National Aeronautics and
Space Administration

Moon

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The regular daily and monthly rhythms of Earth's only natural satellite, the **MOON**, have guided timekeepers since ancient times. Its influence on Earth's cycles, notably tides, has also been charted by many cultures in many ages. More than 70 spacecraft have been sent to the Moon; 12 astronauts have walked upon its surface and brought back 382 kg of lunar rock and soil to Earth.

The presence of the Moon stabilizes Earth's wobble. This has led to a much more stable climate over billions of years, which may have affected the course of the development and growth of life on Earth.

How did the Moon come to be? The leading theory is that a Mars-sized body once hit Earth and the resulting debris (from both Earth and the impacting body) accumulated to form the Moon. Scientists believe that the Moon was formed approximately 4.5 billion years ago (the age of the oldest collected lunar rocks). When the Moon formed, its outer layers melted under very high temperatures, forming the lunar crust, probably from a global "magma ocean."

From Earth, we see the same face of the Moon all the time because the Moon rotates just once on its own axis in very nearly the same time that it travels once around Earth. This is known as "synchronous rotation." Patterns of dark and light features on the near side have given rise to the fanciful "Man in the Moon" description. The light areas are lunar highlands. The dark features, called *maria*, are impact basins that were filled with dark lava between 4 and 2.5 billion years ago.

After this time of volcanism, the Moon cooled down, and has since been nearly unchanged, except for a steady rain of "hits" by meteorites and comets. The Moon's surface is charcoal gray and sandy, with much fine soil. This powdery blanket is called the lunar regolith, a term for mechanically produced debris layers on planetary surfaces. The regolith is thin, ranging from about 2 meters on the youngest maria to perhaps 20 meters on the oldest surfaces in the highlands.

Unlike Earth, the Moon does not have moving crustal plates or active volcanoes. However, seismometers planted by the Apollo astronauts in the 1970s have recorded small quakes at depths of several hundred kilometers. The quakes are probably triggered by tides resulting from Earth's gravitational pull. Small eruptions of gas from some craters, such as Aristarchus, have also been reported. Local magnetic areas have been detected around craters, but the Moon does not have a magnetic field resembling Earth's.

A surprising discovery from the tracking of the *Lunar Orbiter* spacecraft in the 1960s revealed strong areas of high gravitational acceleration located over the circular maria. These mass concentrations (mascons) may be caused by layers of denser, basaltic lavas that fill the mare basins.

In 1998, the *Lunar Prospector* spacecraft team reported finding water ice at both poles. Comet impacts deposited water on the Moon. Some of it migrated to very dark, very cold areas at the poles.

Much remains to be learned about our Moon. Researchers continue to study the samples and data returned by Apollo and other missions, as well as lunar meteorites.

Fast Facts

Mean Distance from Earth	384,400 km
Orbital Period	27.32 days
Orbital Eccentricity	0.05
Orbital Inclination to Ecliptic	18.3°–28.6°
Inclination of Equator to Orbit	6.67°
Rotational Period	27 d 7 h 41 m (synchronous)
Diameter	3,475 km
Mass	0.0123 of Earth's
Density	3.34 g/cm^3
Gravity	0.17 of Earth's
Surface Rocks	basaltic and anorthositic
Atmosphere	None
Mean Temperature at Surface	107 °C (day), -153 °C (night)

Significant Dates

1610	Italian astronomer Galileo Galilei made the first telescopic observations of the Moon.
1959–60	*Luna 1–3* (U.S.S.R) were the first to fly by, impact, and photograph the far side of the Moon.
1964	*Ranger 7* data indicated that the lunar surface would be suitable for a piloted landing.
1966	Soviet *Luna 9* made the first soft landing on the Moon.
1966–67	*Lunar Orbiters* photographically mapped the Moon.
1968	*Apollo 8*, first piloted flight to the Moon, circled 10 times before returning to Earth.
1969	*Apollo 11*, first human landing on the Moon, returned rock and soil samples.
1970	*Luna 16* was the first of 3 Soviet missions to use a robotic rover to return lunar soil samples.
1972	*Apollo 17* was the last of 6 *Apollo* missions to land astronauts and return samples from the Moon.
1994	*Clementine* conducted multispectral mapping and measured altitudes on the Moon.
1998	*Lunar Prospector* made a geochemical map of the Moon and discovered ice at both poles.

About the Images

(Left) The familiar face of the Moon, taken by *Apollo 11* astronauts on their way home, shows the dark maria and lighter highlands.
(Right, top center) *Apollo 11* astronaut Edwin Aldrin stands facing the U.S. flag on the Moon.
(Right, top right) In 1969, *Apollo 12* astronaut Pete Conrad says hello to *Surveyor 3*, which landed in 1967.
(Right, center) *Apollo 17* scientist-astronaut Harrison Schmitt stands next to a huge, split boulder at the Taurus-Littrow landing site on the last human mission to the moon in 1972.
(Right, bottom) Close-up view of *Apollo 15* lunar sample number 15415 in the Non-sterile Nitrogen Processing Line in the Lunar Receiving Laboratory at the Manned Spacecraft Center. This sample is the white anorthositic rock (nicknamed the Genesis Rock) that is 4.5 billion years old—as old as Earth.

References
1) Exploring the Moon Teacher's Guide, NASA, 1997: *http://spacelink.nasa.gov/products/Exploring.the.Moon*
2) Apollo press release images: *http://images.jsc.nasa.gov*
3) *Lunar Prospector* mission: *http://lunar.arc.nasa.gov*
4) *Clementine* mission: *http://www.nrl.navy.mil/clementine*

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