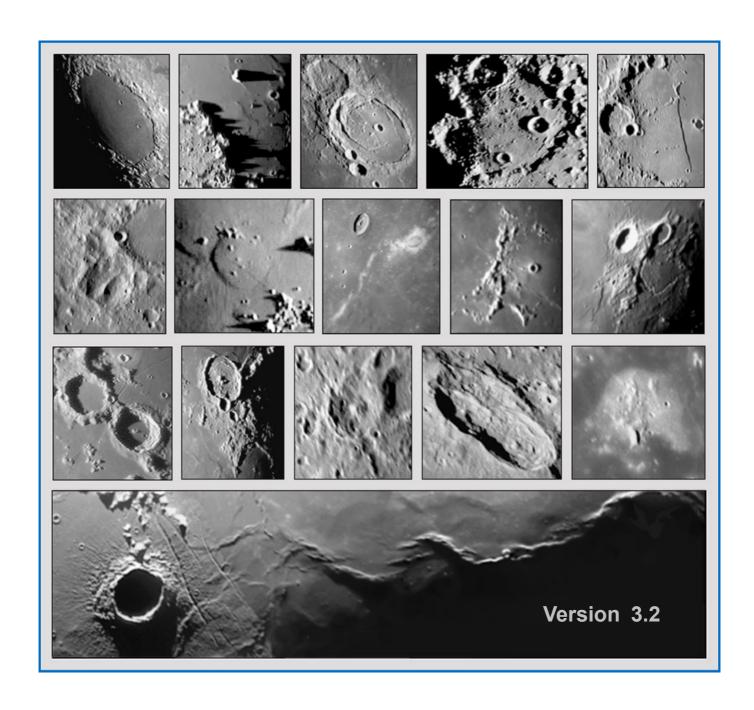
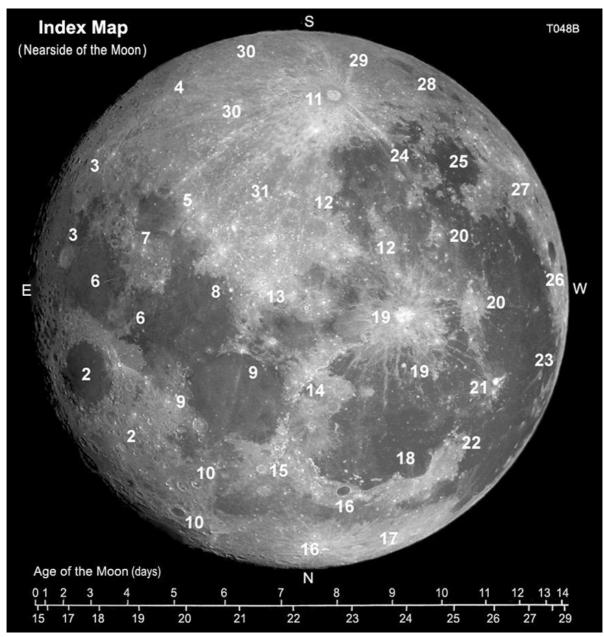
Photographic Moon Book

Alan Chu



(blank page)



The terminator position along the Moon's E-W diameter is marked approximately by the above scale.

Lunar Features by Map No.

- 1. Maria, Impact Basins and Evolution of the Moon
- 2. Mare Crisium, Proclus, Cleomedes, Messala
- 3. Langrenus, Vendelinus, Petavius, Furnerius
- 4. Janssen, Fabricius, Vallis Rheita, Mare Australe
- 5. Theophilus, Cyrillus, Catharina, Rupes Altai, Fracastorius
- 6. Messier, Censorinus, Taruntius, Cauchy
- 7. Capella, Isidorus, Torricelli, Bohnenberger, Gutenberg
- 8. Sabine, Ritter, Hypatia, Delambre, Arago, Lamont
- 9. Serpentine Ridge, Plinius, Posidonius, Menelaus, Manilius
- 10. Atlas, Hercules, Bürg, Endymion, Mare Humboldtianum
- 11. Tycho, Clavius, Maginus, Deslandres, Pitatus, Hesiodus
- 12. Ptolemaeus, Alphonsus, Rupes Recta, Hipparchus, Fra Mauro
- 13. Rima Ariadaeus, Rima Hyginus, Rimae Triesnecker, Agrippa
- 14. Montes Apenninus, Rima Hadley, Archimedes, Aristillus
- 15. Montes Alpes, Vallis Alpes, Cassini, Aristoteles, Eudoxus
- 16. Plato, Mons Pico, W. Bond, Meton, North Pole Region 17. J. Herschel, Anaximander, Philolaus, Pythagoras, Babbage
- 18. Sinus Iridum, Montes Recti, Bianchini, Sharp, Maupertuis
- 19. Copernicus, Eratosthenes, Stadius, Euler, Lambert, Hortensius

- 20. Kepler, Marius, Flamsteed, Reiner Gamma
- 21. Aristarchus, Herodotus, Vallis Schröteri, Prinz
- 22. Mons Gruithuisen Gamma, Mons Rümker
- 23. Eddington, Struve, Russell, Seleucus, Olbers
- 24. Capuanus, Ramsden, Marth, Bullialdus, Kies
- 25. Gassendi, Rimae Hippalus, Vitello, Mersenius
- 26. Grimaldi, Hevelius, Cavalerius, Riccioli, Hedin
- 27. Darwin, Byrgius, Rimae Sirsalis, Crüger, Billy
- 28. Schiller, Schickard, Phocylides, Wargentin
- 29. Bailly, Longomontanus, Wilhelm, Mee, Hainzel
- 30. Maurolycus, Faraday, Stöfler, Boussingault
- 31. Catena Abulfeda, Catena Davy, Crater Arrays
- 32. Domes
- 33. Lunar Rays
- Libration Event 1.
- Terminator Event 2.
- Event 3. Crescent
- Event 4. **Eclipse and Occultation**

Contents

	<u>Page</u>
Index Map	-
About This Book	5
Section 1. Overview	6
Section 2. Lunar Features & Events	
MAP 1 to MAP 33	23
EVENT 1 to EVENT 4	174
Section 3. Farside of the Moon	192
Section 4. Lunar Spacecraft	199
Section 5. Methods of Imaging	201
Appendices : Data of Lunar Images	207
Data of the Moon	211
Glossary	214
References	216
List of Surface Features	217
Index A - Z	222

About This Book

The current version is intended for advanced lunar observations. It is also a complement to the

large-plate "Hatfield" Photographic Lunar Atlas and the cartographic "Rükl" Atlas of the Moon.

The book collects about 270 photographs including the mosaics. Most of them were taken in Hong Kong with the author's 10-inch (254 mm) Newtonian reflector since December 2002. It

meets the following criteria:

All lunar images are selenographic south up unless otherwise noted.

The date, time, Moon age and equipment used during an exposure are given together with a

brief description of the lunar features.

An Overview to refresh the Moon basics.

A section on the Methods of Imaging.

In general, images of the lunar nearside are sequenced in regional MAPs from east to west, e.g. Mare Crisium and Petavius come first, finally Grimaldi and Schickard. Lunar events

such as eclipses are described in the **EVENT** pages. A cross-reference with Hatfield's and

Rükl's maps is also indicated in the page corner whenever applicable.

The English-Chinese index at the back of the book facilitates the search of 1,000 named

features. The glossary explains lunar terms in simple language.

A CD copy of the current version is available by post. It is best viewed in 19-inch or bigger PC

screen.

朱永鴻

Chu Wing Hung (Alan Chu)

email address: *mca@netvigator.com*

Last updated: 2008 January, Hong Kong, China.

5

1. Overview

Our natural satellite, the Moon, is a fascinating object. It is a little more than a quarter of the Earth diameter, about 1.3 light-seconds away. Virtually it has no atmosphere, no surface water and no active volcanism. Lots of surface features can be observed through telescopes as small as 6-cm (2.4-inch) aperture, and they change in view under different angles of sunlight.

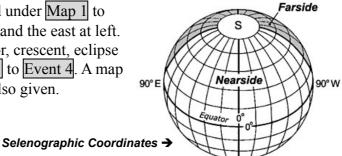
Lunar features are traditionally classified in Latin as

Mare	(sea, plural: maria)	海
Oceanus	(ocean)	洋
Sinus	(bay)	灣
Lacus	(lake)	湖
Palus	(marsh)	沼
Mons	(mountain)	山
Montes	(mountain ranges)	山脈
Vallis	(valley / trough)	谷 / 槽
Promontorium	(promontory / cape)	岬/海角
Rima	(rille / cleft, plural: rimae)	溪 / 溝紋
Rupes	(scarp / cliff / fault)	懸崖/峭壁/斷層
Dorsum	(wrinkle ridge, plural: dorsa)	皺脊
Catena	(crater chain, plural: catenae)	環形山串

while craters are named after mythic legends or individuals who contributed in science, technology, philosophy, mathematics or expedition. Crater is a generic term for circular depression, typically a ring mountain or a walled plain which has relatively large and flat floor. There are 33,000 craters greater than one-km diameter on the visible side of the Moon, about 870 of them bear names and 5,400 are identified by a letter placed towards the center of an adjacent prominent crater, e.g. *Gassendi A*. The largest crater visible from Earth is *Bailly* near the south limb. It is a walled plain, outer diameter 300 km. Dozens of craters are also centers of bright rays. On the maria, wrinkle ridges and small low hills called domes are visible under very oblique sunlight.

Lunar features are best seen when they are near the terminator, the border line between light and shadow. Their positions are defined by the selenographic coordinates in which the 0^0 longitude and 0^0 latitude are within a small mare named *Sinus Medii* (Central Bay). This sinus is visible in binoculars, see next page. The lunar hemisphere permanently facing Earth is termed the nearside; it ranges from 90^0 E to 90^0 W through the 0^0 longitude. When the Moon's south pole is positioned at top, the east limb of the nearside is at the left-hand side, the west limb is at the right-hand side.

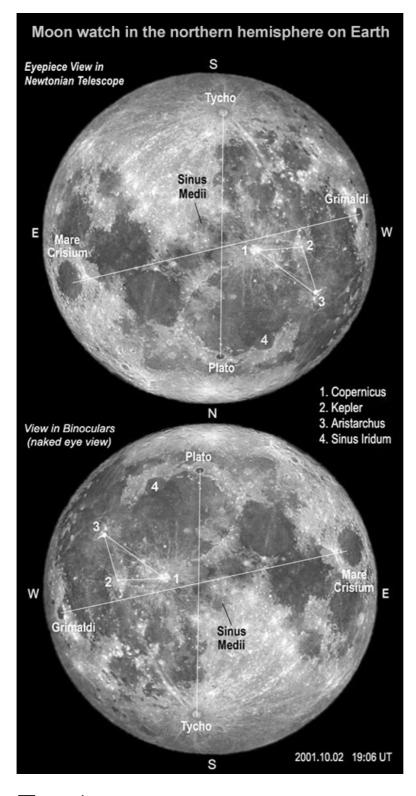
Surface features of the nearside are depicted under Map 1 to Map 33 with the selenographic south at top and the east at left. Lunar phenomena about libration, terminator, crescent, eclipse and occultation are illustrated under Event 1 to Event 4. A map of the Farside that opposes the nearside is also given.



Landmarks on the Moon

Mare Crisium, Grimaldi, Tycho and Plato form a cross; Copernicus, Kepler and Aristarchus form a triangle. Sinus Medii is almost at the center of the disc. The thumbnail is the mirror-reverse image through a star diagonal fitted on refractor or catadioptric telescope. N, S, E and W are selenographic directions as seen by an astronaut on the Moon; they are similar to the geographic directions on Earth.

In telescopes, the eastern half of a Moon disc (S-E-N) looks slightly brighter than the western half (S-W-N).





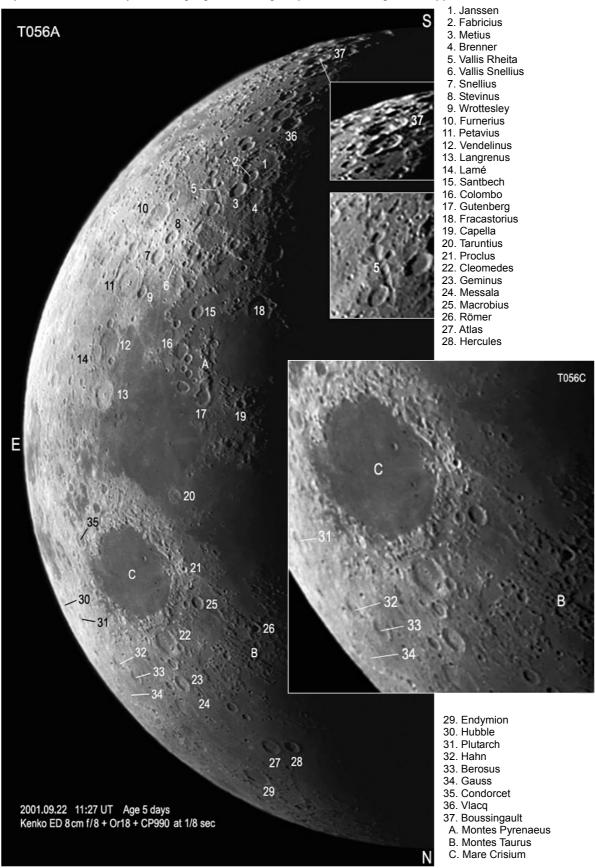
In refractor or catadioptric telescope with star diagonal



Turn diagram upside-down for lunar observation in the southern hemisphere.

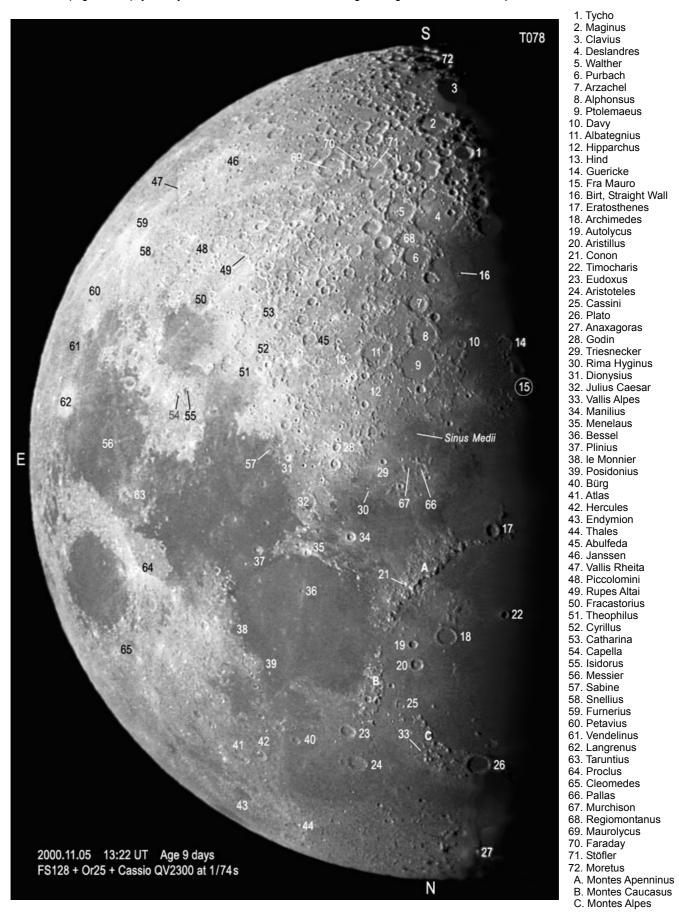
The Moon in small telescopes

This Moon crescent was photographed with a digital camera one hour after sunset through a 3-inch (8 cm) refractor. South is up. It represents a typical view of the Moon from a small telescope at low magnification. Although the telescope is small, it shows plenty of lunar features such as craters, mountains and dark plains. Small telescopes are easy to carry and less sensitive to atmospheric turbulences. Even owners of big instruments enjoy the use of smaller telescopes in field work and poor-seeing nights. The original parts of this image are cropped and shown in the inlets.



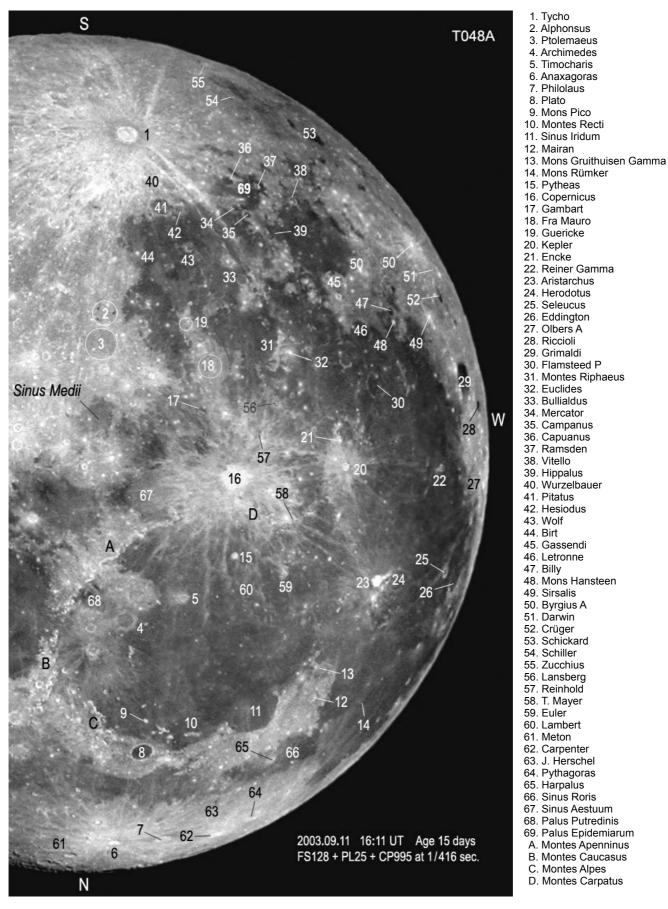
The Moon and its Terminator

The terminator is the border line between light and shadow. It looks irregular because of different height and albedo (reflectivity) of surface features. Features away from the terminator are often too bright (e.g. No. 62) or hidden in darkness (e.g. No. 15), yet they become distinctive when the bright margin of the terminator passes over them.



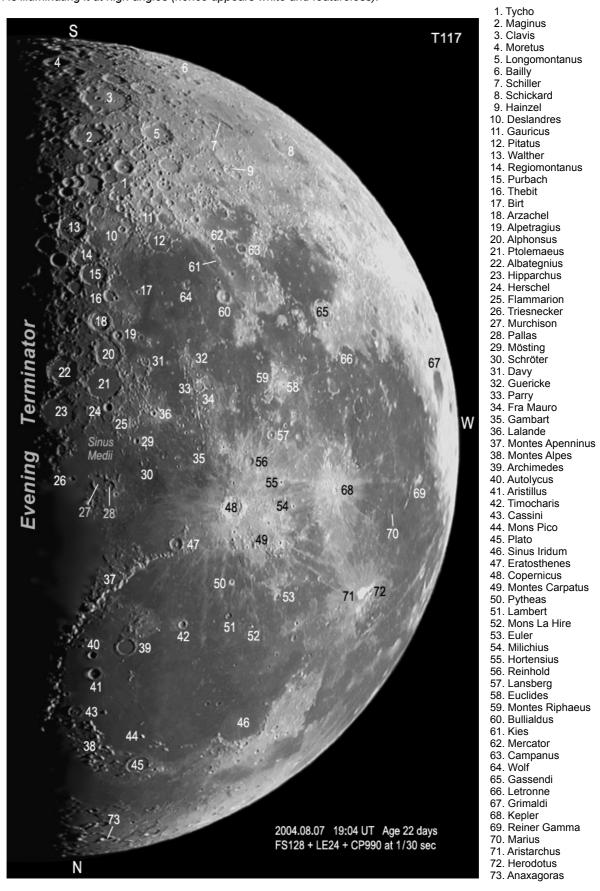
The Moon at full brightness

This photograph shows the western half of a full moon. The terminator has gone completely. Crater Tycho, Copernicus, Kepler and Aristarchus (No. 1, 16, 20 & 23) radiate extensive bright rays that overwhelm large areas of the surface. Other landscapes lose their contrast too, though recognizable. The full moon is not a favorable time to spot lunar details.



The Moon and its "Evening" Terminator

The terminator is designated "evening" because the places under it are experiencing sunset. If a moon man stands now on the floor of crater No.23, he will see the setting Sun and anticipate nighttime as the terminator crosses the crater from east to west (from left to right of the frame). Compare this photograph with T078 in previous page which was taken 6 days before the full moon. T078 shows the "morning" terminator implying the Sun is rising over that part of the Moon. In T117, note also the highland region, around 2~3 o'clock position of the west limb. It is even brighter than the full moon because the Sun is illuminating it at high angles (hence appears white and featureless).



Impact Craters and Lunar Rays

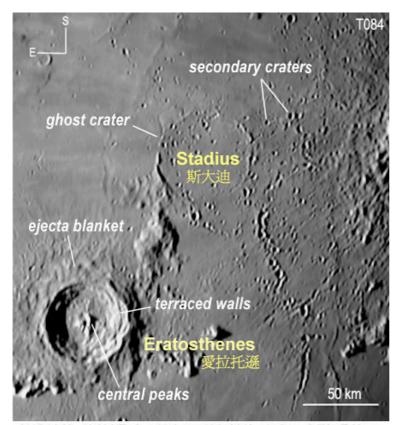
Over 99% of the existing lunar craters are impact originated. Their diameters range from about 300 km to 1 km and below. Diameters larger than 300 km are generally referred to **Impact Basins**.

A mid-sized impact crater is illustrated by Eratosthenes in Image T084. It is a prominent object in the central region of the Moon disc. The crater is characterized by **central peaks** and **terraced walls**. The highest peak rises 3600 m above the crater floor, and the rim of the terraced walls measures 58 km across. Both the peaks and terraced walls are natural formations from a massive impact process, in which the impactor was an asteroid-like body of several kilometers only, hitting the lunar surface at 10 km per second or so. The tremendous impact energy vaporized a portion of the impactor and melted the rocky materials of the impact site to a much larger circular cavity. The sudden release of impact pressure also induced a concentrated rebound that uplifted subsurface rocks into central peaks. Other impact melt splashed out in all directions as **ejecta**. Most of the ejecta deposited around the cavity as **ejecta blanket**, the rest might take the advantage of low surface gravity (1/6 that of Earth) to fly far away before raining down to hit the surface again as **secondary craters**. All secondary craters are too small to have central peaks. The right part of T084 shows a mix of secondary craters produced by various sources including the Eratosthenes impact.

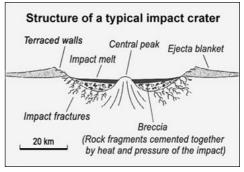
The inner terraced walls of Eratosthenes formed marginally few minutes after the impact contact. At later stage when the walls could not sustain their own weights, they collapsed in segments along the steep slopes, making the terrace more profound. Usually, lunar craters with diameters less than about 20 km are lack of terraced walls; small craters with diameters less than about 15 km are lack of central peaks and are shaped like a bowl with sharp crested-rim. Craters with off-center peaks are likely due to oblique impacts.

A unique feature, known as **ghost crater**, is also shown in T084. It is a crater almost buried beneath the surface of the Moon or destroyed through aging, leaving only a bare hint of recognition.

In general, craters created by explosion on impact remain circular regardless of the impact direction, except for very oblique impacts (less than about 5° measured from ground level). A typical crater caused by very oblique impact is Messier A as shown below. It appears elongated, and its ejecta in the pattern of dual **rays** implies a grazing impactor traveling from east to west. Lunar rays are elaborated in Map 33.



2005.04.18 11:29 UT Age 10 days. 10-in f/6 Newtonian + 2.5X + ToUcam





Bradley is a simple bowled-shaped crater, diameter 14 km.



Messier A is a crater with dual ejecta rays, diameter 13 km.

