis, leading to a relatively stable climate over billions of years. From Earth, we always see the same face of the Moon because the Moon is spinning on its axis at the same speed that it is going around Earth (that is, it is in synchronous rotation with Earth).

The light areas of the Moon are known as the highlands. The dark features, called maria (Latin for seas), are impact basins that were filled with lava between 4.2 and 1.2 billion years ago. These light and dark areas represent rocks of different composition and ages, which provide evidence for how the early crust may have crystallized from a lunar magma ocean. The craters themselves, which have been preserved for billions of years, provide an impact history for the Moon and other bodies in the inner solar system.

The leading theory of the Moon's origin is that a Mars-sized body collided with Earth approximately 4.5 billion years ago, and the resulting debris from both Earth and the impactor accumulated to form our natural satellite. The newly formed Moon was in a molten state. Within about 100 million years, most of the global "magma ocean" had crystallized, with less-dense rocks floating upward and eventually forming the lunar crust. The early Moon may have developed an internal dynamo, the mechanism for global magnetic fields for terrestrial planets.

Since the ancient time of volcanism, the arid, lifeless Moon has remained nearly unchanged. With too sparse an atmosphere to impede impacts, a steady rain of asteroids, meteoroids, and comets strikes the surface. Over billions of years, the surface has been ground up into fragments ranging from huge boulders to powder. Nearly the entire Moon is covered by a rubble pile of charcoal-gray, powdery dust and rocky debris called the lunar regolith. Beneath is a region of fractured bedrock referred to as the megaregolith.

The Moon was first visited by the U.S.S.R.'s Luna 1 and 2 in 1959, and a number of U.S. and U.S.S.R. robotic spacecraft followed. The U.S. sent three classes of robotic missions to prepare the way for human exploration: the Rangers (1961–1965) were impact probes, the Lunar Orbiters (1966–1967) mapped the surface to find landing sites, and the Surveyors (1966–1968) were soft landers. The first human landing on the Moon was on July 20, 1969. During the Apollo missions of 1969–1972, 12 American astronauts walked on the Moon and used a Lunar Roving Vehicle to travel on the surface and extend their studies of soil mechanics, meteoroids, lunar ranging, magnetic fields, and solar wind. The Apollo astronauts brought back 382 kilograms (842 pounds) of rock and soil to Earth for study.

After a long hiatus, lunar exploration resumed in the 1990s with the U.S. robotic missions Clementine and Lunar Prospector. Results from both missions suggested that water ice might be present at the lunar poles, but a controlled impact of the Prospector spacecraft produced no observable water.

The European Space Agency was first in the new millennium with SMART-1 in 2003, followed by Kaguya (Japan), Chang'e 1 (China), and Chandrayaan-1 (India) in 2007–2008. The U.S. began a new series of robotic lunar missions with the joint launch of the Lunar Reconnaissance Orbiter (LRO) and Lunar Crater Observation and Sensing Satellite (LCROSS) in 2009. In 2011, a pair of repurposed spacecraft began the ARTEMIS (Acceleration, Reconnection, Turbulence, and Electrodynamics of the Moon's Interaction with the Sun) mission. In 2012, the Gravity Recovery and Interior Laboratory (GRAIL) twin spacecraft studied the Moon's gravity field and produced the highest-resolution gravity field map of any celestial body. The Lunar Atmosphere and Dust Environment Explorer (LADEE) is scheduled to launch in 2013.

FAST FACTS

Mean Distance from Earth	384,400 km (238,855 mi)
Orbit Period	27.32 Earth days
Orbit Eccentricity (Circular Orbit = 0)	0.05490
Orbit Inclination to Ecliptic	5.145 deg
Inclination of Equator to Orbit	6.68 deg
Rotation Period	27.32 Earth days
Equatorial Radius	1,737.4 km (1,079.6 mi)
Mass	0.0123 of Earth's
Density	3.341 g/cm^3 (0.61 of Earth's)
Gravity	0.166 of Earth's
Temperature Range	–248 to 123 deg C (–414 to 253 deg F)

SIGNIFICANT DATES

1610 — Galileo Galilei is the first to use a telescope to make scientific observations of the Moon.
1959–1976 — The U.S.S.R.'s Luna program of 17 robotic missions achieves many "firsts" and three sample returns.
1961–1968 — The U.S. Ranger, Lunar Orbiter, and Surveyor robotic missions pave the way for Apollo human lunar landings.
1969 — Astronaut Neil Armstrong is the first human to walk on the Moon's surface.
1994–1999 — Clementine and Lunar Prospector data suggest that water ice may exist at the lunar poles.
2003 — The European Space Agency's SMART-1 lunar orbiter inventories key chemical elements.
2007–2008 — Japan's second lunar spacecraft, Kaguya, and China's first lunar spacecraft, Chang'e 1, both begin one-year missions orbiting the Moon; India's Chandrayaan-1 soon follows in lunar orbit.
2008 — The NASA Lunar Science Institute is formed to help lead NASA's research activities related to lunar exploration goals.
2009 — NASA's LRO and LCROSS launch together, beginning the U.S. return to lunar exploration. In October, LCROSS was directed to impact a permanently shadowed region near the lunar south pole, resulting in the discovery of water ice.
2011 — Twin GRAIL spacecraft launch to map the interior of the Moon from crust to core, and NASA begins the ARTEMIS mission to study the Moon's interior and surface composition.

ABOUT THE IMAGES

1 About 1,300 images from LRO's wide-angle camera were used to compose this spectacular view of the lunar nearside.

2 Apollo 12 astronaut Charles Conrad approaches Surveyor 3, a robotic spacecraft that soft-landed on the Moon in 1967.

3 This bootprint marks one of the first steps human beings took on the Moon in July 1969.

4 This LRO false-color image shows elevations on the farside of the Moon: highest elevations are in red and lowest in blue.

5 This LRO image reveals that one edge of Giordano Bruno crater has collapsed, creating a slump terrace.

6 The Apollo 8 crew took this picture of Earth rising over the surface of the Moon in 1968.

7 Diviner, LRO's temperature instrument, measured the floor of the permanently shaded crater Hermite and recorded the coldest temperature measured anywhere in the solar system (middle right, in purple): –240 deg C (33 kelvins or –400 deg F).

FOR MORE INFORMATION

solarsystem.nasa.gov/moon

LG-2013-07-568-HQ — JPL 400-1489G 07/13