It must be aware that lunar nomenclature is not always exact. For instance, today's selenographic coordinates make Mare Orientale (Eastern Sea, Farside map) confusingly on the western longitude. Vallis Rheita in Map 4 is not a true valley but a chain of overlapping craters. Grimaldi in Map 26 appears like a lava-filled basin more than a crater. Rupes Recta (the Straight Wall) in Map 12 is not a narrow wall but a fault where its western side slopes down by 300 m. Many lunar views in Earth-based telescopes are dramatically different from the scenes on the Moon's surface and from the images taken in space. Below are some comparisons.

The Straight Wall 直壁



View in telescope, Map12

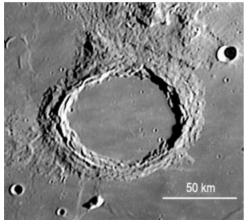
P001

Standing at the foot of the 300-m high Straight Wall.

In telescope, the Straight Wall with shadow appears like a steep cliff. Actually its slope is rather gradual, average gradient under 10°. The steepest slope is roughly 30°.

(Modified from a sketch in Perelman's Astronomy For Entertainment, Moscow, 1958.)

Crater Archimedes 阿基米德環形山



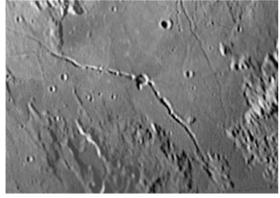
View in telescope, Map14



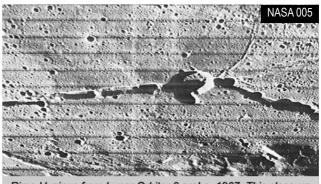
For an observer at the center of Achimedes, a large lava-flooded crater, his horizon distance is 2.5 km. He can only see the upper part of the distant surrounding walls because the curvature of the lunar surface blocks the bottom slopes of the walls.

(Sketch from Perelman's Astronomy For Entertainment, Moscow, 1958.)

Rima Hyginus 海金努斯月溪

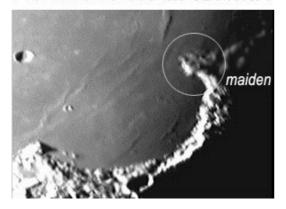


View in telescope, Map 13

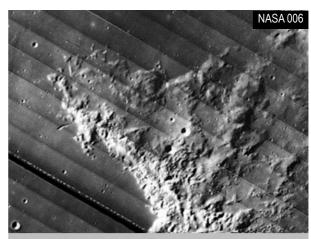


Rima Hyginus from Lunar Orbiter 3 probe, 1967. This close-up shows numerous craterlets on the lunar surface not resolvable by any observatory telescopes. The central crater is Hyginus, diameter 9 km. It is rimless, has flat floor and hence appears volcanic rather than impact-originated.

Prom. Heraclides 赫拉克萊特海角



View in telescope, Map 18. Poor seeing creates illusion which makes Promontorium Heraclides to resemble a maiden's face with waving hair.



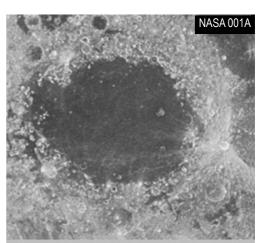
Closeup image of Promontorium Heraclides from the Lunar Orbiter mapping. Here it is rotated with south up.

Mare Criusium 危海



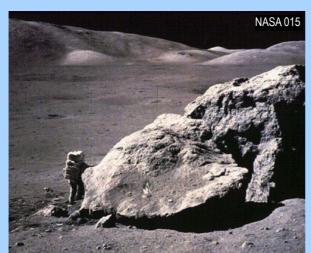


Two views of Mare Crisium in telescope, Map 2. They differ slightly in aspect ratio (east-west: north-south diameter) due to libration. Libration is the apparent vertical or horizontal rocking motion of the Moon as it orbits around the Earth. It distorts the surface features seen near the Moon's limb, or even makes them temporarily out of sight. Libration is detailed in Event 1 pages.



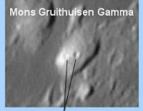
This image from Apollo 11 spacecraft shows the non-oblique view of Mare Crisium. Its east-west diameter is longer than the north-south by 33%.

Resolving Power of Telescopes



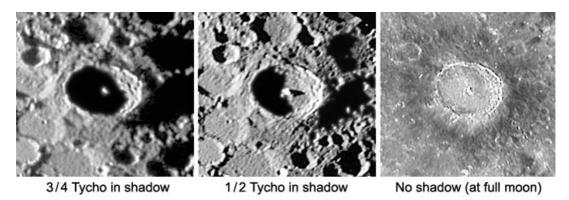
Left: The isolated boulder on the Moon is probably a dropping of ejecta from crater impact. Although it looks big to the Apollo-17 astronaut, it is not detectable by any observatory optics. Even the Hubble Space Telescope, with its 2.4-m mirror, is unable to spot moon rocks smaller than about 80 m. At best night, a 25-cm (10-inch) telescope resolves to 0.45 arcseconds, or lunar craters of about 800 m in diameter.

Right: A 25-cm (10-inch) telescope can be tested by resolving the pit-craterlet pair in Mons Gruithuisen Gamma, Map 22.

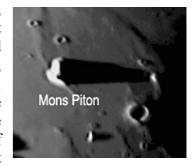


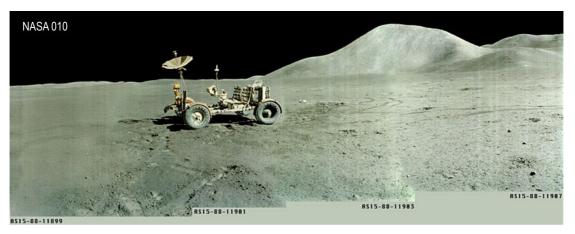
pit-craterlet pair (diameter ~1 km)

In telescopes, a crater close to the lunar terminator looks like deep hollow because the shadow on it exaggerates the impression of depth. Actually the floor of a lunar crater is not deep against its diameter. For example, the cavity of Tycho (figure below) is 85 km in diameter, 4.8 km deep. The depth-diameter ratio is 1:18, rather shallow by terrestrial norm. During the full moon, the exaggerated depth of Tycho will vanish, and the crater looks almost flat with a dark halo.



The shadow effect, together with the global curvature of the Moon, also play trick to the appearance of lunar mountains. In the right figure which shows the telescope view of Mons Piton, an isolated mountain in Map 15, it has the appearance of a steep cliff, exaggerated by the long triangular shadow under low illumination. However, an astronaut on the Moon would find its slope quite gradual, roughly 20°. This is because the global curvature of the Moon is greater than that of the Earth; the short horizon distance of the astronaut (2.5 km) makes him or her to perceive Mons Piton not as steep as the shadowed view in telescopes.





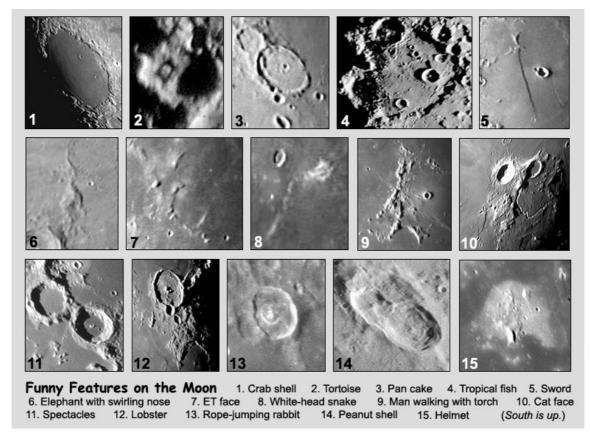
The above mosaic shows the landing site of Apollo 15 (1971 July). The mountain is Hadley Delta at the foothills of Montes Apenninus Map 14. Astronauts called it a "featureless mountain" (quite true in this picture). They found lunar scenery almost white or black. They also reported that distances on the Moon were hard to estimate, partly because the Moon's surface curves more sharply than that of the Earth and hence the horizon is closer, partly because there is no atmosphere and hence no softening of shadows. Note that on the airless Moon, the sky is dark even at daytime.

Here is the shadow effects experienced by the Apollo astronauts on the Moon: http://science.nasa.gov/headlines/y2006/03jan_moonshadows.htm

Although the Moon is physically a barren world compared to our vivid Earth, yet there are lots of surface features visible in telescopes. See these funny highlights:

Funny Features on the Moon

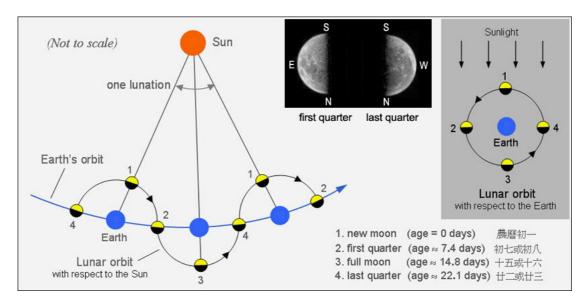
Under certain illuminating conditions, the lunar features may look conspicuous and funny in telescopes. Below are the glimpses of them. Their details are traceable from the MAP pages.



Age of the Moon

The age is the number of days that has elapsed since the last new moon. In average, the new moon repeats every 29.53 days; this period is called synodic month or one lunation. Because the Moon's and Earth's orbital speeds are not uniform, the first quarter, the full moon and the last quarter may occur slightly earlier or later than the indicated age. It is also possible to have two full moons in a calendar month, e.g. 2004 August and then 2007 June (once every 33 months). "Blue Moon" is an ambiguous term for the second full moon in the same calendar month. Rarely the Moon is tinted blue unless there is an excessive amount of dusty particles in the atmosphere.

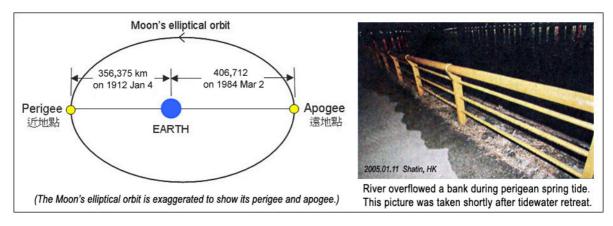
In the drawing below, note also the Moon must orbit about the Earth more than 360° from new moon to next new moon.



Perigee and Apogee

The angular diameter of the Moon is about 0.5° , equivalent to viewing a pencil thickness at an arm's length. It is not constant but changes according to the instantaneous Moon-observer distance. Thus the Moon appears about 1.5 % bigger at zenith (overhead) than at horizon, though this change is quite small. To an observer on the Earth's equator, the Moon's angular diameter can vary up to 34.1 arcminutes at **perigee** (closet to Earth) or down to 29.8 arcminutes at **apogee** (farthest from Earth), a total change of almost 14 %. The average is 31.6 arcminutes, when the Moon is 378,000 km (30 times Earth's diameter) from the observer. A lunar crater of 2 km diameter and facing Earth gives a visual angle of about 1 arcsecond.

Greatest high tide, also called **perigean spring tide**, will occur when the Moon is at perigee and when the Sun, the Earth and the Moon (whether new moon or full moon) are aligned to reinforce gravitational interactions. Such high tides are not uncommon and are notable at some coastal spots in Hong Kong, e.g. on 2005.01.10~11, the new moon was at perigee; the river in Shatin overflowed the bank during the high tide.



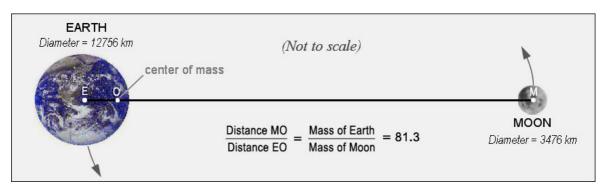
The Earth-Moon System

Actually the Earth and the Moon move in slightly elliptical orbits about the **center of mass** of the system which acts as if all the mass were concentrated there. The Earth and the Moon are always in opposite sides of the center of mass. They go around this center once every **sidereal month** (27.322 days).

The center of mass is about 1900 km below the Earth's surface when the Moon is at perigee, and 1400 km below the Earth's surface when the Moon is at apogee.

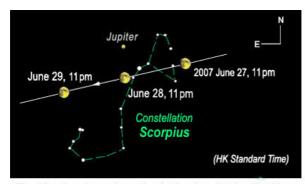
The center of mass is not stationary. It follows the Moon's orbital motion to sweep an elliptical loop inside the Earth globe.

Over time, the friction of tidewater slows down the Earth's axial spin by 0.0017 second per century. This loss of spin is absorbed in the Moon's orbital motion by the principle of conservation of angular momentum. It causes the Moon to spiral away from the Earth at average of 3.8 cm per year. However, the Moon remains with the same face (nearside) locked towards Earth. The Moon's distance shall not increase forever. It would stabilize billion years later, probably at 550,000 km. By that time, one lunation would be lengthened to 1.8 times of present; the Earth's rotation would be dramatically slowed down; or perhaps the Sun might have expanded to a red giant swallowing up the Earth and the Moon!

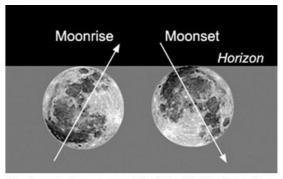


Moonrise and Harvest Moon

Between apogee and perigee, the Moon moves $12 \sim 15$ degrees per day eastward among the star background. As a result, moonrise repeats every $24.3 \sim 25.2$ hours, and so it must be delayed in successive days. There is always one day with no moonrise (e.g. 2007 July 08 in Hong Kong) and one day with no moonset (2007 July 23) in each lunar month.



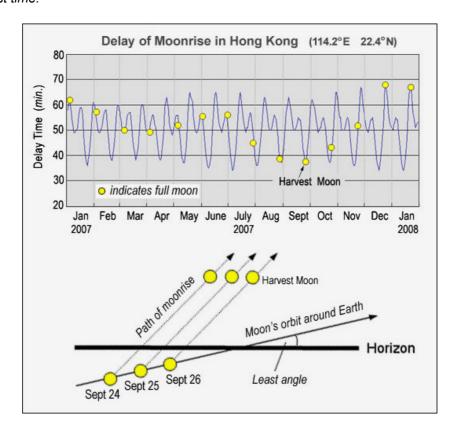
The Moon's retrograde motion in the sky: It takes the Moon two full days to cross Scorpius from west to east.



Exact moonrise or moonset is defined by the time when the upper limb of the Moon contacts with the horizon.

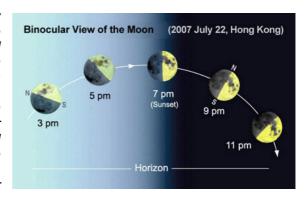
The graph below shows the delay of moonrise during 2007 in Hong Kong. For example, the delay time changes from about 35 to 65 minutes and vice versa in each month in the second half of the year. This proves a very large variation of moonrise time in a lunation. The general saying that the Moon rises about 50 minutes later per day is not applicable most of the time.

Harvest Moon refers to the full moon that rises at minimum delay time during a year. It happens in few successive nights close to autumnal equinox (September 23) in the northern hemisphere. At these nights, the full moon rises around the time of sunset, and it appears only ~35 minutes later than the Moon did the day before. This is because at days close to autumnal equinox, the ecliptic, and hence the Moon's orbit, is at its least angle to the horizon at the time of moonrise in the northern latitudes. In higher latitudes (e.g. 50° N), the daily delay time of the Harvest Moon is even shortened to 20 minutes or less. Harvest Moon happens in March in the southern hemisphere. It is so named because the moonlight helps farmers to work at harvest time.



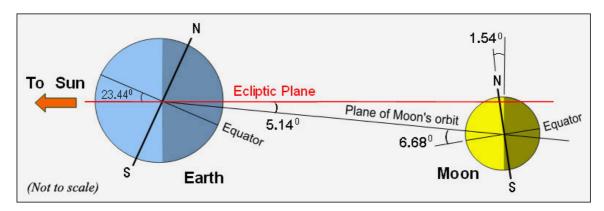
Tilting of the Moon's terminator, as seen from Earth

Between moonrise and moonset, the Moon in the sky seems to tilt differently from the vertical. This is because our eyes see the sky as its projection on the celestial sphere, and the Moon appears to move in a curved path above the horizon. Such perception is illustrated by a binocular watch on 2007 July 22 Hong Kong. At 3 pm, the first-quarter Moon was visible in daylight at an altitude of 30°. It was rising in south-east with the upper end of the terminator tilting to the observer's left hand side. At transit when the Moon was highest above horizon, the terminator looked almost vertical. Thereafter the Moon sank westward, and the terminator tilted to the right.



Tilting of the Moon's rotation axis, as seen from space

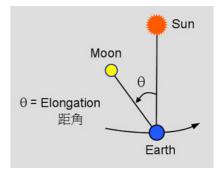
The Moon's rotation axis is tilted 1.54° from the vertical of the ecliptic (plane of the Earth's orbit). Hence the Sun always appears very low above the horizon at the polar regions of the Moon. Some craters at the poles are so deep that sunlight probably never reaches their bottoms. Based on the spectroscopic surveys by spacecraft, scientists speculate upon the existence of water-ice on the Moon (e.g. from impacts of water-bearing comets), especially an area of about 100 km diameter around the south pole which contains permanently shadowed depressions and where the temperature does not exceed –180° C. So far traces of water-ice on the Moon are not affirmative. (http://science.nasa.gov/newhome/headlines/ast03sep99 1.htm)



Brightness of the Moon

Due to the elongation of the Moon from the Sun, the brightness of the Moon changes against its age in a lunation. Maximum brightness is at the full moon, equivalent to visual magnitude of about –12.7. Minimum brightness is at the crescents, see the following table. A moon-filter is sometimes needed to suppress the lunar brightness in visual observations.

Note that the eastern half of a Moon disc is slightly brighter than the western half, and that at ages approaching full illumination, the Moon rises in the afternoon and is naked-eye visible in daylight.



Moon Age (days)	3	5	7	First Qtr.	9	11	13	Full Moon	17	19	21	Last Qtr.	24	26	28
Elongation	370	610	850	900	1100	1340	158º	1800	2070	2320	2560	2700	2930	3170	3410
Relative Brightness	0.7	3	6	8	16	30	58	100 (full illumination)	49	26	13	8	4	1	0.2

Notes on lunar observation

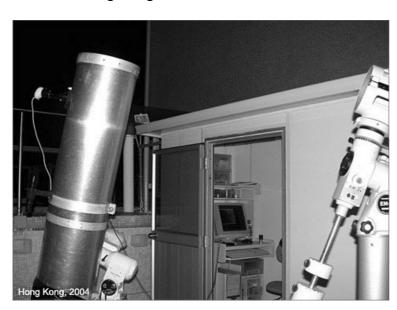
This book presents lunar images taken with small and medium-sized telescopes. They indicate that the requirements of a Moon telescope are not critical except personal preference. The author's preference tends to have three:

- A 4-inch (102 mm) f/8 refractor for portability; the front objective is fluorite for supreme sharpness in visual enjoyment.
- A 5-inch (128 mm) f/8 refractor for imaging at wide field (happened to be fluorite too).
- A 10-inch (254 mm) f/6 Newtonian for imaging lunar details. It is most frequently used by the author, and its optics hardly dews in nighttime.

The 5- and 10-inch are not supposed portable. Newtonian bigger or longer than 10-inch f/6 is seldom used because the observer needs to "stand high on stool" by the eyepiece (sounds to cause falling accident), and the seeing is not always supportive. The C9 (Celestron 9.25-inch Schmidt-Cassegrain) is sometimes used when the 10-inch Newtonian is unavailable, e.g. recoating of mirror. In the author's experience, a collimated C9 gives best optics among all Celestron Schmidt-Cassegrain, but it never outperforms a quality, equal-aperture Newtonian. The Celestron kit of vibration suppression pads is highly recommended. It kills vibration residue of the telescope almost instantly, and has been tested equally well for loading as heavy as 150 lbs (68 kg).

Try to observe the Moon even when the seeing is mediocre, because the peculiar view of a landscape lasts for few hours only (e.g. the "golden handle" and wrinkle ridges of Sinus Iridum MAP 18). If this session is missed, the observer must wait at least 4 weeks to meet similar view. Avoid the use of star diagonal because it gives an awkward (mirror reversed) view. During image capture, it does not matter to orientate "south- or north-up". South-up is more convenient to observers who really look into telescopes, and north-up is more common in topography.

Moon after the last quarter rises late at night or even at dawn. Be relaxed before observation. It is advantageous to plan an observing session in advance, such as the example in next page. Always check the collimation of the optics and allow them to reach thermal equilibrium; these are essential for high magnification works.



The author's current site for lunar (and planetary) observation.

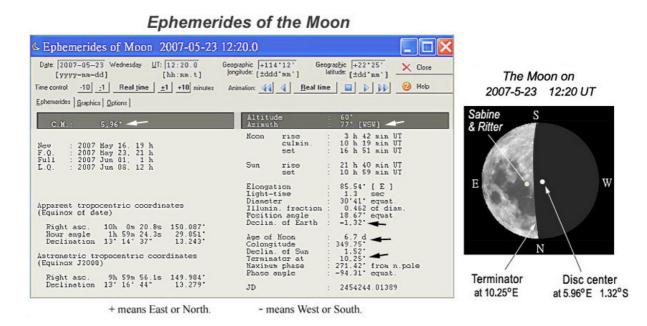
Left is a 10-in (254 mm) f/6 Newtonian; right is a moveable mount for 4- to 5-in refractors. The site is at open top of a 32-storey building in Hong Kong. A high wall behind the site chamber blocks the east to south view. No roof is allowed by building regulations. When the Newtonian is not used, it is simply protected with plastic sheet.

During the very hot summer (50°C+ on ground surface in afternoon!), it helps to spray the floor by water, and hence to minimize local air turbulences.

Here is an example to plan observing the features in Map 8 where Apollo 11 landed on their vicinity. They include crater Sabine, Ritter, Lamont, Armstrong, and the nearby domes, rilles and wrinkle ridges.

***** EXAMPLE *****

The References page at the end of the book suggests a freeware *WinJupos* for moon ephemerides, a set of tables giving the predicted positions of the Moon (and planets). Download this freeware from Internet. After setup, select the object "Moon" in the dialogue window. Input the date, time and geographic location similar to below.



WinJupos then predicts that at the given input, the Moon is 60^0 high in WSW direction and is sinking. Its age is 6.7 days. Its C. M. (*Central Meridian*) is 5.96°, meaning the Moon disc is centered at longitude 5.96° E and hence an extra 5.96° zone of libration** is visible along the east limb. Similarly, *Declination of Earth* -1.32^0 implies that the Moon disc is centered at latitude 1.32^0 S, giving an extra 1.32^0 zone of libration near the south pole. *Terminator at* 10.25^0 (E) indicates that crater Sabine & Ritter are illuminated at favorable angles similar to T096 of Map 8. The angles are also oblique enough to spot the wrinkle ridges around Lamont. On the other hand, crater Armstrong is known small (about 5 km or 2.5 arcseconds angular). It is easier to spot Armstrong with bigger telescopes, as well as the domes and rilles in the map.

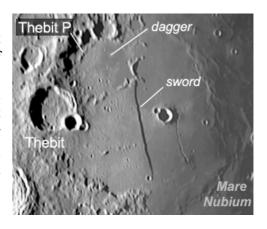
In the above table, *Terminator at* 10.25° (E) is just an alternative quote of *Colongitude* 349.75° , because they always sum to 360° , 180° or 0° . The colongitude tells the instantaneous position of the terminator from which one can calculate the sunlight angle, and hence the height of a surface feature from the length of its shadow. Methods to determine feature heights are demonstrated in http://paganastronomy.net/lunarcrater.html.

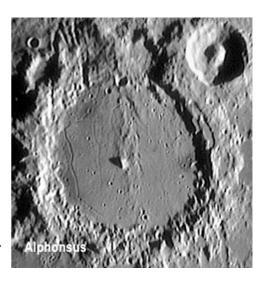
WinJupos is not the only program available. There are other Internet sources of moon ephemeredes.

** Libration is elaborated in the Event 1 pages.

IMAGINATION helps tremendously in lunar observation. Give a name or token to your feature favorite. It will not appear in standard Moon atlas but is a good marker of memory. For instance, the Straight Wall (Rupes Recta) can be thought as a sword with a handle at the southern end. This handle is also the wall portion of the "ghost crater" Thebit P, see figure at right or Map 12. The floor of Thebit P is shaded by a pattern of darker lava which resembles a dagger. The combination is then a sword and a dagger side by side on the edge of Mare Nubium.

The imagination may be extended to crater Alphonsus, see figure at right or Map 12. A close look at its floor shows three small, dark lava patches along the inner rim, and there are clefts and craterlets on the patches. Such appearance suggests that it might be a remnant of local volcanism, probably very young by geologic age. If the Moon's interior is not totally inert, someday volcanic outgases may leak through the craterlets. They would be ionized by sunlight, becoming luminously noticeable as some kind of LTP (lunar transient phenomena). LTP are short durations of brightness, color or shape changes on the lunar surface. They have been reported for decades even during the Apollo missions, although a lot of them remain controversial. The three most likely explanations of LTP are: a flash from meteorite impact, some form of electrostatic discharge and outgoing gases ionized by high-energy particles from space.



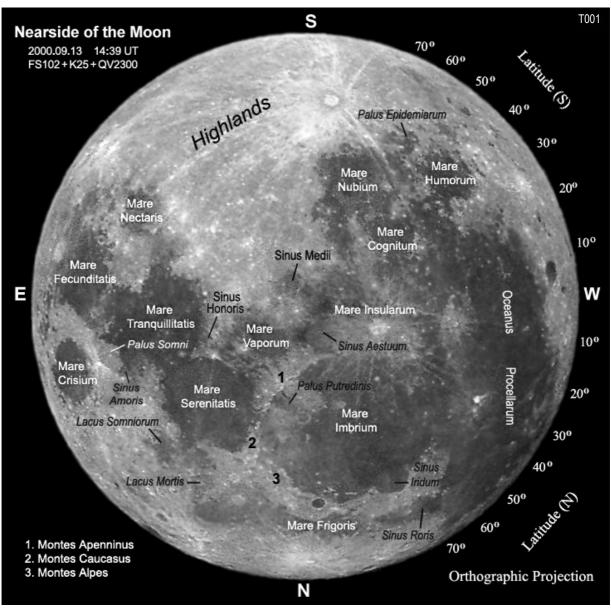


In Map 1, there is a page on three families of Moon rocks. The mare basalt looks dark. The anorthosite, which exists in highlands or beneath the mare basalts, is light-colored. The breccia is a cemented type caused by the heat and pressure of a meteorite impact. This rock scenario may inspire speculation about the peculiarities of some surface features. Books and web links about lunar geology are highlighted in the References page.

Maria, Impact Basins and Evolution of the Moon

The Moon keeps the same face towards the Earth. The large dark area of this face (the nearside) is termed *Mare*, the Latin for "Sea". The term was originated in the 17th century, when the dark plains were thought to be water. Maria are physically smooth lowlands of solidified lava, typically 500~1500 m thick over the lunar crust. They erupted 3~4 billion years ago and are younger than the bright surrounding highlands. Maria share 17 % of the total lunar surface.

Plains of relatively small areas are Latinized as Sinus (Bay), Lacus (Lake) or Palus (Marsh). Montes are "mountain ranges". Three huge montes run along the eastern edge of Mare Imbrium — Montes Apenninus, Montes Caucasus and Montes Alpes as shown in T001. They are part of the rising rim of the impact basin that holds the lava floor of Mare Imbrium.



Mare Cognitum Mare Crisium Mare Fecunditatis Mare Frigoris Mare Humorum Mare Imbrium Mare Insularum

Mare Nectaris

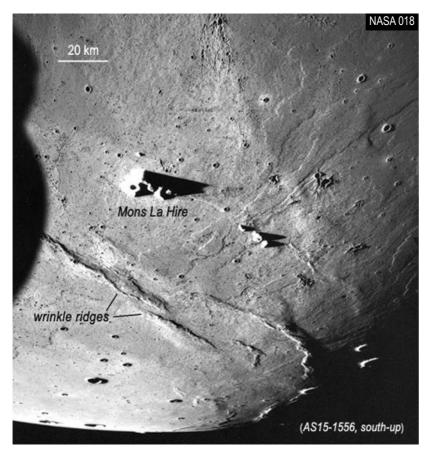
Known Sea 知海 Sea of Crises 危海 Sea of Fertility 豐富海 Sea of Cold 冷海 Sea of Moisture 湿海 Sea of Rains 雨海 Sea of Isles 島海 Sea of Nectar 酒海

Mare Nubium Mare Serenitatis Mare Tranquillitatis Mare Vaporum Oceanus Procellarum Lacus Mortis Lacus Somniorum Palus Epidemiarum Maria on the east limb are given in Event 1 pages.

Sea of Clouds 雲海 Sea of Serenity 澄海 Sea of Tranquillity 靜海 Sea of Vapors 汽海 Ocean of Storms 風暴洋 Lake of Death 死湖 Lake of Dreams 夢湖 Marsh of Epidemics 疫沼

Palus Putredinis Palus Somni Sinus Aestuum Sinus Amoris Sinus Honoris Sinus Iridum Sinus Medii Sinus Roris

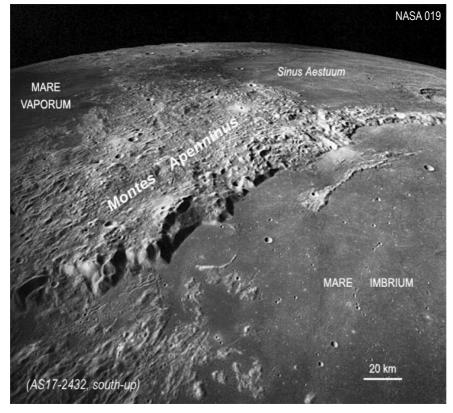
Marsh of Decay 凋沼 (腐沼) Marsh of Sleep 夢沼 Bay of Billows 暑灣 (浪彎) Bay of Love 愛灣 Bay of Honor 榮譽灣 Bay of Rainbows 虹灣 Central Bay 中央灣 Bay of Dew 露灣



Close-up view of Mare Imbrium

This is an oblique view taken by the crew of Apollo 15 in July 1971 when they flew over the southern region of Mare Imbrium. South is up. Ancient lava flow on the mare floor (shown in top right corner) is evident. Prominent wrinkle ridges are also seen in the bottom half of the picture. Wrinkle ridges are common in lunar maria, height up to about 200 m. Generally, they tend to group like concentric ripple rings along the inner edge of a mare. Wrinkle ridges may have resulted from surface shrinkage following the cease of volcanism, or buckling of the lunar crust due to the weight of accumulating lava in the mare.

Mons La Hire, which has a crater on the slope, is a highland remnant partially submerged in lava. It is about 1500 m high, base size 11 x 25 km. The telescope view of this mountain is given in Map18.



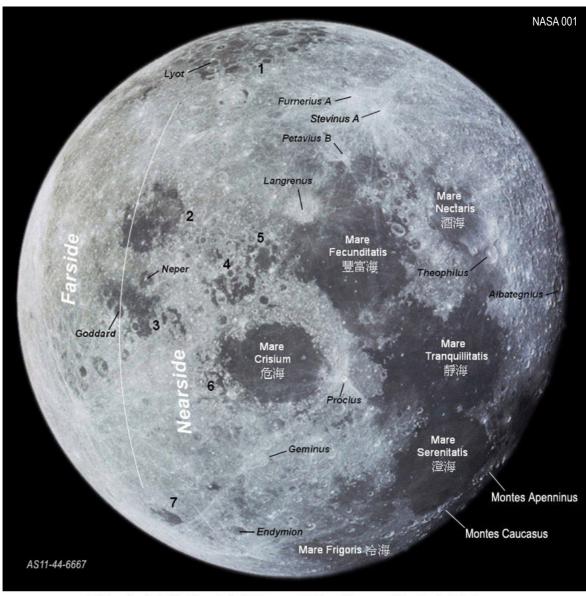
Close-up view of Montes Apenninus

A picture by Apollo 17 crew in December 1972. Montes Apenninus, which forms part of the rising rim of Mare Imbrium, is the largest mountain ranges on the nearside of the Moon. The height of some peaks exceeds 5000 m above the mean level. A similar telescope view is given in Map 14.

Note that the slopes of Apenninus towards Mare Imbrium are quite steep but the back slopes between Mare Vaporum and Sinus Aestuum are gradual. The back slopes are believed to form from a gigantic hurricane of ejecta at low angle during the Imbrian impact which happened 3.85 billion years ago. (One can imagine the stunning moment of this very massive impact!)

The Moon seen by Apollo 11 crew on return trip, 1969 July

This view is not visible from Earth-based telescopes. Mare Crisium and Mare Fecunditatis now appear close to the center of the disc. Maria Nos. 1 to 7 (seen obliquely along the east limb of the Moon from Earth) are positioned in better perspective. The curve passing through Goddard is approximately at longitude 90° E which separates the Moon's nearside from its farside.

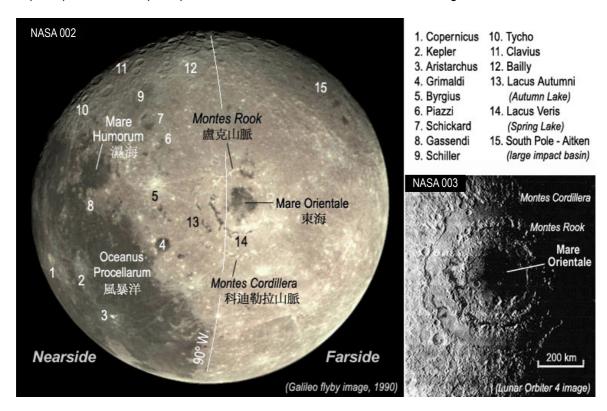


- 1. Mare Australe (Southern Sea) 南海
- 2. Mare Smythii (Smyth's Sea) 史密斯海
- 3. Mare Marginis (Border Sea) 界海
- 4. Mare Undarum (Sea of Waves) 浪海
- 5. Mare Spumans (Foaming Sea) 泡海
- 6. Mare Anguis (Serpent Sea) 蛇海
- 7. Mare Humboldtianum (Humboldt's Sea) 洪堡海

Note the shape of Mare Crisium in above image. It is more circular compared to the oblique view in Image T001.

Mare Orientale (Eastern Sea)

Mare Orientale is near the center of Image NASA 002, but on Earth it is hidden behind the west limb of the Moon and is partially visible only at very favorable librations. The mare is centered at 93°W 19°S, about 320 km across. Physically it is the lava-flooded portion of an impact basin. The shock waves from the impact resulted in concentric multi-ring mountains, including Montes Rook and Montes Cordillera with outmost span of 900 km. In wide-field maps, the Orientale ejecta can be traced in the surrounding highlands as distant as the regions of Piazzi (No. 6) and Grimaldi (No. 4). NASA 003 shows a closer view of the multi-ring basin.



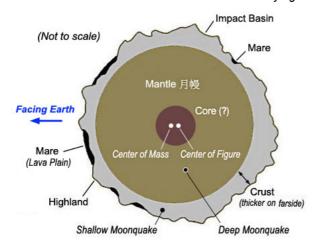
By comparing the nearside of the Moon (T001) with the two spacecraft images (NASA 001 and 002), it can be seen that the dark maria are concentrated in the nearside but the farside is mostly brighter highlands with very few maria. It also shows, in general, maria tend to be circular in shape. This suggests that, like craters, the maria were firstly created by huge impactors which struck the Moon some billion years ago, thus forming basins. The basins subsequently flooded with lava that flowed out from the Moon's interior through cracks in the crust, forming the maria that appear in T001. However, the total volume of maria is small, about 0.1% of the bulk Moon.

A question is why maria are concentrated in the nearside. The common belief is that asymmetric development of the Moon made the farside crust thicker than the nearside, as shown in next page. The farside crust has limited deep cracks to eject magma (subsurface molten rocks), hence very few maria. The density of lunar crust (~2.9 g/cc) is also less than that of magma (~3.3 g/cc). These combined effects shift the Moon's center of mass from the center of figure by 2 km and make the nearside hemisphere slightly more massive than the farside. Over time, the Earth's gravity must have dragged the Moon until its more massive nearside locked towards the Earth.

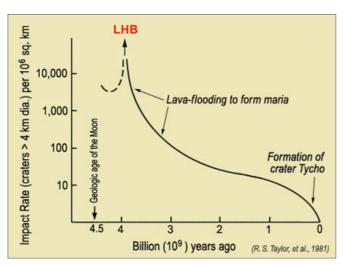
In the above image, No.15 marks the South-Pole Aitken of the lunar farside. It is the largest impact basin in the solar system, diameter 2300 km and depth 12 km. It is also the oldest among all impact basins ever known, with age at least 4.1 billion years. A research suggested that the shock waves from this impact traversed the Moon's interior to the opposite face, producing part of the cracks in the nearside crust. The South-Pole Aitken is supposed responsible for part of the maria formation. (http://researchnews.osu.edu/archive/moonboom.htm)

Cross-section of the Moon's interior

The Moon's nearside crust has an average thickness of 60 km, and the farside crust is roughly 50% thicker. It is easier to eject magma (non-solidified lava) through cracks of the nearside crust after colossal impacts, hence creating vast areas of dark plains or maria we see from the Earth. The farside has very few maria due to thicker crust. The lack of global magnetic field on the Moon's surface and measurement of its dynamics (moment of inertia) suggest that the present Moon may or may not have an iron-rich core. If it has, the core is plastic (~1100° C) and small, probably less than 800 km in diameter. The mantle is the zone lying below the crust; it constitutes the major volume of the Moon.



Moonquakes: The Moon is lack of plate tectonics. Therefore it is not surprising that moonquakes are less intensive and less frequent than earthquakes. Most moonquakes are 700 ~ 1000 km deep in the mantle; they are triggered by the Earth's and Sun's tidal forces especially during the perigee, and may have mild magnitude below 2.5 in the Ritcher scale. Shallow moonquakes are rare but stronger with magnitude up to about 5.5; they are caused mainly by slumping of crater walls or meteorite impacts. Roughly 1000 moonquakes are detected per year, whereas hundred thousands of earthquakes are recorded per year with similar equipment on Earth. During moonquakes, the Moon "rings" like a bell for tens of minutes because there is no water on the Moon. (http://science.nasa.gov/headlines/y2006/15mar_moonguakes.htm)



Lunar Impact History

Left: The impact rate on the Moon can be deduced from crater counts. Generally it is much higher during the first 0.8 billion years of lunar history. The high initial impact rate is probably due to early stages of planetary accretion, or fragmentation of nearby asteroids. The exact cause of early bombardment is uncertain but it is likely that the impact rate increased abruptly at about 3.9 billion years ago, a transient stage known as LHB (Late Heavy Bombardment) or lunar cataclysm.

http://en.wikipedia.org/wiki/Late_Heavy_Bombardment

Most impact basins formed during the LHB. Following the LHB is a rapid drop of impact rate between 3.8 and 3.2 billion years ago. In this period, many impact basins on the thinner side of the crust were lava flooded. Since then the lunar impact rate has been quite slow. The maria and mountains we see today remain nearly same status as 3.0 billion years ago.

Lunar Regolith

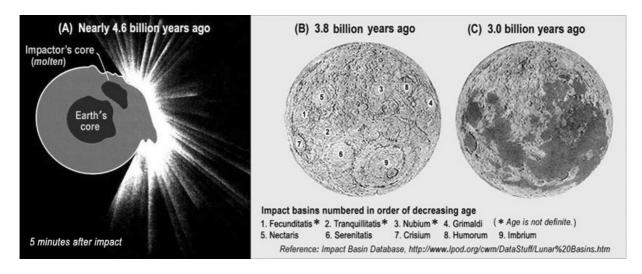
Although the impact rate to produce craters is slow today, the airless Moon is still under day-night temperature stress and continuous bombardment by countless micrometeoroids, cosmic rays and charged particles of the solar wind. As a result, a layer of loose and broken rock and dust, termed regolith, has accumulated 3 to some tens of meters thick over the lunar crust. The right picture from Apollo 16 Mission shows the astronaut's bootprints on the lunar regolith. He is dragging a rake through the regolith to collect rock fragments. Despite the "light" weight of the astronaut under low surface gravity (1/6 that of the Earth or about 25 kg on the Moon), his bootprints appear quite deep suggesting that the regolith is loose indeed. It is this loose layer that scatters sunlight making the full moon very bright.

The dusty particles in lunar regolith are known as "moondust". They are abrasive and electrostatically sticky, as noted by the Apollo astronauts. Lunar regolith also contains traces of small black glass beads, size 1 mm in average. These beads were produced by melting due to the heat and pressure of micro bombardment.



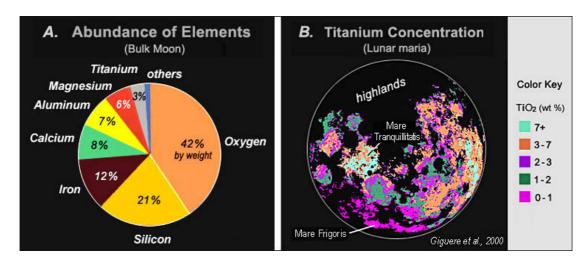
The Giant Impact Theory

- **A.** The giant impact theory, developed after the Apollo missions and supported by computer modeling, is widely accepted to explain the origin of the Moon. It states that nearly 4.6 billion years ago, a proto-planet "Theia" of diameter 6300 km impacted the proto-Earth at an oblique angle. The dense heavy core of Theia fell into the surviving Earth while its less dense mantle and part of the Earth exploded as debris into space. Some debris fell back to Earth. Other debris accreted to form the Moon orbiting Earth at less than 1/10 of present distance but beyond the Roche limit. The process of giant impact and accretion finished within 100 years. It made the initial Moon covered by a global hot magma ocean possibly 800 km thick. The giant impact also caused the early Earth to spin 4 times faster than today.
- **B.** 800 million years after the giant impact, the Moon migrated to 1/3 of present distance. Its surface had solidified with impact basins and craters covering 80 % area of the global crust.
- **C.** About 3.0 billion years ago, nearly all impact basins on the thinner side of the crust flooded with lava, forming the dark maria much similar to those seen today. The flooding spread over vast areas because of the low surface gravity and intensive eruption of magma at low-viscosity (roughly 1/10 that of its terrestrial counterpart). At present the Moon is locked with its maria-rich side towards Earth at mean distance of 384,000 km, and one day is lengthened to 24 hours.

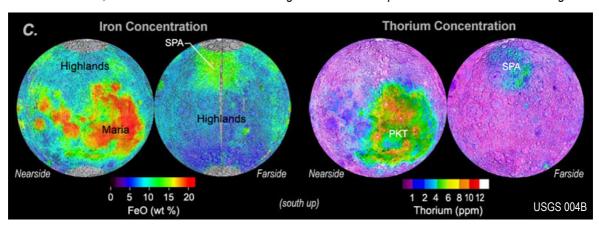


Abundance of Elements

- **A:** The abundance of elements on the Moon is shown by a statistical pie chart. These elements do not stand alone but are bonded to oxygen as oxides, so iron may exist as FeO and titanium as TiO₂. Note that hydrogen is enormously depleted, reflecting the almost total absence of water on the Moon.
- **B:** This map was derived from filtered images of Galileo probe en route to Jupiter. It shows the titanium / TiO₂ concentration in the Moon's nearside. Highland areas have been masked black. Generally lunar maria contain titanium at different weight percentages. They can be grouped as high-titanium (more than 7 % TiO₂), low-titanium (2-7 % TiO₂) and very-low-titanium (less than about 2 % TiO₂). In spectral measurements, areas of high-titanium tend to be bright in the blue end of the spectrum, e.g. Mare Tranquillitatis. Areas of low-titanium tend to be brighter in the red end, e.g. Mare Frigoris. The variation of Ti levels indicates that magma could erupt from different depths and at different times.



C: Iron and thorium concentration in the lunar crust. **Left:** The iron (FeO) map was derived from Clementine spectral reflectance data in 750 & 950 nm wavelengths. It shows the maria have iron contents much higher than the highlands. The farside green area is SPA (South-Pole Aitken basin) with intermediate iron level. **Right:** The thorium map was derived from the data of the gamma ray spectrometer in Lunar Prospector spacecraft. It shows thorium, a radioactive element, is concentrated in the zone known as PKT (Procellarum KREEP Terrane) which corresponds to Oceanus Procellarum. Mare Imbrium and its southern region. KREEP is a special radioactive rock containing thorium.



Moon Rocks

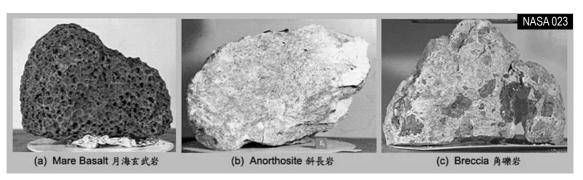
Compared with terrestrial, Moon rocks are completely free of water molecules and contain relatively few volatile elements. This is a strong support to the giant impact theory that the Moon had been molten in its initial stage.

Among the moon rocks sampled from the Apollo missions, there are two distinct families: mare basalt in the lava plains and anorthosite in the mountainous highlands. The mare basalt is mostly 3.2 ~ 3.8 billion years old whereas the anorhosite is older, age up to 4.4 billions years (http://www.psrd.hawaii.edu/April04/). Mare basalt and anorthosite are just broad terms in geology; they can be subdivided into various rock types depending on their mineral concentrations.

Figure (a) shows a sample of dark, vesicular mare basalt. It is these basaltic rocks and overlaying material of similar composition that make the maria look dark in telescopes. The rock sample is vesicular because of many holes in its body. It indicates that gas must have dissolved under pressure in the lava from which this rock solidified. When the lava reached the airless Moon's surface, bubbles formed as the gas pressure dropped. The dark color is a characteristic of mare basalt. It implies enriched contents of heavy elements like iron and titanium. Compare Figure (a) with (b) which shows another sample collected from the lunar highlands. The rock, so called anorthosite, is rich in silicon, calcium and aluminum. Hence it is light-colored and less dense than iron-rich materials. During the period when the Moon's surface was molten, the less dense anorthosite rose to the top, forming the highlands. The anorthosite is believed to be the most ancient type of moon rocks; it is the material of the original lunar crust. On the other hand, the mare basalt formed from lava flooded on the lunar crust; hence it must be a relatively shallow layer over the anorthosite.

Figure (c) shows another rock type **breccia**, commonly exists in impact melt and ejecta terrain. It is made up of different types of rock fragments cemented mechanically by the heat and pressure of a meteorite impact. The lunar regolith (Image NASA 021 in previous page) acts as the cementing agent.

A special type of lunar basalt or breccia was found in PKT (Oceanus Procellarum, Mare Imbrium and its southern region). The rock, uniquely named KREEP, is relatively rich in potassium (K), rare-earth elements (REE), phosphorus (P) as well as radioactive elements such as thorium and uranium. It is these radioactive elements that had given the heat energy to support the viscosity of magma in the early Moon's interior. KREEP is incompatible to common rock-forming process and hence it floated to the upper lunar crust in the last chemical differentiation (crystallization) of the magma ocean. The presence of KREEP enables scientists to trace the pre-mare volcanic history of the Moon.

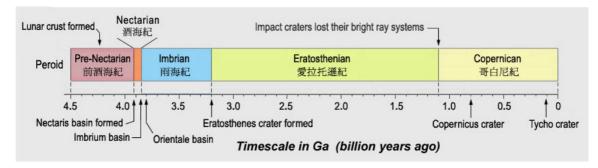


A minor group of rocks named **Mg-suite** also exists in some lunar highlands. It is Magnesium-rich, but its origin and how it reached the highlands are not well understood. Some proposed that the Mg-suite formed at depths deeper than the source region of mare basalts, and massive overturning in the interior of the early Moon brought these rocks within the reach of surface. The Mg-suite appears KREEP-related, because both rock types tend to concentrate in PKT.

During massive impact, some ejecta pieces escaped from the Moon's gravity. A rare number reached Earth as lunar meteorites. So far about 30 lunar meteorites have been known through comparison with rock samples from the Apollo.

Lunar Geologic Timescale

The lunar geologic (or selenologic) timescale is divided into several unequal periods, beginning as early as 4.55 Ga (one Ga = 1 billion years ago) when the Moon had accreted from impact debris that orbited around the Earth.



- <u>4.55 4.5 Ga</u> The initial Moon was red hot due to the giant impact and accretion. The global surface was covered by a magma ocean possibly 800 km thick. A second model suggests the entire globe was molten due to heat released by the decay of radioactive elements in the deep interior.
- <u>Pre-Nectarian 4.5 3.92 Ga</u> The magma ocean was cooling down through chemical differentiation, primarily the crystallization of minerals which are the basic components of rocks. Heavy minerals (e.g. pyroxene 輝石 and olivine 橄欖石) sank to the mantle. Less-dense minerals (e.g. plagioclase feldspar 斜長石) rose to form the most ancient anorthosite crust. The KREEP and other minorities were the last to intrude into the crust. Due to asymmetric crystallization, the crust was not uniform in thickness. Some oldest craters and about 30 impact basins including the farside South-Pole Aitken are recognized in this period.
- <u>Nectarian 3.92 3.85 Ga</u> This period corresponds approximately to the transient stage of LHB (Late Heavy Bombardment) mentioned earlier. At least 10 impact basins, including the nearside Nectaris, Serenitatis, Crisium and Humorum basins are recognized. Their ejecta formed the upper layer of the rugged and cratered terrain found in the highlands.
- Imbrian 3.85 3.2 Ga The Imbrium basin on the nearside marks the beginning of this era. Other impact basins formed progressively in the next 100 million years, including the youngest Orientale on the farside. Intensive lava-flooding inside the basins and large craters (e.g. Archimedes Map 14 and Plato Map 16) followed to produce mare basalts. The flooding might repeat at different time sessions within millions of years, hence it reshaped the pre-existing terrain. Localized volcanism was active.

Remark: Sometimes the Imbrian period is subdivided into Lower Imbrian and Upper Imbrian epochs. The Lower Imbrian ranges from 3.85 to about 3.75 Ga (formation of relatively young basins). The Upper Imbrian ranges from about 3.75 to 3.2 Ga (formation of maria). This subdivision, however, is obscure.

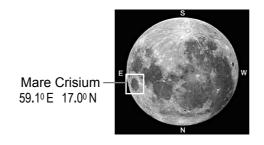
- <u>Eratosthenian 3.2 1.1 Ga</u> Volcanism faded and virtually ended in about 3.0 Ga. Less intensive bombardment continued to form craters. Most craters, such as Eratosthenes formed in the beginning of the period, lost their ejecta rays gradually through space weathering by cosmic rays, solar winds and micrometeoroids. By the end of this period, old (pre-existing) impact craters were virtually lack of bright rays.
- <u>Copernican 1.1 Ga Present</u> Additional impact craters such as Copernicus and Tycho formed in this
 period although the impact rate was slow. They are relatively young and hence able to preserve their ejecta
 rays in visibility. At present a thin layer of regolith has accumulated over the lunar surface. It is a source for
 the studies of space weather because it traps the atoms from the Sun and cosmic rays apart from the Moon.

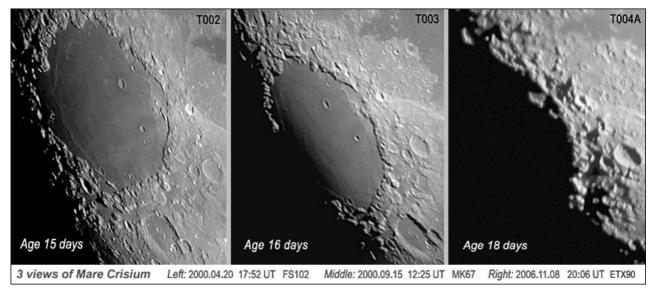
For comparison: Copernicus on the Moon formed 0.8 Ga; Tycho formed 0.1 G.a. The most ancient life on Earth dates to 3.5 Ga; creature lives bloomed 0.5 Ga; dinosaurs became extinct 0.065 Ga.

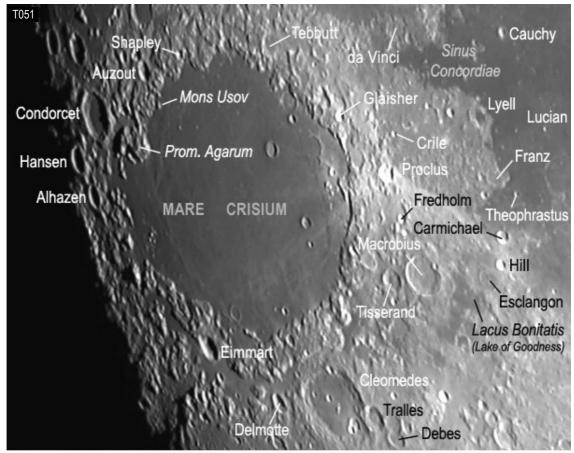
Due to limited samples of Moon rocks and the possibility of land reshaping on the lunar surface in the very ancient past, there is still much debate to mark certain key events along the geologic timescale. The timescale is therefore a general marker of lunar evolution and not the absolute age of surface features.

Mare Crisium, Proclus, Palus Somni, Cleomedes, Messala

Hatfield 3, 4 Rükl 26, 27, 37, 38, 16







MARE CRISIUM 2004.08.31 19:07 UT Age 15 days. Longitudinal libration 6°. 10-in f/6 + ToUcam at prime focus

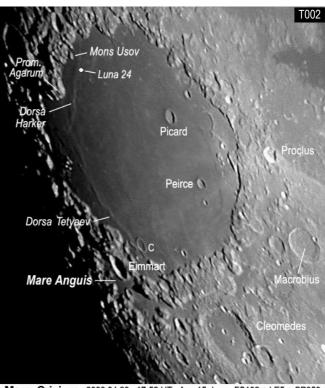
Mare Crisium (Sea of Crises) is a dominating feature near the east limb of the Moon. It is a dark, lava-filled basin surrounded by mountain walls. The mountains average to 3000 m high. The mare measures approximately 560 km east-west and 420 km north-south, but to Earth the north-south diameter always appears longer due to foreshortening. Mare Crisium is the site of a gravity anomaly known as a "mascon," or mass concentration that represents thick accumulation of dense lava, or the fragments of an impactor that created the basin buried beneath the mare surface. Mascons exist in other mare regions and few flat-floored craters as well, e.g. Mare Imbrium, Mare Humorum, Mare Orientale, craters Ptolemaeus and Grimaldi; details in the maps of Moon Data page. Their high-gravity causes lunar satellites orbiting at low altitudes to either impact the Moon or to be flung out into interplanetary space after a few years.

Under oblique illumination, concentric wrinkle ridges are visible along the inner circumference of Mare Crisium. The most apparent wrinkle ridges are *Dorsa Harker* and Dorsa Tetyaev on the eastern edge (Image T002); they measure $180 \sim 200$ km in length. Crater *Eimmart C* happens to locate on the northern tip of Dorsa Tetyaev, and the combined formation resembles a string looped at one end. The neighbor of *Eimmart* is an irregular patch of lava named Mare Anguis (Serpent Sea); it seems to be a leak piece from Mare Crisium. The cape on the southern edge is *Promontorium Agarum*; it rises about 5000 m above the mare and looks almost disconnected from the rest of the highlands. In 1976, the former USSR probe, Luna 24, returned soil samples from the vicinity of Promontorium Agarum.

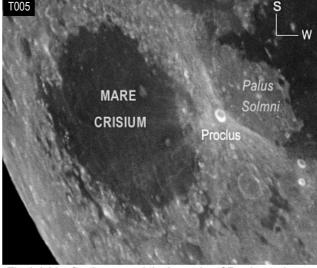
The end pages of this map give the closer views of Crisium region.

Proclus 46.8° E 16.1° N **Palus Somni** 45.0° E 14.1° N

Proclus is a prominent impact crater on the western highlands of Mare Crisium. It has sharp rim and rough floor, 28 km in diameter, 2400 m deep. Its ejecta begins to shine as asymmetrical pattern of rays around Moon age of $5 \sim 6$ days, gradually glowing up to be one of the brightest features on the entire Moon. The longest rays slide through the dark floor of Mare Crisium. The asymmetrical ray pattern is an evidence of a grazing impact, in which the space impactor intruded from southwest (top right corner of T005) and hit the Moon surface at very low angle, likely a

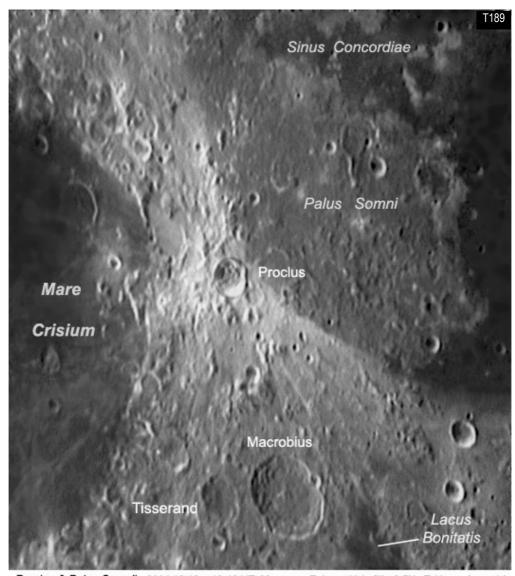


Mare Crisium 2000.04.20 17:52 UT Age 15 days. FS102 + LE5 + CP950



The bright reflection around the inner rim of Proclus makes this crater resembling a bull's eye. (2000.06.15 16:28UT Age 13 days)

few degrees from ground. A low-angled impact is characterized by ejecta in confined directions. The lower the impact angle, the more unidirectional the ejecta is. This explains *Palus Somni* (Marsh of Sleep), a diamond-shaped area at immediate west of Proclus, is lack of Proclus' ejecta rays. Palus Somni measures 150 km east-west and looks neither a complete highland nor dark mare. Its northern floor is rough but the southern floor is relatively flat. The peculiar gray tone of Palus Somni has been a study subject by astrogeologists.



Proclus & Palus Somnii 2004.12.19 ~12:13 UT Moon age 7 days. 10-in f/6+2.5X+ToUcam (mosaic)

Macrobius 46.0° E 21.3° N

An impact crater with terraced walls and central peaks, 64 km in diameter. Its rim is interrupted by a small crater. The adjacent *Tisserand* (36 km) looks like a small version of Macrobius. A small irregular patch of mare named *Lacus Bonitatis* (Lake of Goodness) spreads in the vicinity; its full view is given in T051, starting page.

Sinus Concordiae 43.2° E 10.8° N

Bay of Concord, an inconspicuous bay-like mare adjoining the southern edge of Palus Somni, east-west length about 140 km.

(Image T111)

O'Neill's Bridge 49.2° E 15.2° N This nicknamed feature, firstly noted by amateur John O'Neill in 1953, is elusive. It is noticeable shortly after the full Moon when the terminator approaches the west edge of Mare Crisium. During unfavorable seeing, it resembles a bridge connecting two spiky capes: *Promontorium Lavinium* and *Promontorium Olivium* (both are unofficial names). When seeing is good, it resolves into two adjoined, small eroded craters.

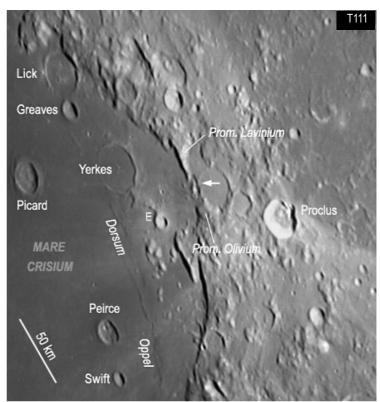
Picard 54.7° E 14.6° N **Peirce** 53.5° E 18.3° N

Picard (diameter 22 km) and Peirce (18 km) are the most noticeable craters on the floor of Mare Crisium.

Lick 52.7° E 12.4° N **Yerkes** 51.7° E 14.6° N

This is a pair of similar shaped flooded craters. Lick is 31 km in diameter. Yerkes

is 36 km and connects to a satellite crater (Yerkes E, 10 km) through a ridge.



O'Neill's Bridge (arrow) is a nicknamed feature composed of two adjoined, small eroded crater. 2004.08.31 16:53 UT Age 15 days. 10-in f/6 + 2.5X + ToUcam

Dorsum Oppel 52.6⁰ E 18.7⁰ N

The most noticeable wrinkle ridges on the western edge of Mare Crisium, length 270 km. This dorsum, together with *Dorsa Harker* and *Dorsa Tetyaev* on the eastern edge (Image T002), form a concentric ring of mare ridges. All sizeable lava-flooded impact basins on the Moon, including Mare Crisium, are characterized by concentric mare ridges.

(Images in next page)

 Cleomedes
 56.0° E
 27.7° N

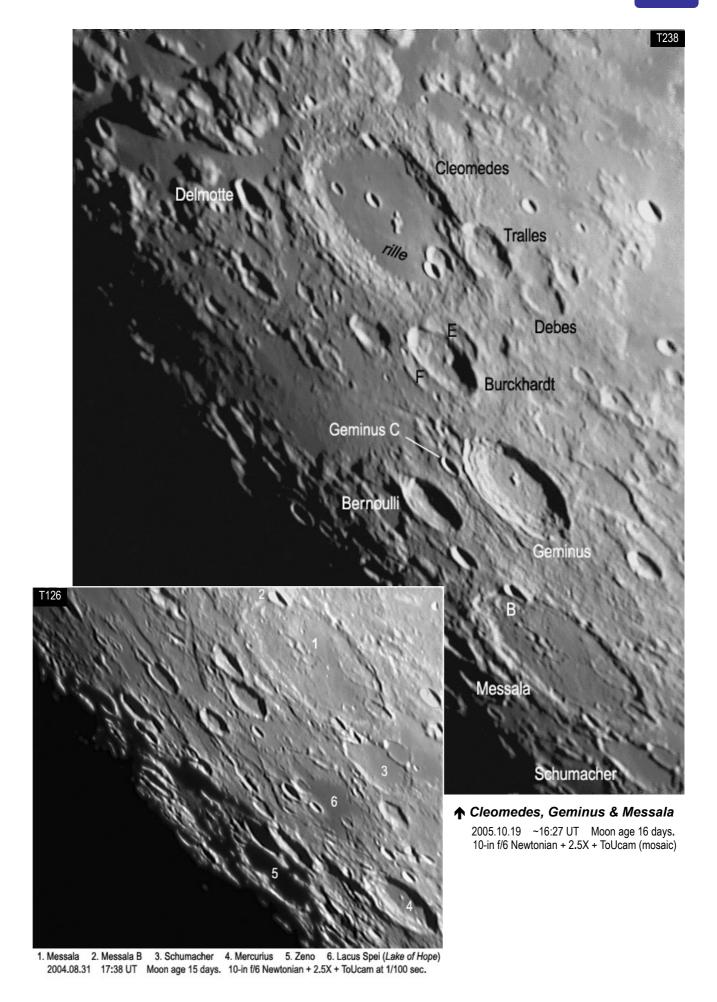
 Geminus
 56.7° E
 34.5° N

 Messala
 60.5° E
 39.2° N

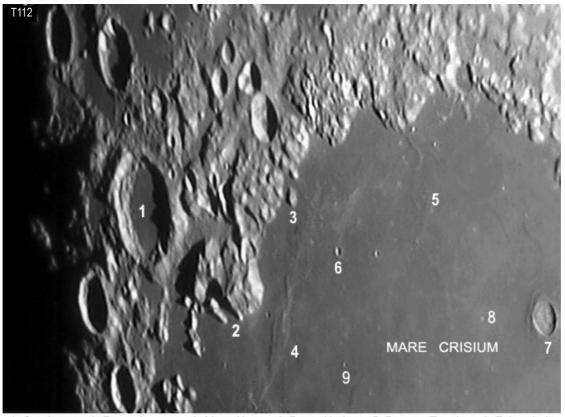
Cleomedes is a prominent crater in the north of Mare Crisium. It is 125 km in diameter, with small craters, central peaks and an elusive rille (*Rima Cleomedes*) on the floor. Its northern wall is somewhat eroded and interrupted by the smaller crater *Tralles* (43 km). On the contrary, *Burckhardt* (56 km) is a bigger crater that overlaps a close pair of small craters (*Burckhardt E* & *Burckhardt F*). This is an exception of the trend that small craters superposed on larger ones.

Further north of Cleomedes are two small craters *Geminus C* and *Messala B*. They appear no special near the terminator but become centers of bright rays during the full moon. *Geminus* itself is 85 km across, with a central peak and a wide cleft cutting on the southern rim. *Messala* is a fairly large walled plain with irregularities on the floor, 125 km in diameter.

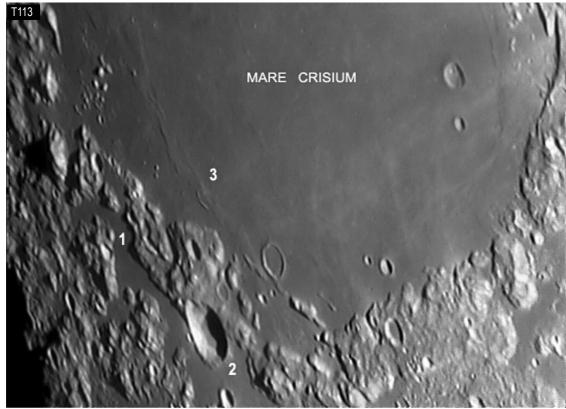
Lacus Spie (Lake of Hope) 65.0° E 43.0° N A small lava plain, about 80 km across.



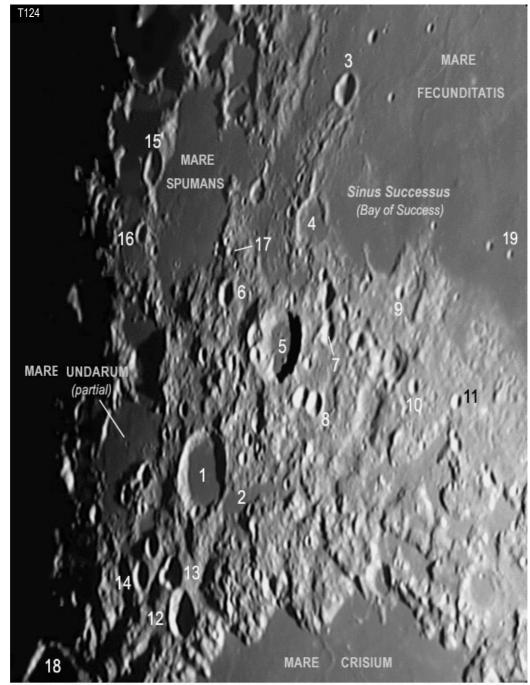
Features along the edges of Mare Crisium



1. Condorcet 2. Prom. Agarum 3. Mons Usov 4. Dorsa Harker 5. Dorsum Termier 6. Fahrenheit 7. Picard 8. Curtis 9. Eckert 2004.08.31 18:38 UT Age 15 days. 10-in f/6 Newtonian + 2.5X + ToUcam



1. Mare Anguis (Serpent Sea) 2. Elmmart 3. Dorsa Tetyaev 2004.08.31 18:54UT Age 15 days. 10-in f/6 + 2.5X + ToUcam



South of Mare Crisium 2004.08.02 ~17:53 UT Age 16 days. 10-in f/6 Newtonian + 2.5X + ToUcam

- **1. Firmicus** (63.4°E 7.3°N, diameter 56 km)
- 2. Lacus Perseverantiae (Lake of Persistence, a small wedge-shaped lava plain extruded from Firmicus.)

 3. Webb (60.0 E 0.9 S, diameter 21 km)

 4. Condon (60.4 E 1.9 N, diameter 34 km)

- **5. Apollonius** (61.1°E 4.5°N, diameter 53 km)
- **6. Townley** (63.3°E 3.4°N, diameter 18 km)

- 7. Cartan (59.3°E 4.2°N, diameter 15 km) 8. Daly (59.6°E 5.7°N, diameter 17 km) 9. Ameghino (57.0°E 3.3°N, diameter 9 km)

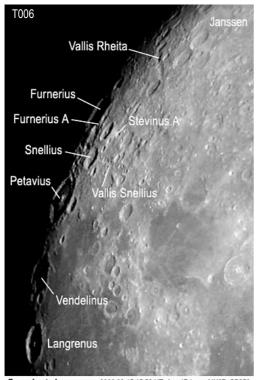
- **10. Bombelli** (56.2°E 5.3°N, diameter 10 km)
- **11. Abbot** (54.8°E 5.6°N, diameter 10 km)
- **11. Abbot** (54.0 E 5.0 N, diameter 10 km) **12. Auzout** (64.1 E 10.3 N, diameter 32 km) **13. van Albada** (64.3 E 9.4 N, diameter 21 km) **14. Krogh** (65.7 E 9.4 N, diameter 19 km) **15. Pomortsev** (66.9 E 0.7 N, diameter 23 km)

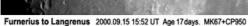
- **16. Stewart** (67.0°E 2.2°N, diameter 13 km)
- **17. Petit** (63.5°E 2.3°N, diameter 5 km)
- **18. Condorcet** (69.6°E 12.1°N, diameter 74 km)
- **19. Smithson** (53.6°E 2.4°N, diameter 5 km)

Hatfield 15, 16 Rükl 49, 59, 60, 69

Langrenus, Vendelinus, Petavius, Furnerius









Petavius to Langrenus 2000.04.20 17:58 UT Age 15 days. FS102+CP950 1/4 sec DSCN1591

The magnificent chain of craters in Image T006 — The Great Eastern Chain — lines up on the terminator when the Moon age is $15 \sim 17$ days.

Langrenus $61.1^{\circ}E$ $8.9^{\circ}S$

A prominent crater with terraced walls, central twin peaks and hilly floor, 127 km in diameter. The walls rise to nearly 3000 m high. At high illuminations, the floor takes on a distinctly yellowish-brown tint, compared to its surroundings. At full moon, Langrenus emits bright rays. In the past, the crater was reported a site of LTP (lunar transient phenomena) gas glow.

Vendelinus 61.6° E 16.4° S

A worn walled plain, dia 131 km. Its rim is interrupted by *Lamé* (84 km) and few smaller craters.

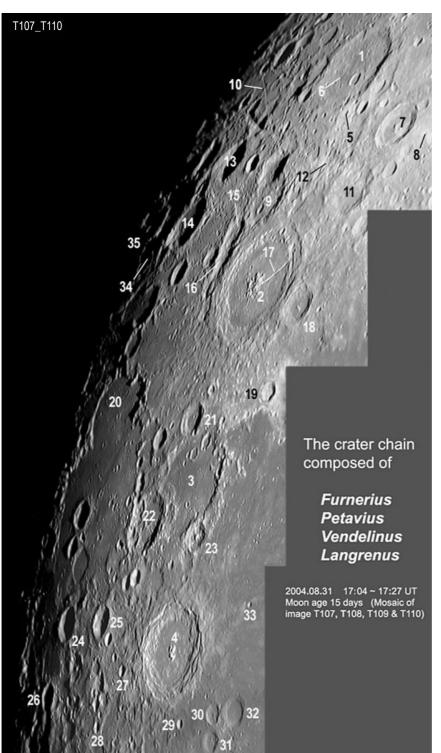
Petavius 60.4° E 25.2° S

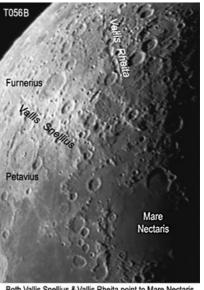
A large ring mountain with central peaks, clefts and dark patches on its floor, 188 km in diameter, 3300 m deep. Part of the ring mountain splits into a double wall. The cleft running from central peaks to the south-western wall (main part of *Rimae Petavius*) is very distinct. Minor clefts also run on the northern floor. In fact the whole floor of Petavius is fractured, likely caused by post-volcanism that took place inside the crater. The western wall of Petavius is flanked by Wrottesley (57 km) and the eastern wall is flanked by a crater-valley pair, Palitzsch (41 km) and *Vallis Palitzsch* (130 x 20 km). Petavius is very bright during the full moon.

Furnerius 60.6° E 36.0° S

Furnerius is a walled plain, 135 km in diameter. Its northern wall is heavily worn. Its floor contains lava patches, an off-center crater and a rille (*Rima Furnerius*, length 50 km). Outside the northern wall is *Vallis Snellius*, a 590 km-long valley pointing towards the impact basin that holds *Mare Nectaris*, see Image T056B. The valley floor appears as a chain of many overlapping craters. Similar to Vallis Rheita in Map 4, Vallis Snellius was created by secondary impacts during the formation of Nectaris basin.

Snellius, Petavius B, Furnerius A, **Stevinus A** These craters are centers of bright rays.





Both Vallis Snellius & Vallis Rheita point to Mare Nectaris.

- 1. Furnerius (Dia. 135 km)
- 2. Petavius (188 km)
- 3. Vendelinus (131 km)
- 4. Langrenus (127 km)
- 5. Furnerius A
- 6. Rima Furnerius
- 7. Stevinus (74 km)
- 8. Stevinus A
- 9. Hase (83 km)
- 10. Rimae Hase (83 km)
- 11. Snellius (82 km)
- 12. Vallis Snellius
- 13. Adams (66 km)
- 14. Legendre (78 km)
- 15. Palitzsch (41 km)
- 16. Vallis Palitzsch
- 17. Rimae Petavius
- 18. Wrottesley (57 km)
- 19. Petavius B
- 20. Balmer (138 km)
- 21. Holden (47 km)
- 22. Lamé (84 km)
- 23. Lohse (41 km)
- 24. Kapteyn (49 km)
- 25. Barkla (42 km)
- 26. von Behring (38 km)
- 27. Somerville (15 km)
- 28. Born (14 km)
- 29. Acosta (13 km)
- 30. Atwood (29 km)
- 31. Naonobu (34 km)
- 32. Bilharz (43 km)
- 33. Al-Marrakushi (8 km)
- 34. Phillips (122 km)
- 35. Humboldt (189 km, hidden)



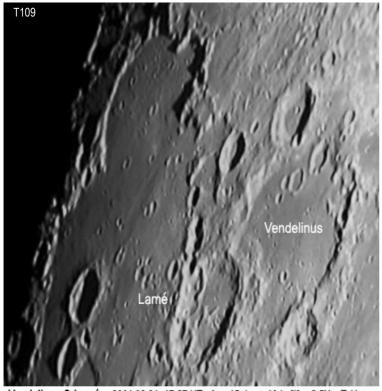
Furnerius 2. Furnerius A (bright)
 Stevinus 4. Stevinus A (bright)
 Rimae Hase 6. Snellius 7-7. Vallis Snellius (end to end)
 Adams 2004.08.31 17:14 UT Age 15 days. 10-in f/6+2.5X+ToUcam

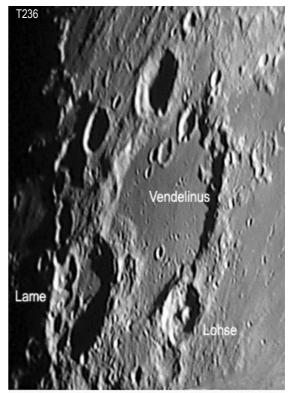


Petavius 2004.08.31 17:04 UT Age 15 days. 10-in f/6 scope



Petavius 2005.10.19 16:08 UT Age 16 days. 10-in f/6 Newtonian + 2.5X + ToUcam





Vendelinus & Lamé 2004.08.31 17:27 UT Age 15 days. 10-in f/6 + 2.5X + ToUcam

2004.08.02 18:15 UT Age16 days. 10-in f/6 + 2.5X + ToUcam



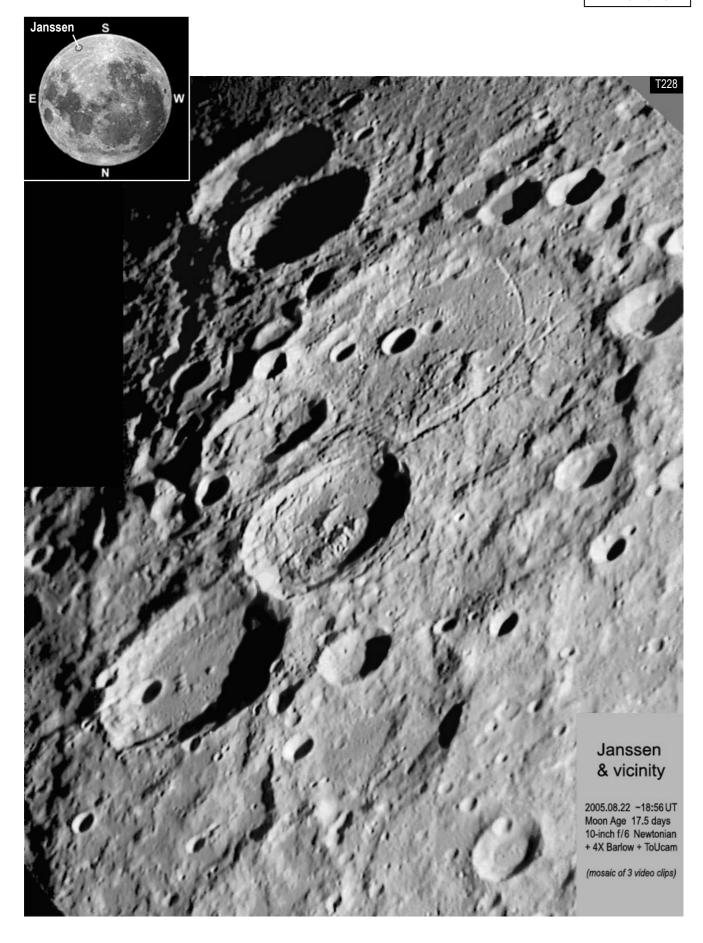
Langrenus 2004.08.31 17:16UT Age 15 days. 10-in f/6+2.5X+ToUcam

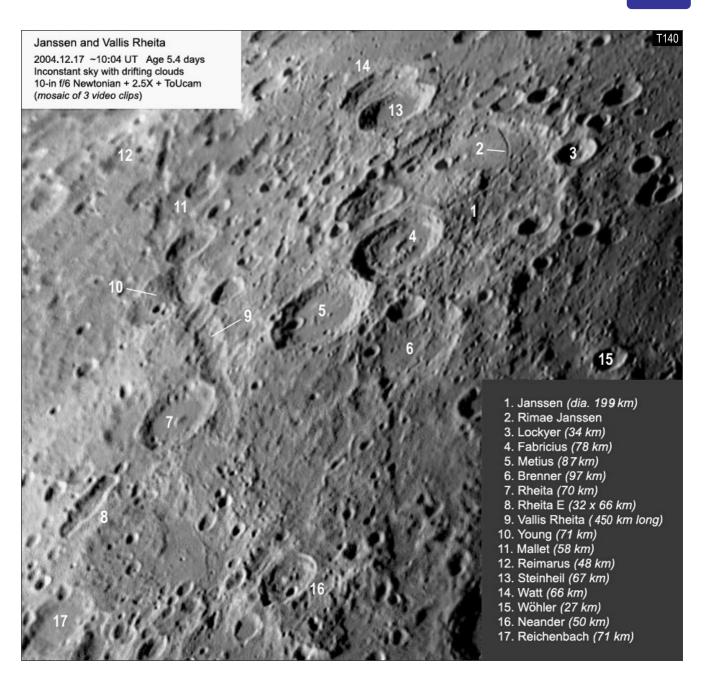


Langrenus 2004.08.02 18:10 UT Age 16 days. 10-in f/6 Newtonian + 2.5X + ToUcam

Hatfield 16 Rükl 67, 68, 69, 76

Janssen, Fabricius, Vallis Rheita, Mare Australe





Janssen 40.3° E 45.4° S

A large walled formation with craters, rilles and mountain massifs on its floor, 199 km in diameter. It is highly eroded by impacting debris and hence must be very ancient. The system of curved rilles that crosses the southern floor is *Rimae Janssen*, length about 120 km. So far no one knows how these curved rilles formed. The northwest wall of Janssen is broken by the fairly large crater *Brenner* (97 km).

Fabricius 42.0° E 42.9° S

This crater hits on Janssen. It is 78 km in diameter, with a small central peak. At one observation with small telescope, the wall appeared double, making it look as though one crater is almost perfectly centered in another. However, high-power telescopes confirm this is not a double wall but a lumpy ridge like a horse-shoe.

Metius 43.3° E 40.3° S

A crater joining the walls of Janssen and Fabricius, 87 km in diameter, with a low central peak.

Vallis Rheita 51.5° E 42.5° S

Vallis Rheita is a long valley near Janssen, 450 km in length, width up to 30 km. It begins from the outer rim of *Rheita* (70 km), passes through **Young** (71 km) and **Mallet** (58 km), then ends beyond **Reimarus** (48 km). The floor of Vallis Rheita appears as a chain of overlapping craters more than a true valley. The chain also points to Mare Nectaris (T056B, Map 3), suggesting it was created by secondary impacts during the formation of Nectaris basin. *Rheita E* is an elongated crater-valley feature, 32x66 km, probably created by the fusion of few pre-existing craters or by a grazing secondary impact during the formation of Janssen.

Young 50.9° E 41.5° S

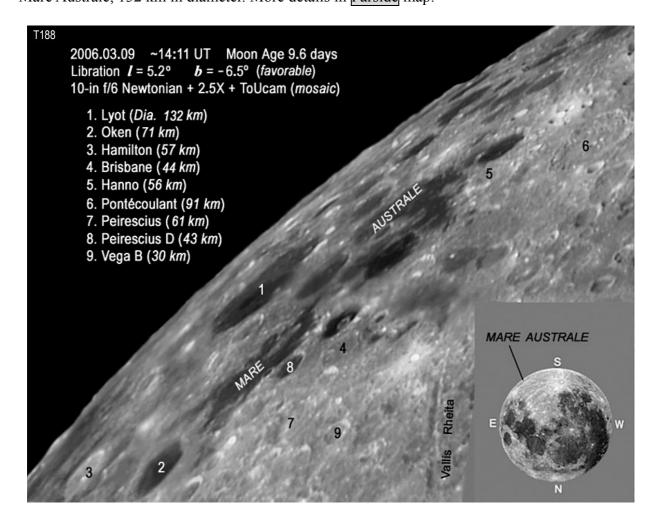
A shallow crater superimposed on Vallis Rheita, 71 km in diameter.

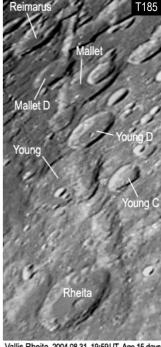
Steinheil 46.5° E 48.6° S Watt 48.6° E 49.5° S

A pair of overlapped craters, each about 67 km in diameter. The east inner wall of Steinheil houses a group of small but noticeable craters (T228).

Mare Australe 93.0°E 38.9°S (*Image T188*)

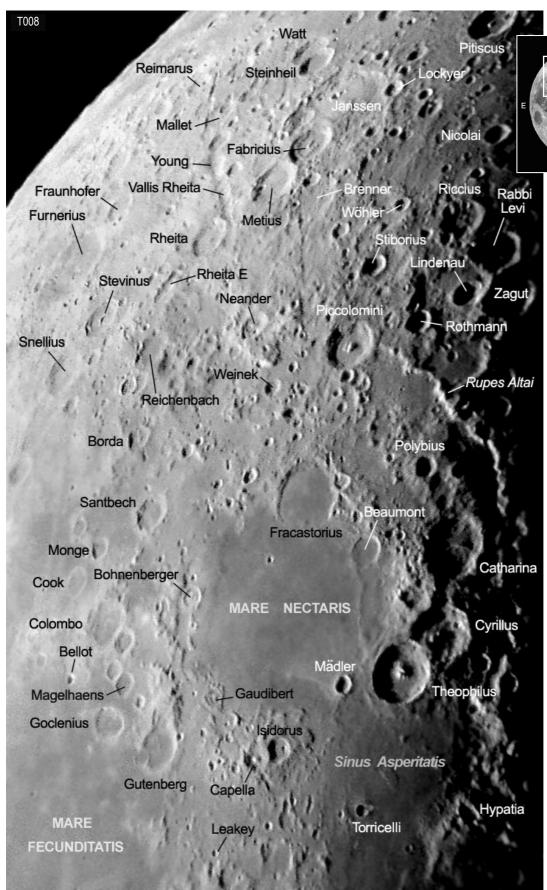
Mare Australe (Southern Sea) is on the south-east limb, overlapping the nearside and farside of the Moon. It is a difficult object due to foreshortening. Its dark irregular shape stretches 35° x 35°, covering a span of about 600 km. In Lunar Orbiter mapping, nearly 200 craters of different sizes are scattered in this mare, hence scientists thought Australe could be the most ancient mare among all. *Lyot* (84.5°E 49.8°S) is a large flooded walled plain lying within Mare Australe, 132 km in diameter. More details in Farside map.





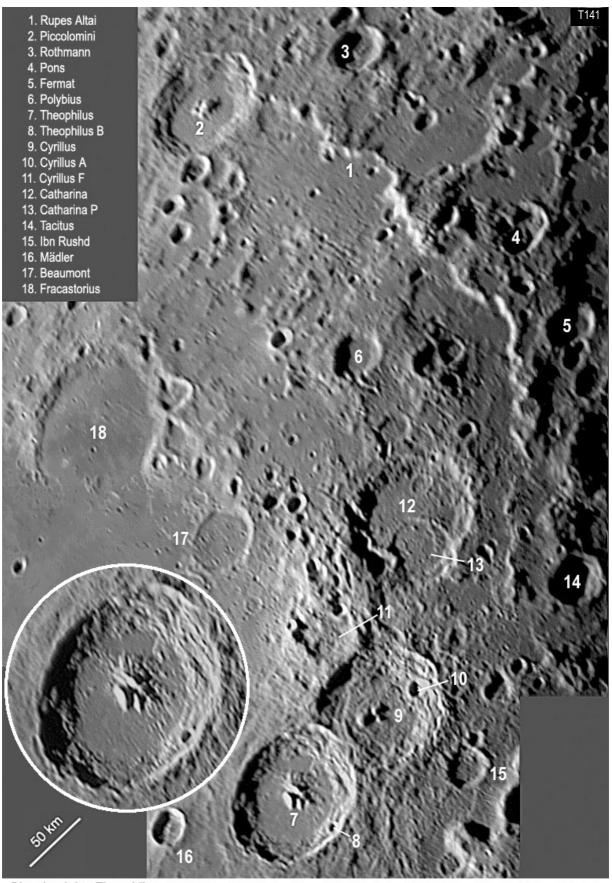
Hatfield 15, 13,14 Rükl 46, 57, 58, 67

Mare Nectaris, Theophilus, Cyrillus, Catharina, Piccolomini, Rupes Altai, Fracastorius



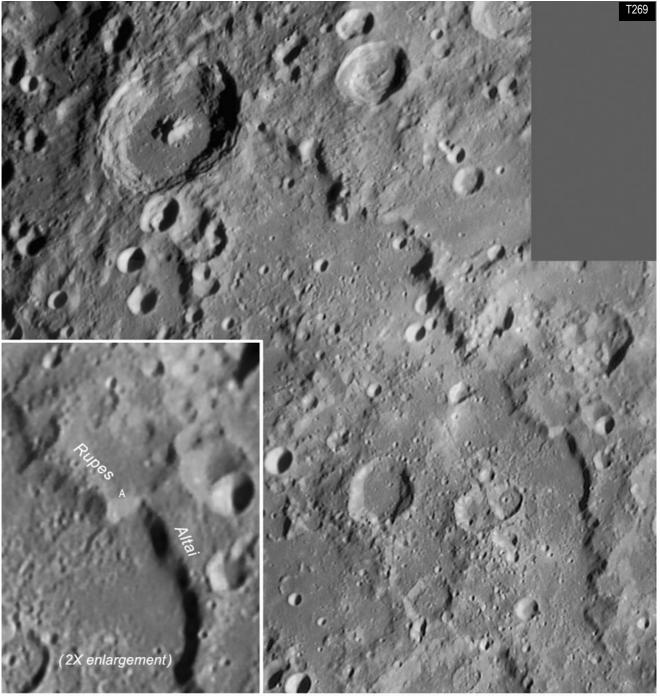
Janssen to Torricelli 2000.11.02 12:14 UT Age 6 days. FS128 + LE12.5 + QV2300 at 1/6 sec.

From Piccolomini to Theophilus



Piccolomini to Theophilus 2004.09.20 ~12:00 UT Age 6 days. 10-in f/6 Newtonian + 2.5X + ToUcam (Thumbnail is from 4X Barlow)

Piccolomini and Rupes Altai at Moon Age of 18 days



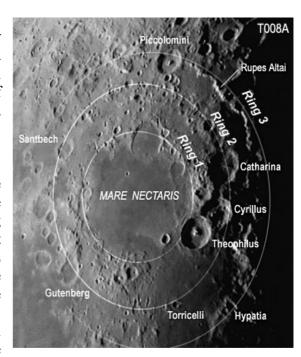
Piccolomini and Rupes Altai 2006.08.12 21:30 ~ 21:41 UT Age 18.5 days. 10-inch f/6 Newtonian + 2.5X + 1.6X + ToUcam, 95 % resized. (mosaic) The 2X enlargement shows a section of Rupes Altai with abrupt slope. Position A is roughly 1000 m higher than the foot of the cliff. Due to low surface gravity (1/6 that of Earth), a stone dropping from position A will take half minute to reach the ground.

<u>Remark</u>: Distance dropped by a free-falling object on the lunar surface is equal to $1/2 \cdot g \cdot t^2$, where g is the gravitational acceleration (= 1.62 m/s²) and t is the time of falling.

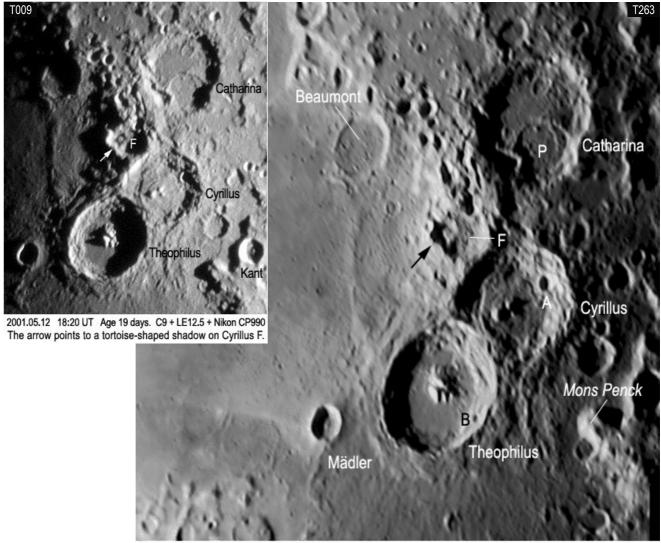
Mare Nectaris (Sea of Nectar) 35.5° E 15.2° S This is a small mare inside an impact basin, diameter about 330 km. The impact basin is traceable by a pattern of three concentric rings, as suggested in Image T008A. Rupes Altai lies on the outmost ring of the basin. Theophilus, Cyrillus and Catharina form a prominent crater trio between Ring 1 and Ring 2.

Theophilus 26.4° E 11.4° S

A ring mountain, 110 km in diameter. Its massive terraced walls rise 4000 m above the interior. These huge walls appear as two to three concentric ring mountain ranges, each successively lower to the next until the floor is reached. At lower powers Theophilus appears to be circular while higher powers show the walls to be composed of linear segments. On the north-western wall is a small crater *Theophilus B*. Theophilus also contains magnificent multiple central mountains with one of the peaks rising 1400 m above



the floor. Theophilus is a rayed center under high illumination.

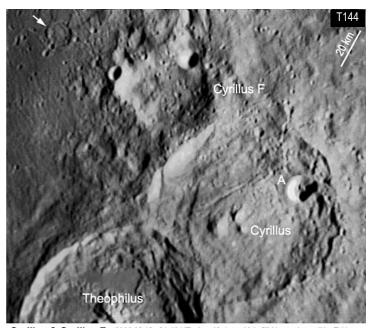


Theophilus, Cyrillus & Catharina 2006.07.31 12:18 UT Age 6.3 days. 10-in f/6 Newtonian + 2.5X + ToUcam (mosaic)

Cyrillus 24.0° E 13.2° S

A ring mountain with disintegrated wall and three central peaks, 98 km in diameter. It is obvious that the Theophilus impact destroyed a section of Cyrillus's walls. Cyrillus is therefore older than Theophilus. The southwest wall contains a small crater, Cyrillus A. The floor of Cyrillus does not appear smooth like the floor of Theophilus, but rough with ridges and depressions. The floor of Cyrillus F (diameter 44 km) also contains a shallow depression with central uplift. It casts a tortoise-shaped dark shadow during Moon age of 18~19 days. (Image T009 & T144).

In the vicinity of Cyrillus F is an Cyrillus F 2006.08.12 21:43 UT Age 18 days 10-in f/6 Newtonian + 4X + ToUcam interesting trio of craters (Beaumont A + 2 craterlets) that resembles a magnifying glass.



The arrow points to an interesting crater trio (Beaumont A + 2 craterlets) that resembles a magnifying glass

Catharina 23.4° E 18.1° S

A ring mountain with disintegrated wall, 104 km in diameter. Catharina is connected to Cyrillus by a broad valley, and is believed the oldest of the trio. It has been nearly obliterated by several impacts. There are big and small craters on its floor (the most prominent being *Catharina P*), but no sign of central peaks. The central peaks must have existed years ago but finally overwhelmed by Catharina P.

Mädler 29.8° E 11.0° S

A 27-km crater. Its ejecta blanket is fan-like and relatively whitish. See also Map 7.

Piccolomini 32.2⁰ E 29.7⁰ S

A prominent crater with terraced walls and central peaks, 87 km in diameter, 4500 m in depth.

Rupes Altai 22.6° E 24.3° S

A sinuous mountain fault running between Piccolomini and Catharina, about 450 km in length. It is the remains of the rising rim of an impact basin in which the central part is Mare Nectaris. See also Image T008A. The slope of this fault toward Mare Nectaris drops 1000 m in average.

(Image T245, next page)

Lindenau 24.9° E 32.3° S

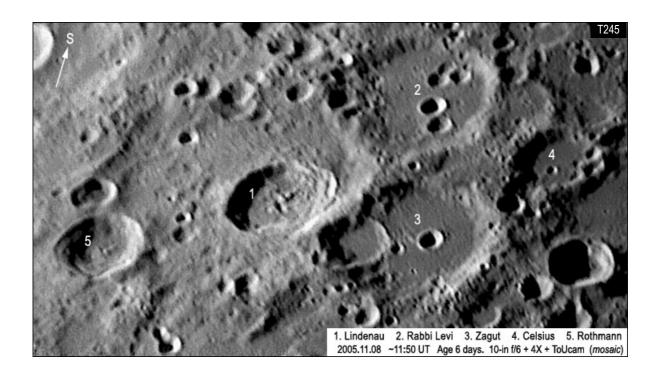
A prominent terraced crater with multiple central peaks, 53 km in diameter, 2900 m in depth.

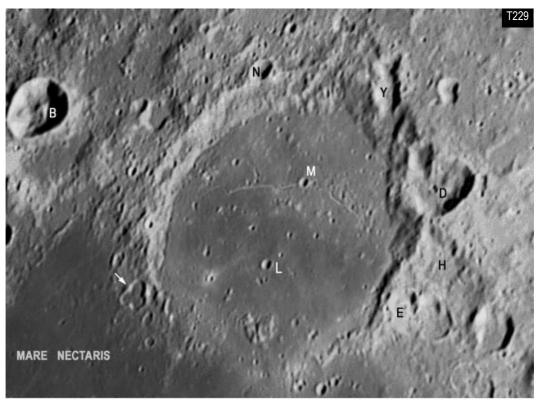
Rabbi Levi 23.6° E 34.7° S

An 81-km crater with 5 smaller but prominent ones on the floor. Its eastern wall is heavily ruined by a cluster of impact craters.

Zagut 22.1° E 32.0° S

A crater adjoining Rabbi Levi, 84 km in diameter. Its floor contains a small central crater. Its southeastern wall looks linear and interrupted by a fairly large crater (**Zagut E**, diameter 35 km).





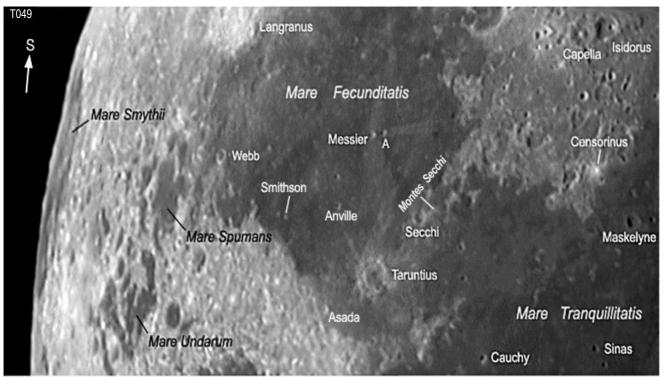
Fracastorius 2005.08.22 19:07 UT Age 17.5 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam, 93 frames stacked.

Fracastorius 33.2° E 21.5° S (*Image T229*)

An incomplete walled plain, 112 km in diameter. Its bay-like floor opens to Mare Nectaris and contains a long narrow, unnamed rille that intersects *Fracastorius M*. This rille is rather elusive to spot unless the illumination angle is appropriate. The floor also contains a tiny rayed crater and dome-like hills. The western wall of Fracastorius is partially ruined by irregular craters *Fracastorius Y, D* and *H*. Note the interesting crater-trio formation (arrow in T229).

Hatfield 3 Rükl 36, 37, 47, 48

Messier, Censorinus, Taruntius, Cauchy



Messier A and Censorinus 2004.10.21 ~14:26 UT Age 8 days. Libration I = 3.3° b = 6.8°. 10-in f/6 + ToUcam at prime focus (mosaic)

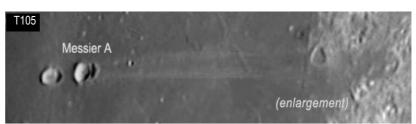
(Image T105)

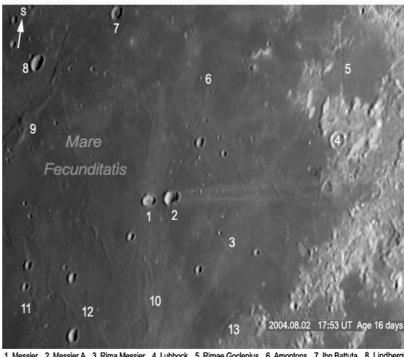
Messier 47.6° E 1.9° S **Messier** A 47.0° E 2.0° S

A pair of small impact craters in Mare Fecunditatis (Sea of Fertility), diameter 11 ~ 13 km. Messier looks oval in shape that is definitely not caused by foreshortening. Messier A is a double crater and hence looks somewhat elongated. Its ejecta splashs out as two long bright rays like a comet; each ray is over 100 km long towards the west. This crater pair probably formed simultaneously by a grazing binary or broken impactor.

Rima Messier 45.0° E 1.0° S An inconspicuous rille, length about 100 km.

Rimae Secchi 44.0° E 1.0° N An elusive short rille, length 35 km. It is in the south of **Secchi** (Label 13, T262 in next page).





Messier 2. Messier A 3. Rima Messier 4. Lubbock 5. Rimae Godenius 6. Amontons 7. Ibn Battuta 8. Lindbergh 9. Dorsa Mawson 10. Dorsa Cato 11. Dorsum Cayeux 12. Dorsum Cushman 13. Rimae Secchi (10-in f/6 Newtonian)

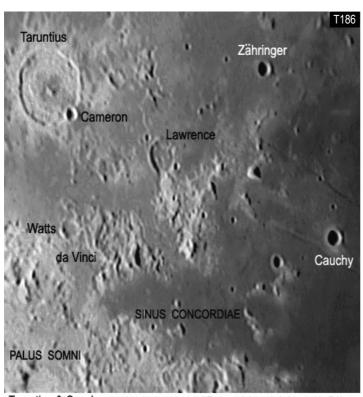


1. Messier 2. Messier A 3. Censorinus 4. Censorinus C 5. Censorinus N 6. Maskelyne 7. Maskelyne A 8. Leakey 9. Isidorus B 10. Torricelli 11. Lubbock 12. Secchi 13. Rimae Secchi 14. Montes Secchi 15. Menzel 2006.07.02 12:40UT Age 7 days. 10-in f/6 Newtonian + 2.5X + ToUcam

(Image 262)

Censorinus 32.7° E 0.4° S

A crater on the southern edge of Mare Tranquillitatis, 3 km in diameter. It is surrounded by a white halo and is exceptionally bright under high illumination.



Taruntius & Cauchy 2004.12.17 10:54 ~ 11:01 UT Age 5.4 days. 10-in 1/6 + 2.5X + ToUcam

Maskelyne 30.1°E 2.2°N

A crater with terraced walls and central peak, 23 km in diameter. Its rim is somewhat polygonal.

Secchi 43.5° E 2.4° N

A crater with broken wall, 22 km in diameter. Its western rim adjoins a narrow mountain range (*Montes Secchi*, length about 50 km).

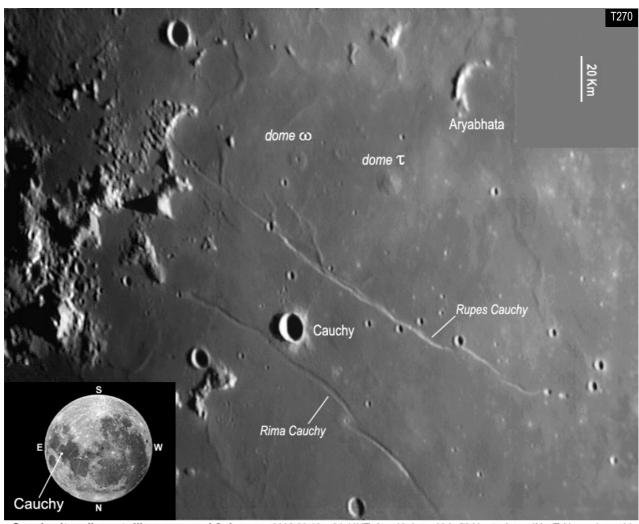
(Image T186)

Taruntius 46.5° E 5.6° N

A rayed crater at the "neck" between Mare Fecunditatis and Mare Tranquillitatis. It is 56 km in diameter, with concentric walls and a central peak rising from the partially darkened floor.

da Vinci 45.0° E 9.1° N

A heavily disintegrated crater, 37 km in diameter. Its floor is rough.



Cauchy, its adjacent rille, scarp and 2 domes 2006.08.12 ~21:11UT Age 18 days. 10-in f/6 Newtonian + 4X + ToUcam (mosaic)

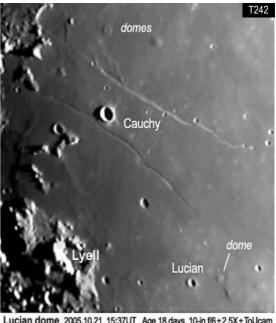
Cauchy 38.6° E $9.6^{0} \, \text{N}$

A 12-km crater with sharp rim, bright in the full moon. It sits between two parallel features: Rupes Cauchy (fault, length 120 km) and *Rima Cauchy* (rille, length 140 km). Their appearance is similar to Rupes Recta and Rima Birt in Map 12. Rupes Cauchy looks strange because its ends taper off to narrow rille segments. The twin probably formed when the lava floor of Mare Tranquillitatis was under excessive stress. To the south are two domes designated *Cauchy* **Omega** (ω) and **Cauchy Tau** (τ). They are visible only at low illumination. Each dome has a summit craterlet, but the one on Tau is less distinctive.

Aryabhata 35.1° E 6.2^{0} N

A heavily flooded crater, 22 km in diameter. Its western wall is overwhelmed in lava.

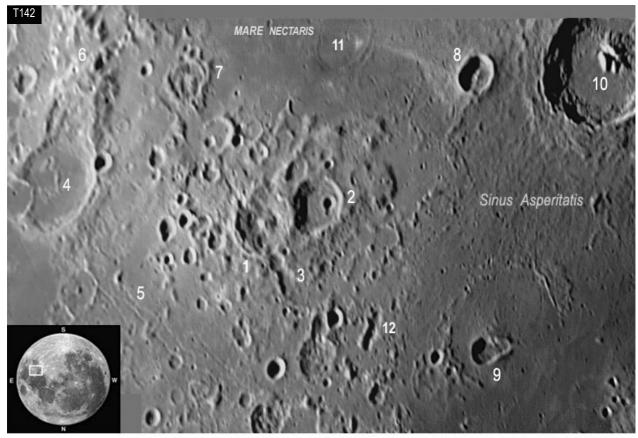
Lucian 36.7° E 14.3^{0} N A 7 km-crater. It has a nearby dome.



Lucian dome 2005.10.21 15:37UT Age 18 days. 10-in f/6+2.5X+ToUcam

Hatfield 15 Rükl 47, 48, 58

Capella, Isidorus, Torricelli, Bohnenberger, Gutenberg



1. Capella 2. Isidorus 3. Vallis Capella 4. Gutenberg 5. Rimae Gutenberg 6. Montes Pyrenaeus 7. Gaudibert 8. Mädler 9. Torricelli 10. Theophilus 11. Daguerre 12. a crater-valley 2004.09.20 ~11:17 UT Age 6 days. 10-in f/6 Newtonian + 2.5X + ToUcam.

Capella $35.0^{0} \,\mathrm{E}$ $7.5^{0} \,\mathrm{S}$

A crater in the north of Mare Nectaris, 49 km in diameter. It has an oversized central peak with a summit pit. A valley cuts through Capella and the adjacent smaller craters. The northern section of this valley (*Vallis Capella*) is composed of two overlapped craters, length 50 km. If Image T142 is turned clockwise, Capella resembles a monkey face.

Isidorus 33.5°E 8.0°S

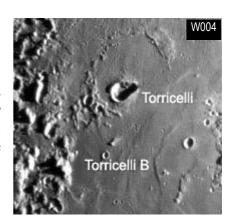
A crater with relatively flat floor, 42 km in diameter. Its wall is interrupted by Capella. It has no central peak. A prominent crater (*Isidorus A*, 10 km) is located on the floor near the western rim. A nameless crater-valley feature, formed by overlapping craters, exists in the north of Isidorus.

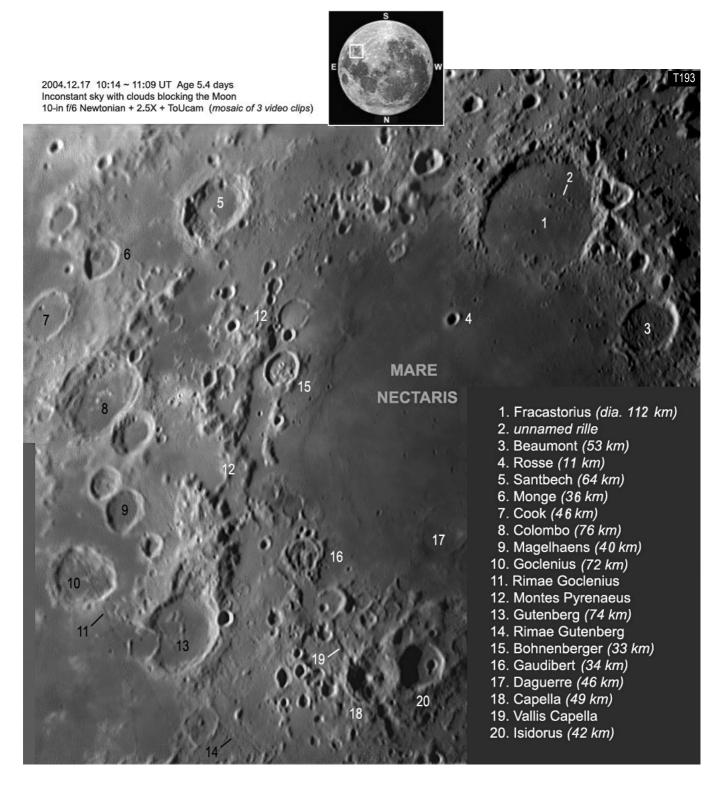
Mädler 29.8° E 11.0° S

A 27-km crater with prominent ejecta blanket. See also Map 5

Torricelli $28.5^{\circ}E$ $4.6^{\circ}S$

Torricelli is a strange-looking crater, 22 km in diameter. It is inside a ghost crater located in an uneven mare called *Sinus Asperitatis* (Bay of Roughness). The western wall of Torricelli is open and linked with a smaller crater, so that the whole formation appears pear-shaped.





Fracastorius Details in Map 5.

Gaudibert 37.8° E 10.9° S (*Image T193, Label 16*)

A crater with internal massifs and ridges, 34 km in diameter. Its southern wall adjoins a trio of small craters while the rest of the walls are surrounded partially by mountain ranges.

Daguerre 33.6° E 11.9° S (T193, Label 17 and T142, Label 11)

A ghost crater in Mare Nectaris, 46 km in diameter. A rayed craterlet is in the inner western floor.

Santbech 44.0° E 20.9° S **Colombo** 45.8° E 15.1° S

These are typical craters with terraced walls, central peaks and relatively flatten floor. Santbech is 64 km in diameter, Colombo is 76 km.

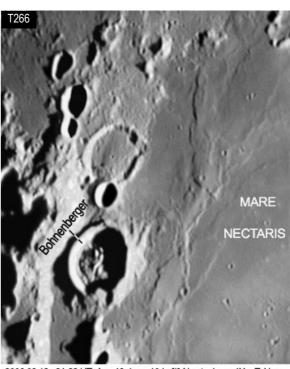
Bohnenberger 40.0° E 16.2° S

A crater with internal low hills, 33 km in diameter. It rests on the eastern edge of Mare Nectaris where wrinkle ridges are prominent at Moon age of 18 days.

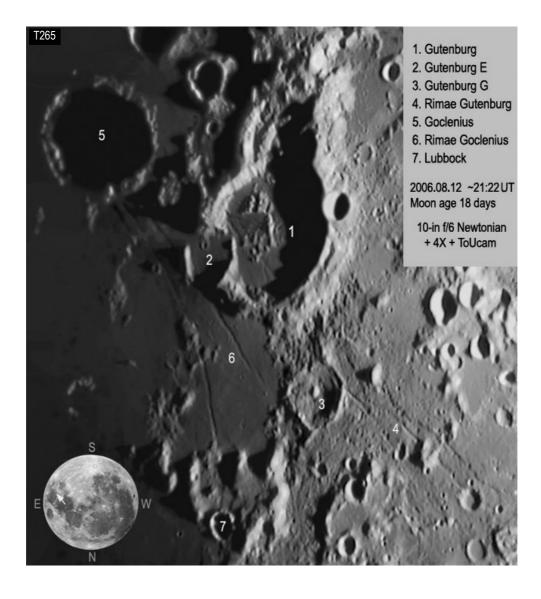
Gutenberg 41.2° E 8.6° S

A flooded crater, 74 km in diameter. Its eastern wall is broken by a smaller flooded crater. Two wide systems of rilles, *Rimae Gutenberg* (length 330 km) and *Rimae Goclenius* (length 240 km) run in the vicinity.

Montes Pyrenaeus 41.2° E 15.6° S (*Image T193*) Mountain range from the south of Gutenberg to Bohnenberger and beyond, length 164 km. It appears as part of the rising rim of the Nectaris impact basin.

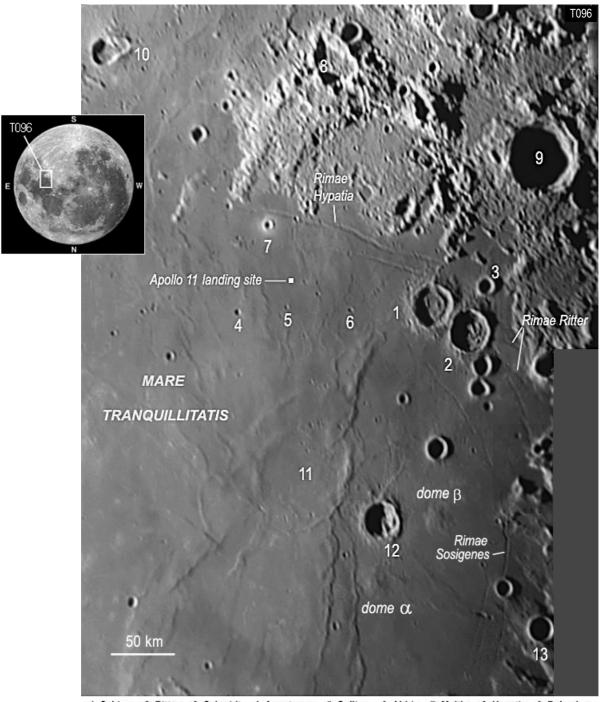


2006.08.12 21:23 UT Age 18 days. 10-in f/6 Newtonian + 4X + ToUcam



Hatfield 1,13 Rükl 35, 46

Sabine, Ritter, Hypatia, Delambre, Arago, Lamont



1. Sabine 2. Ritter 3. Schmidt 4. Armstrong 5. Collins 6. Aldrin 7. Moltke 8. Hypatia 9. Delambre 10. Torricelli 11. Lamont 12. Arago 13. Sosigenes 2004.09.20 11:13UT Age 6 days. 10-in f/6+2.5X+ToUcam

Sabine 20.1° E 1.4° N **Ritter** 19.2° E 2.0° N

Two adjoining craters near the equator, each about 30 km in diameter and with rough floors. A prominent ridge intersects the southern rim of Sabine. On 1969 July 20, the Apollo 11 Lunar Module landed on the east of Sabine. The landing site is a flat area called *Statio Tranquillitatis* (Tranquillity Base). It is truly flat and was chosen by the Apollo mission planners to prevent any obstacle or hazard during final descent. To honor this pioneer expedition, three nearby craters are named after *Armstrong* (4.6 km), *Collins* (2.4 km) and *Aldrin* (3.4 km). Armstrong is the Apollo 11 astronaut who first set his foot on the Moon; Collins and Aldrin are other crew members.

Two systems of parellel rilles, *Rimae Hypatia* (length 200 km) and *Rimae Ritter* (length 100 km) are in the close vicinity of Sabine and Ritter.

Moltke 24.2° E 0.6° S

A small crater with a bright halo, 6 km in diameter. The bright halo makes easier to recognize where crater Armstrong should be.

Hypatia 22.6° E 4.3° S

A curiously shaped crater. It measures 28 x 40 km and appears to sit on its own plateau.

Delambre 17.5° E 1.9° S

A terraced crater, 51 km in diameter, about 3000 m deep.

Arago $21.4^{\circ}E$ $6.2^{\circ}N$

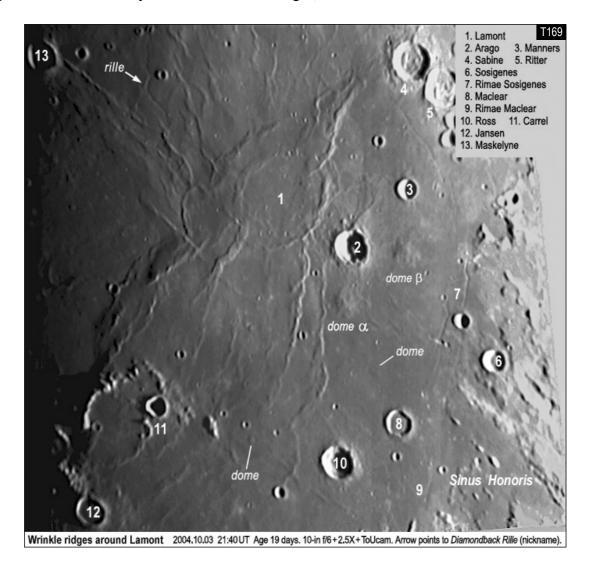
A crater with sharp rim and ridged floor, 26 km in diameter. Two domes (α, β) and few smaller domes are in the vicinity.

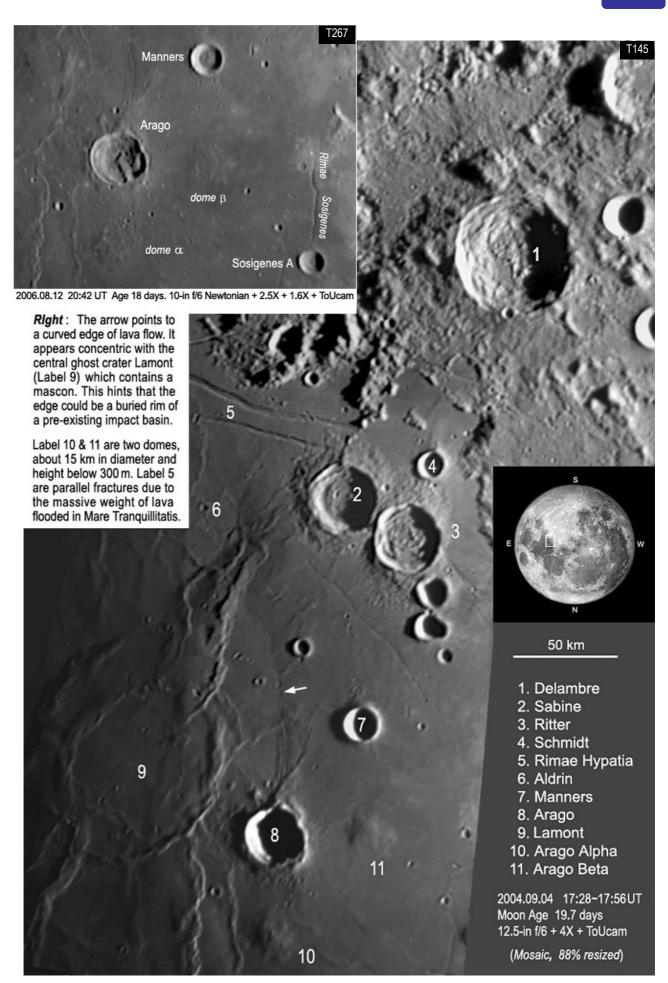


Apollo 11 Landing Module (picture corner) and the Laser Ranging Retro-reflector Array. The reflector was left by Apollo 11 crew on the landing site, and is still used today by the McDonald Observatory to monitor the precise Earth-Moon distance. (http://www.csr.utexas.edu/mlrs/)

Lamont 23.7° E 4.4° N

A ghost crater outlined by concentric wrinkle ridges, 106 km in diameter. It contains a macon.

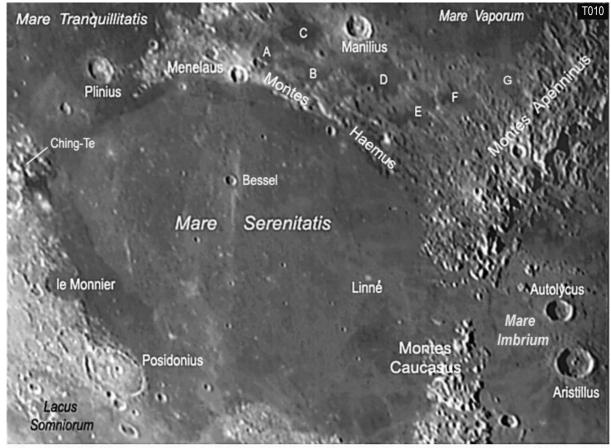






Hatfield 1, 3 Rükl 23, 24, 25, 14

Serpentine Ridge, Plinius, Posidonius, Menelaus, Manilius

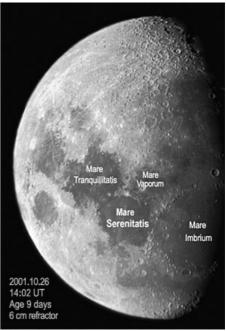


Mare Serenitatis 2004.06.26 14:54 UT Age 9 days. 10-in f/6 Newtonian + ToUcam at prime focus, 1/100s, 38 frames stacked.

A. Lacus Hiemalis B. Lacus Gaudii C. Lacus Lenitatis D. Lacus Doloris E. Lacus Odii F. Lacus Felicitatis G. Sinus Fidei (Ninter Lake) (Lake of Joy) (Lake of Tendemess) (Lake of Sorrow) (Lake of Hate) (Lake of Happiness) (Bay of Faith)

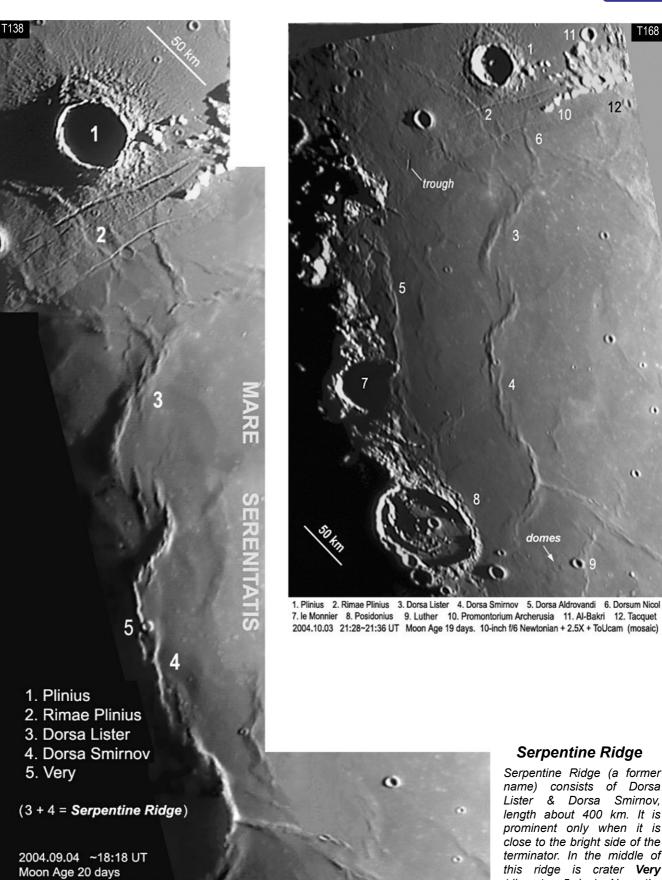
Mare Serenitatis is the Sea of Serenity. It is a vast, near-circular lava plain, size about 500 x 700 km and contains a mascon. The inner collar of the mare looks somewhat darker, suggesting richer in metallic composition (e.g. iron and titanium) than the rest of the floor. The eastern floor is crossed by two snaky wrinkle ridges named Dorsa Lister and Dorsa Smirnov (also collectively called Serpentine Ridge, see next page). Each of them is about 10 km wide and meanders quite a long distance. They may have resulted from surface shrinkage following the cease of volcanism, or buckling of the lunar crust due to the weight of accumulating lava in the Serenitatis impact basin. Wrinkle ridges are typically below 200 m in height, so they are distinctive only under very oblique sunlight.

The southwest edge of Mare Serenitatis is the 560-km long Montes Haemus; it is part of the rising rim of the Serenitatis impact basin. In the vicinity are six irregular lava "lakes", labeled A to F in Image T010. Menelaus, Plinius, le Monnier



Mare Serenitatis and its neighboring maria

and Posidonius are the most conspicuous craters in this region. A lava channel between Montes Apenninus and Montes Caucasus connects Mare Serenitatis with Mare Imbrium.

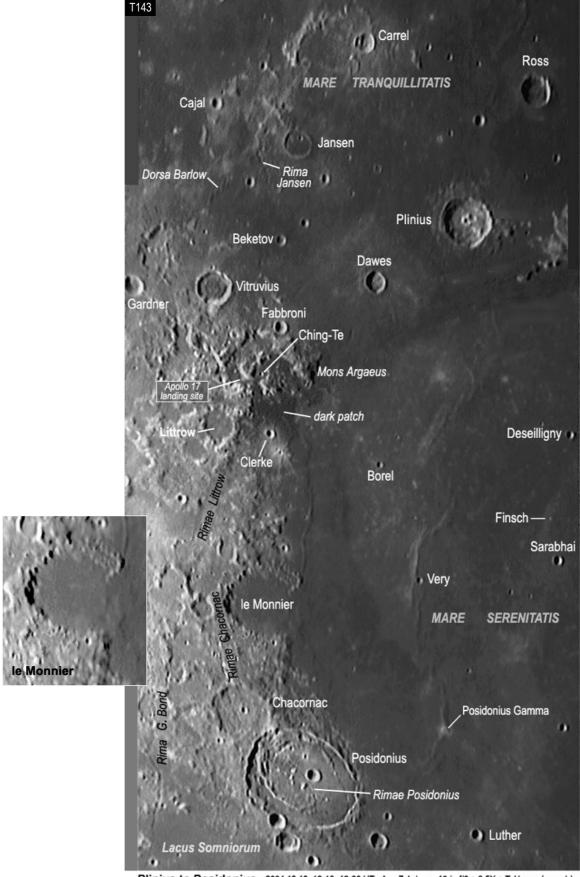


12.5-in f/6 + 4X + ToUcam

Mosaic of 5 video clips

Serpentine Ridge (a former name) consists of Dorsa Lister & Dorsa Smirnov, length about 400 km. It is prominent only when it is close to the bright side of the terminator. In the middle of this ridge is crater **Very** (diameter 5 km). Near the southern end is an unnamed, 12 km-long trough (T168). Near the northern end are Luther and a small group of indistinctive domes.

The Eastern Edge of Mare Serenitatis: It is darker than the rest of the floor, especially the dark patch near Littrow. Posidonius Gamma is a former name referring to the peak on wrinkle ridge (Dorsa Smirnov). It has a summit craterlet surrounded by a halo of bright material.



Plinius to Posidonius 2004.12.19 12:18~12:26 UT Age 7.4 days. 10-in f/6 + 2.5X + ToUcam (mosaic)

Plinius 23.7⁰ E 15.4⁰ N (*Image T138 & T143*)

A sharp rimmed crater between Mare Serenitatis and Mare Tranquillitatis, 43 km in diameter, visible even in the full moon. Its interior has two crater-like hills with broken slopes under low illumination. A system of parallel rilles (*Rimae Plinius*, length 120 km) lies on its immediate north and cuts through the wrinkle ridges on the mare. Plinius is a Roman general and naturist, also the author of the encyclopedia "Historia Naturalis". He died in the witness of the massive eruption of Mount Vesuvius, a volcano in Italy that destroyed the City of Pompeii in AD79.

Montes Taurus 41.1° E 28.4° N (*Image T063*)

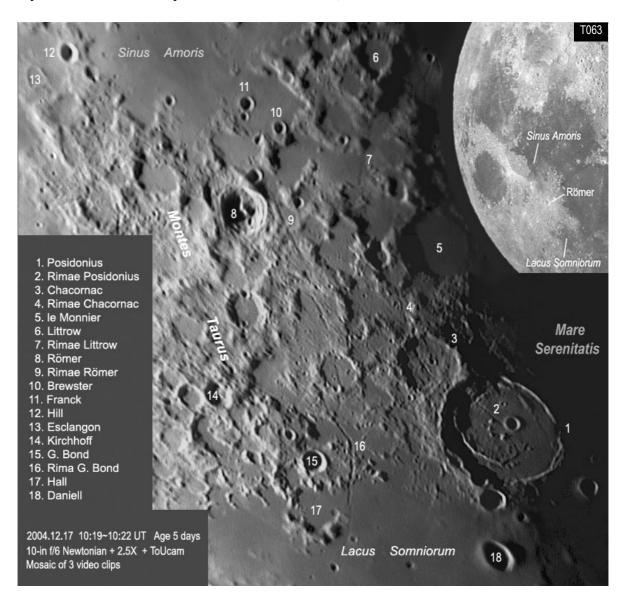
Montes Taurus (Bull Mountains) is in the east of Mare Serenitatis. It rises to 3000 m peak, spanning roughly 200 km south-north from Sinus Amoris (Bay of Love) towards Lacus Somniorum (Lake of Dreams). Its coverage is not well defined. Montes Taurus holds the fairly prominent crater *Römer* with longitudinal rilles *Rimae Römer* and part of *Rima G Bond*. These rilles rely on low angles of sunlight to be distinctive.

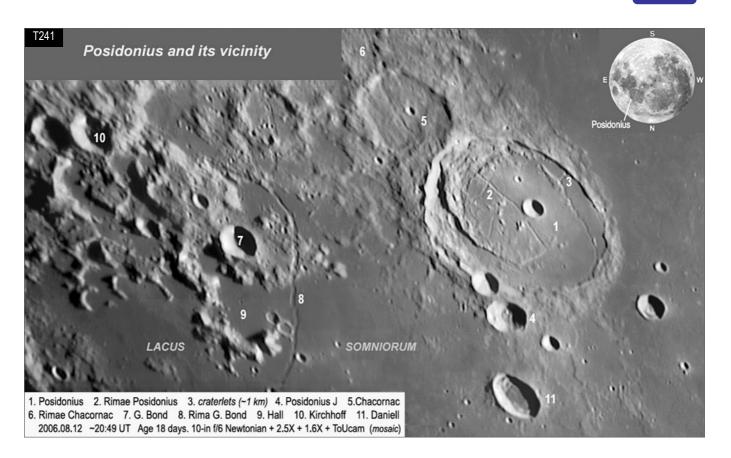
Römer 36.4° E 25.4° N

A sharp rimmed crater with terraced walls and a relatively large central peak, 39 km in diameter.

le Monnier 30.6° E 26.6° N

A bay-like flooded crater opened to Mare Serenitatis, 60 km in diameter. It has a dark flat floor.





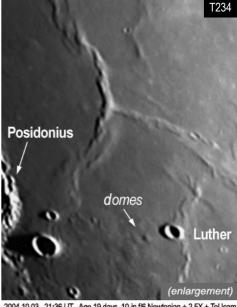
Posidonius 29.9⁰ E 31.8⁰ N (*Image T241*)

A spectacular walled plain between Mare Serenitatis and Lacus Somniorum, 95 km in diameter. Its floor contains low hills (probably volcanic domes), prominent ridges and a wide system of rilles (*Rimae Posidonius*). Near first quarter, Posidonius resembles "a thin pancake on the dark mare" because of its raised floor. Label 3 in T241 is a short chain of tiny craters, barely resolvable in 10-inch telescopes.

In T234, three small domes are distinguishable between Posidonius and *Luther* (diameter 9 km).

Chacornac 31.7° E 29.8° N

A disintegrated crater adjoining Posidonius. It is 51 km in diameter, with hexagonal walls and a small off-center crater. Few rilles (*Rimae Chacornac*) on the floor are visible under high magnifications. Chacornac appears as the little brother of Posidonius.



2004.10.03 21:36 UT Age 19 days. 10-in t/6 Newtonian + 2.5X + ToUcam

Three domes near Luther

Rima G. Bond 35.5° E 33.3° N

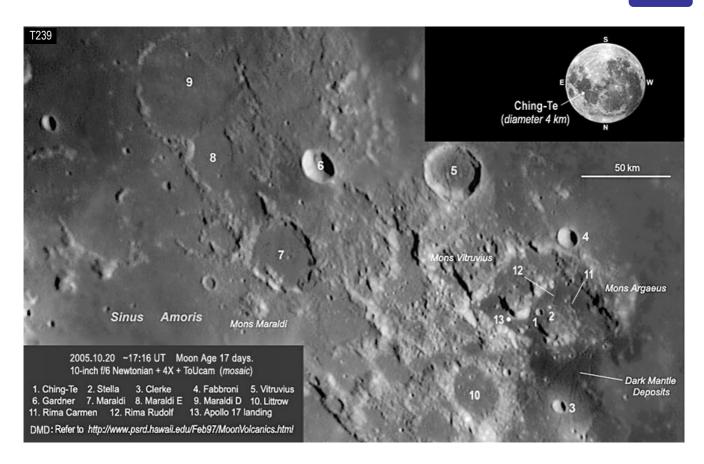
A rille running from Montes Taurus into Lacus Somniorum, length 168 km, width up to 4 km.

Hall 37.0° E 33.7° N

A crescent-like flooded crater, 35 km in diameter. Its exposed walls are heavily worn.

Daniell 31.1°E 35.3°N

A sharp-rimmed oval crater, size 23 x 29 km. See also Map 10.



Ching-Te 30.0° E 20.0° N

Ching-Te (Chinese male name) is a small crater close to Mons Argaeus, 4 km in diameter. It is an obscure object for small telescopes and is likely hidden when the Sun angle is not appropriate. The surroundings of Ching-Te are massifs. Apollo 17 landed on the other side of the massifs on 1972 December 11, about 18 km east of Ching-Te.

In the north of Ching-Te is a remarkably dark patch, so called DMD (dark mantle deposit). It contains a mixture of small black and orange glass debris, possibly formed from quickly cooled droplets during fountain-like volcanic eruption. Other DMDs appear at Sulpicius Gallus Map 9, Alphonsus Map 12, Aristarchus Plateau Map 21, Mare Vaporum and Sinus Aestuum Map 33.

Littrow 31.4° E 21.5° N

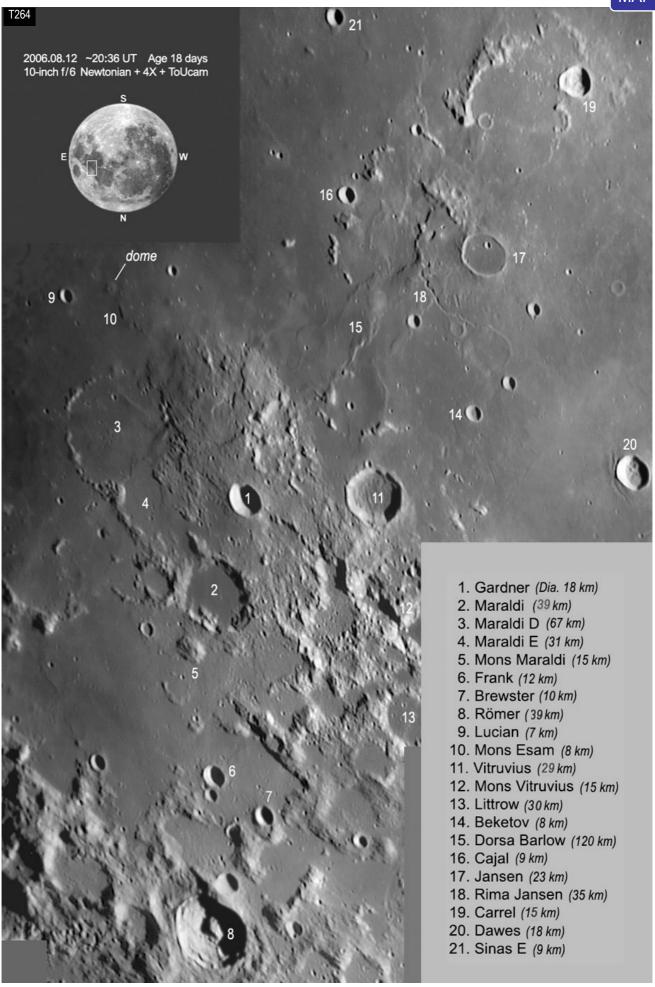
A flooded crater with worn walls, 30 km in diameter. It has an adjacent system of rilles named *Rimae Littrow*, length about 120 km and shown in Image T143.

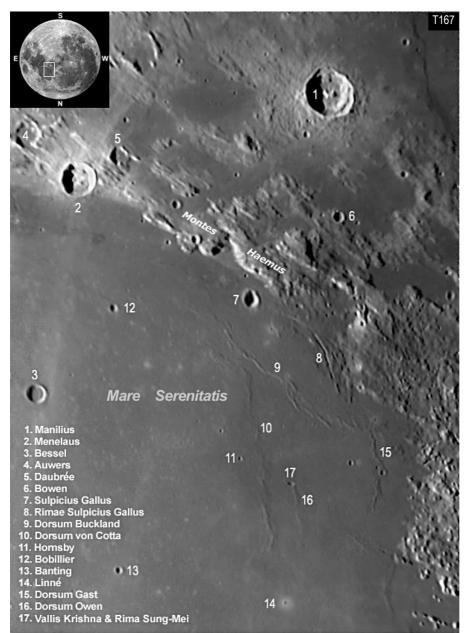
Gardner 33.8° E 17.7° N

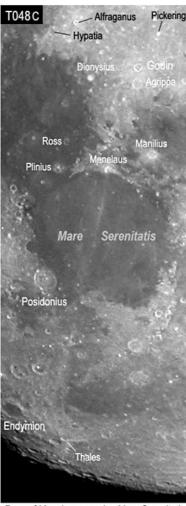
A 18-km crater on a dome-shaped peninsula plateau (informally termed "megadome") where elusive rilles, ridges and irregularities are found. The plateau is flanked by *Maraldi* and two ghost craters *Maraldi D & E*. Details in T264, next page. Note also the dome and the snaky *Rima Jansen* (length 35 km) in T264.



A volcanic fountain in Hawaii. The arching rises to 10 m, much much smaller than a geologist's impression of lunar volcanic eruption where dark mantle deposits are found. (Imaged by J. D. Griggs for USGS)







Rays of Menelaus crossing Mare Serenitatis 2003.09.11 16:11 UT Age 15 days. FS128 + PL15 + CP995

Manilius, Menelaus & Bessel 2005.11.09 11:45 UT Age 7 days. 10-in f/6 Newtonian + 2.5X + ToUcam (mosaic)

Montes Haemus 9.2° E 19.9° N

A 560 km-long mountain range forming the south-western edge of Mare Serenitatis. Just beyond it are several irregular dark lava patches: *Lacus Hiemalis* (Winter Lake), *Lacus Gaudii* (Lake of Joy), *Lacus Lenitatis* (Lake of Tenderness), *Lacus Doloris* (Lake of Sorrow), *Lacus Odii* (Lake of Hate) and *Lacus Felicitatis* (Lake of Happiness). See also T010, front page of this map.

Manilius 9.1^{0} E 14.5^{0} N

A bright rayed crater with sharp rim, terraced walls and central peaks, 38 km in diameter. Details in T257, Map 33.

Menelaus 16.0° E 16.3° N

A remarkably bright rayed crater with sharp rim and central peaks, 26 km in diameter. One of its rays is over 1000 km long, stretching across Mare Serenitatis and beyond. Other rays are traceable from the outer rim of Menelaus, between *Auwers* and *Daubrée* (Label 4, 5 in T167).



Bessel 17.9° E 21.8° N

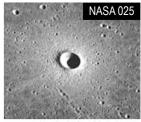
A small but prominent crater in Mare Serenitatis, 15 km in diameter. The bright rays of Menelaus happen to pass over the western half of Bessel, making the latter to mimic a rayed crater as well.

Sulpicius Gallus 11.6°E 19.6°N

A bowl-shaped crater, sharp rimmed, 12 km in diameter and fairly deep (2100 m). Its vicinity is *Rimae Sulpicius Gallus*, a system of prominent rilles of 90 km in length.

Linné 11.8° E 27.7° N

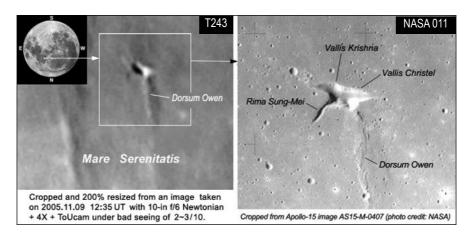
A small young crater surrounded by bright ejecta. Linné is only 2.4 km or one arcsecond in diameter, yet it is easily recognized through telescopes as a bright spot under high illumination. In the second half of the 19th century, numerous mysterious changes and disappearances of Linné were reported due to seeing and inadequate telescope optics. In the past decades, Linné was also a controversial object of LTP (lunar transient phenomena).



Linné (Apollo 15 Pan Photo 5353)

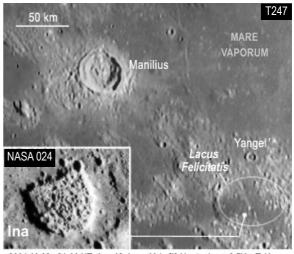
Rima Sung-Mei 11.3°E 24.6°N

Rima Sung-Mei is a 4-km long narrow rille. It is one of the three prongs in a small depression near Dorsum Owen at Mare Serenitatis. The prongs are elusive to spot in 10-inch telescope. A flyover of Apollo-15 resolves them, designated afterwards as *Rima Sung-Mei* (Chinese female name), *Vallis Christel* (German female name) and *Vallis Krishna* (Indian male name). The prongs could have formed from merging three or more volcanic vents on the mare.



Lacus Felicitatis 5.0° E 19.0° N (Lake of Happiness)

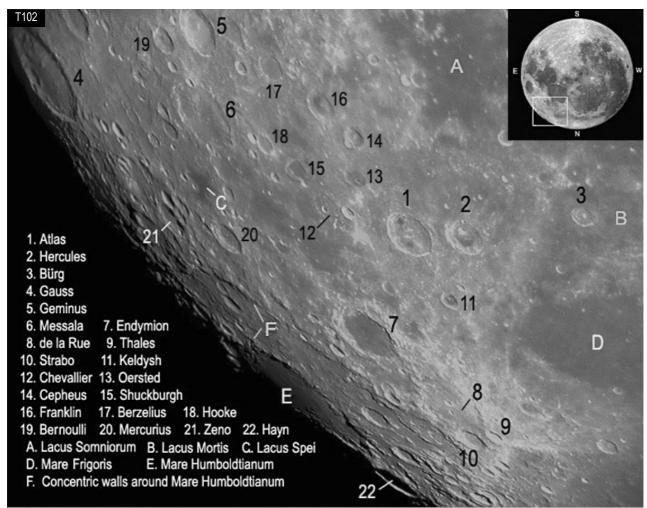
An irregular lava plain where scientists found evidence for volcanic "outgassing" that may have happened within the past ten million years --- and may still be happening today. The evidence was spotted in 2006, inside a young crater named *Ina* at the rim of Lacus Felicitatis. Ina (5.3° E 18.6° N) is a semi-circular depression, about 3 km in diameter and less than 50 m deep. This shallow depression is difficult to observe from Earth. See NASA close-up image at right.



2004.10.03 21:00 UT Age 19 days. 10-in f/6 Newtonian + 2.5X + ToUcam (http://science.nasa.gov/headlines/y2006/09nov_moonalive.htm)

Hatfield 4 Rükl 14, 15, 16, 7, 6

Atlas, Hercules, Bürg, Endymion, Mare Humboldtianum



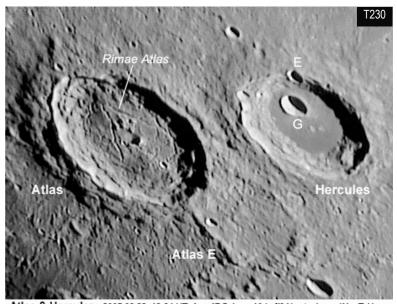
NE limb & vicinity 2004.08.01 14:22 UT Age 15 days. Libration 4.5° (long.) 6.4° (lat.) FS128 + LE12.5 + CP990 at 1/38 sec.

Atlas 44.4° E 46.7° N **Hercules** 39.1° E 46.7° N

Atlas and Hercules are prominent pair of craters near the north-east limb. Their walls look similar but their interiors are very different.

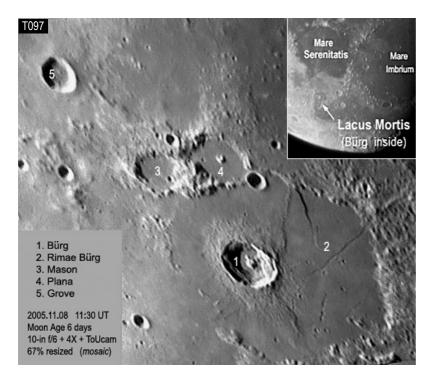
Atlas is 87 km in diameter, with a small central peak and terraced walls rising to about 3000 m. Its rough floor contains two fairly dark patches and a complex fracture of rilles (*Rimae Atlas*) which are believed of volcanic origin.

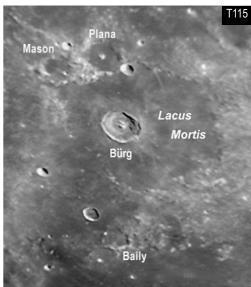
Hercules is a terraced crater with relatively flat floor, 69 km in diameter. It has a lava-submerged central peak and contains the bowl-shaped *Hercules G*,



Atlas & Hercules 2005.08.22 19:34 UT Age 17.5 days. 10-in f/6 Newtonian + 4X + ToUcam

easily seen in small telescopes. A small crater, *Hercules E*, is on the southern wall.





2004.08.02 17:28 UT Age 16 days. Misty sky. 10-in f/6 + 2.5X + ToUcam, 9 frames.

Bürg 28.2° E 45.0° N

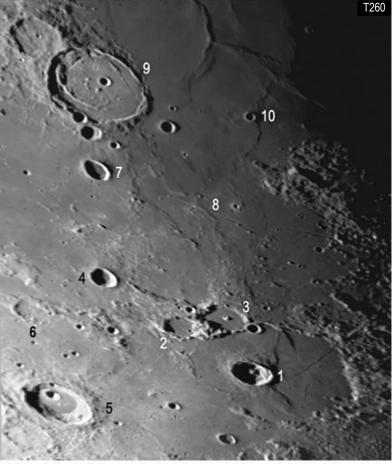
Bürg is a prominent sharp-rimmed crater in *Lacus Mortis* (Lake of Death), 39 km in diameter. It has a large central peak. Its high terraced walls contain deep clefts. Bürg's ejecta blanket can be seen thrown out into two main swaths heading north and south from the impact zone. Between these swaths of material are two rilles (*Rimae Bürg*) that intersect roughtly at right angles. The two rilles add up to 140 km in length.

 $\begin{array}{lll} \textbf{Mason} & 30.5^{0}\,E & 42.6^{0}\,N \\ \textbf{Plana} & 28.2^{0}\,E & 42.2^{0}\,N \end{array}$

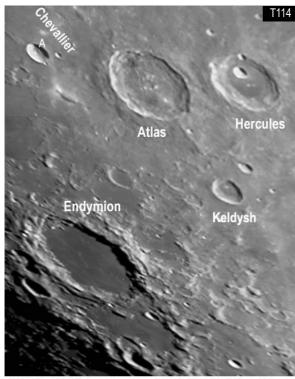
Manson and Plana are overlapped flooded craters. Mason is 33 X 43 km. Plana is 44 km in diameter with a central peak.

Grove 32.9° E 40.3° N A crater, 28 km in diameter. Its ejecta blanket resembles that of Bürg.

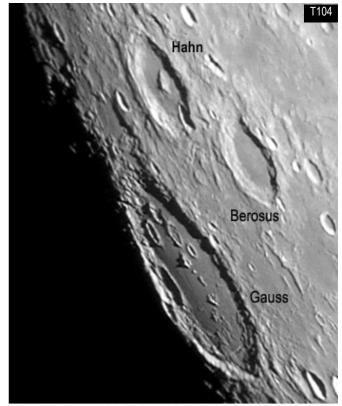
Daniell 31.1°E 35.3°N An oval crater, size 23 x 29 km. In its west is *Rimae Daniell*, a system of straight rilles up to 200 km long.



1. Bürg 2. Mason 3. Plana 4. Grove 5. Hercules 6. Williams 7. Daniell 8. Rimae Daniell 9. Posidonius 10. Luther 2006.04.04 11:46 UT Age 6 days. 10-in f/6 + 2.5X + ToUcam (mosaic)



2004.08.02 17:24 UT Age 16 days. Misty sky. 10-in f/6 + 2.5X + ToUcam, 12 frames.



2004.08.01 17:12 UT Age 15 days. 10-in f/6 + 2.5X + ToUcam, 4 frames stacked.

Image T114:

Endymion 57.0° E 53.9° N A prominent crater with flat and fairly dark floor, no central peaks, 123 km in diameter.

Chevallier 51.2° E 44.9° N A heavily flooded, shallow walled plain, 52 km in diameter. Its rim is interrupted by the small but deeper crater *Chevallier A*.

Keldysh 43.6⁰ E 51.2⁰ N A crater, 33 km in diameter. Its southern floor contains a tiny crater.

Image T104:

Gauss 79.0° E 35.7° N A vast walled plain, 177 km in diameter. Its floor contains small hills and craters which become distinctive under favorable illumination

Hahn 73.6° E 31.3° N
A mid-sized crater with terraced walls and

Gauss
Atlas
Endymion Hercules
Humboldtianum
Thales

Gauss, Endymion & Mare Humboldtianum seen by Galileo spacecraft, 1992

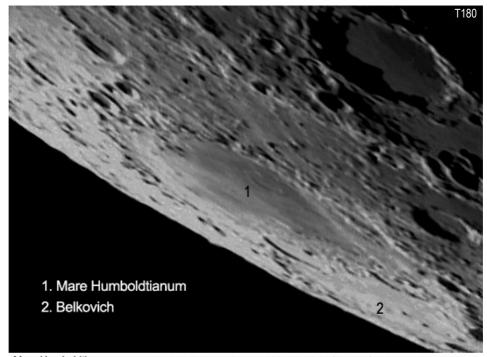
central peak, 84 km in diameter. Its northern rim is interrupted by a small crater.

Berosus 69.9°E 33.5°N

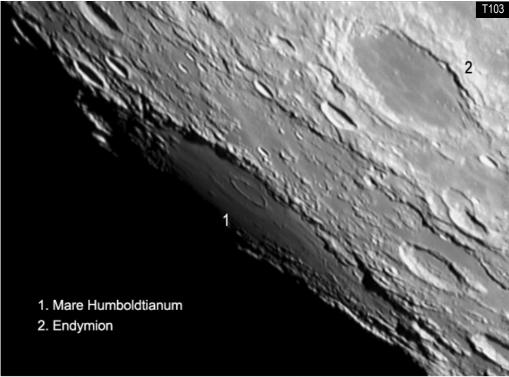
A flooded crater, 74 km in diameter. Its flat floor contains no central peak.

Mare Humboldtianum 81.5° E 56.8° N

Mare Humboldtianum (Humboldt's Sea) is a difficult visual object because its rim extends to the farside of the Moon. A better terrestial view is given in T180 and T103, when the libration was favorable. Mare Humboldtianum is physically the central lava-flooded portion of a multi-ring impact basin. The lava floor is 270 km in diameter, but the whole basin including the outer concentric walls is 600 km across. See also the non-oblique view of Mare Humboldtianum in the NASA image (previous page).



Mare Humboldtianum 2004.12.15 19:13 UT Age 3.4 days. Libration I = 4.6° b = 6.5°. 10-in f/6 + 2.5X + ToUcam

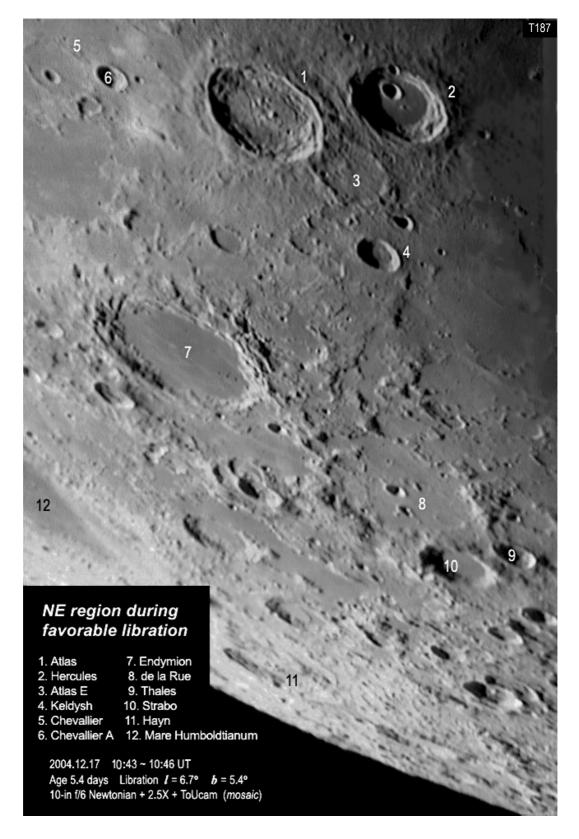


2004.08.01 16:50 UT Age 15 days. Libration 4.5°(long.) 6.5°(lat.) 10-in f/6 + 2.5X + ToUcam at 1/100s, 9 frames stacked.

de la Rue 52.3⁰ E 59.1⁰ N

A disintegrated walled plain with small off-centered craters, 134 km in diameter. It is named after the British amateur astronomer Warren de la Rue (1815-89). He was the first to produce a copper plate for printing from a photographic negative of the Moon.

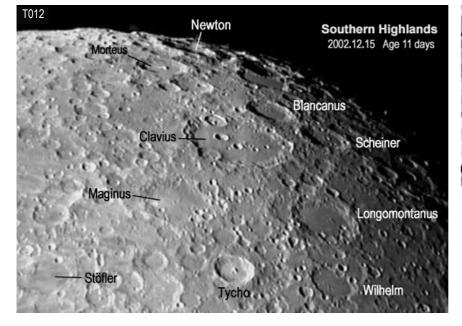
Thales 50.3° E 61.8° N **Strabo** 54.3° E 61.9° N Thales is a rayed crater, 31 km in diameter. The neighboring Strabo (55 km) is non-rayed.

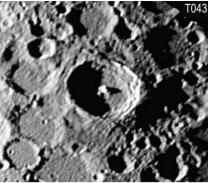




Hatfield 10 Rükl 64, 65, 72, 73, 54

Tycho, Clavius, Maginus, Deslandres, Pitatus, Hesiodus





Tycho 2001.04.03 10:08 UT Age 9 days. FS128+CP990 DSCN8764



Tycho 2003.03.17 16:49UT Age 14 days. 10-in+2.5X + ToUcam The dark halo around Tycho is impact melt



Tycho and its system of rays

The rays are lines of deposits of highland rocks and debris ejected from the Tycho impact. The X denotes the site where regolith (lunar soil) was examined by Surveyor 7 probe in 1968.

Tycho $11.1^{0} \text{ W} 43.4^{0} \text{ S}$

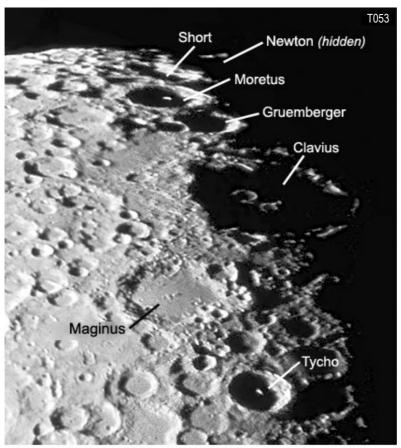
Tycho is a prominent object in the Southern Highlands. It has a nominal diameter of 102 km (cavity 85 km), depth 4800 m. The central peak is 2300 m high. During the full moon, Tycho stands out as the brightest beacon with a system of long rays ranging to 1800 km. It is this system of rays that shows Tycho is a very young impact crater, about 110 million years old. The dark halo is impact melt, which will be diminished by space weathering over time. Shortly after the first quarter, Tycho appears as an abyss surrounded by thick walls (T053, next page).

Clavius 14.1° W 58.8° S

Clavius is a spectacular, vast walled plain in the Southern Highlands, diameter 245 km. Its walls are broken by crater *Rutherfurd* (48 km) and *Porter* (51 km), and there are ridges running between them, see T080 & T085. Note also the L-shaped relief near Porter. An arc-array of craters extends across the floor, which also contains many craterlets and small hills. Clavius is best seen shortly after first quarter or before last quarter but hardly visible during the full moon.

Newton 16.9° W 76.7° S

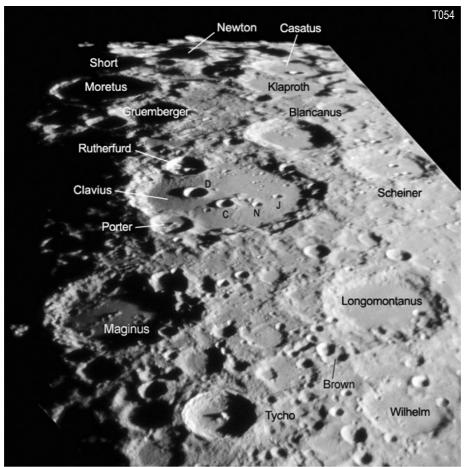
A crater close to the south limb, 78 km in diameter. Its depth is not ascertained, probably over 6000~8000 m. Details in T197, Event 1 pages.



Clavius right on the terminator

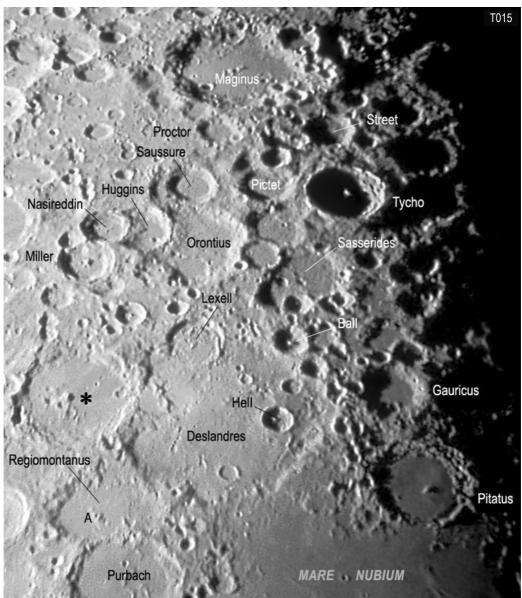
It looks like an abyss. The inside craters are Clavius D (larger) and Clavius C.

Clavius on terminator 2000.11.05 13.50 UT Age 9 days. FS128+QV2300



Clavius outside terminator 2001.08.11 20:21 UT Age 22 days. C9+LE12.5+CP990 DSCN9622

Clavius just outside the terminator.



Deslandres to Maginus The ★ was crater Walter but now renamed as Walther. 2000.11.05 13:35 UT Age 9 days. FS128+LE12.5+QV2300

Maginus 6.3°W 50.5°S

A large walled plain, 194 km in diameter. It is much older than Tycho, as suggested by the eroded rim, the interior peppered with impact craters and the absence of rays.

Deslandres 4.8° W 33.1° S

A vast ruined walled plain, 256 km in diameter. Its floor contains crater *Hell* (33 km), short chains of secondary craterlets and a bright spot. See Image T074.

Walther (formerly *Walter*) 1.0° E 33.1° S

A walled plain with mountain massif on its eastern floor, 128 km in diameter. (Remark: This crater is now renamed as Walther.

The original "Walter" is confusingly allocated to a 1-km crater at 33.8°W 28.0°N near Diophantus. See Map 22.)



Deslandres in shadow 2001.08.11 21:01UT Age 22 days

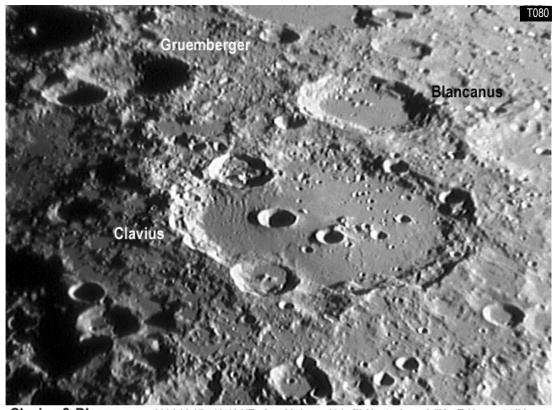
Regiomontanus 1.0° W 28.3° S

A walled plain, 126x108 km. It has a summit crater *Rigiomontanus A* (6 km) on the central peak.

Clavius at age of 10 and 22 days

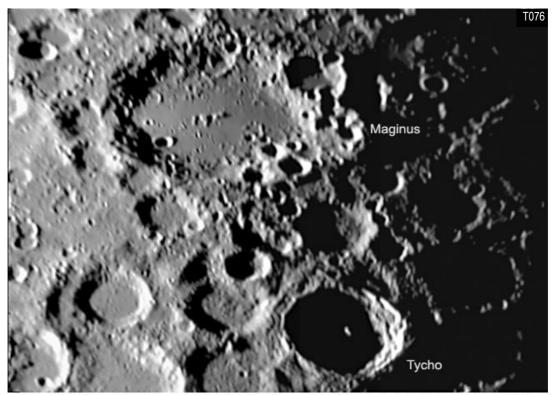


Clavius 2005.04.18 ~14:53 UT Age 9.8 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam (mosaic of 2 video clips)

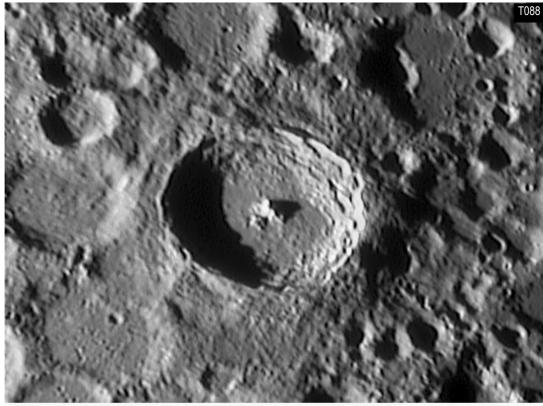


Clavius & Blancanus 2004.08.07 19:48 UT Age 22 days. 10-in f/6 Newtonian + 2.5X + ToUcam at 1/33 sec

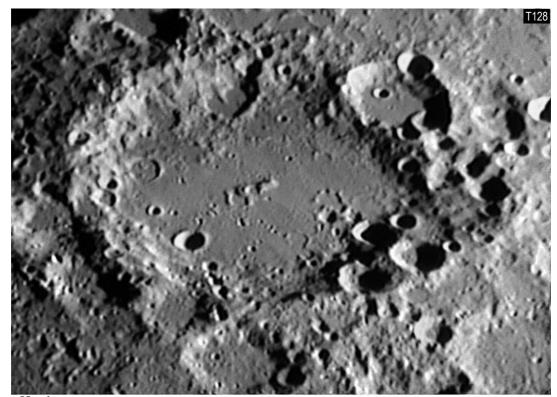
Tycho at age of 9 and 10 days (1 day difference).



Maginus and Tycho (in shadow) 2004.06.26 13:53 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam, 12 frames stacked.



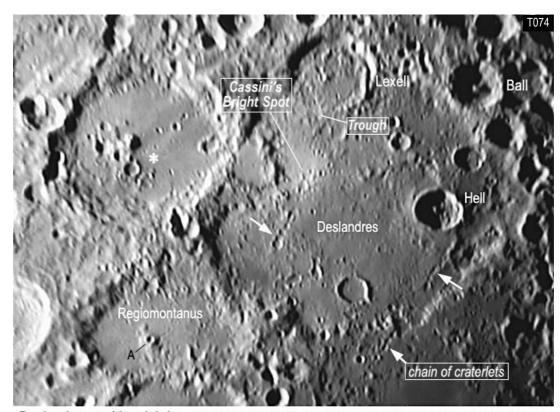
Tycho 2005.04.18 14:56UT Age 10 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam at 1/33 sec, 52 frames.



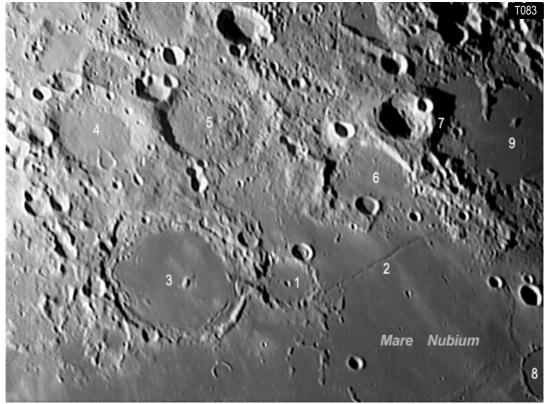
Maginus 2004.09.05 21:18 UT Age 21 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam at 1/25 sec. 47 frames.



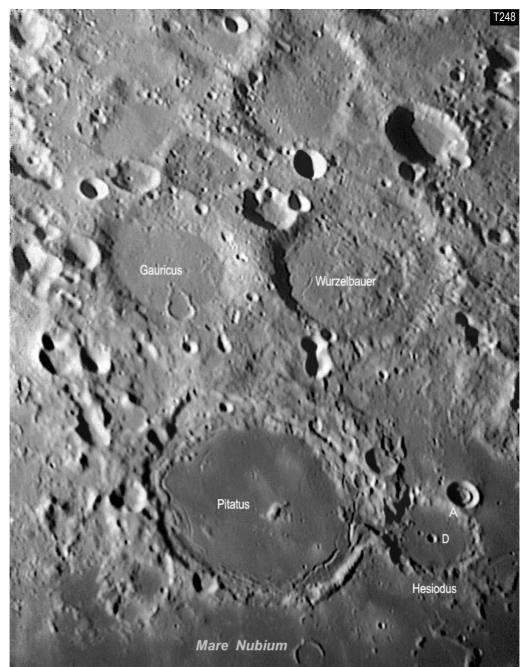
1. Moretus 2. Newton 3. Gruemberger 2004.09.05 21:16 UT Age 21 days. 10-in f/6 + 2.5X + 1.6X + ToUcam



Deslandres and its vicinity 2004.06.26 13:47 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam. The ★ was crater Walter but currently renamed as Walther. Note "Cassini's Bright Spot" and the chains of craterlets on the floor of Deslandres. A shallow, valley-like trough intersects the northeastern rim of Lexell. See also Image T127 in Map 33.



1. Hesiodus 2. Rima Hesiodus 3. Pitatus 4. Gauricus 5. Wurzelbauer 6. Weiss 7. Cichus 8. Kies 9. Palus Epidemiarum 2005.11.11 12:06 UT Age 9.5 days. 10-inch f/6 Newtonian + 2.5X + ToUcam, 97 frames stacked.



Pitatus, Gauricus, Wurzelbauer & Hesiodus 2005.11.11 12:19 UT Age 9.5 days. 10-in f/6 Newtonian + 4X + ToUcam (mosaic)

Pitatus 13.5°W 29.9°S

A large flooded crater with central peak submerged partially in lava, 106 km in diameter. A system of sinuous rilles (*Rimae Pitatus*, length 94 km) runs along the inner rim. The white patches on the floor are remnant of deposited materials thrown out from the Tycho impact.

Gauricus 12.6° W 33.8° S

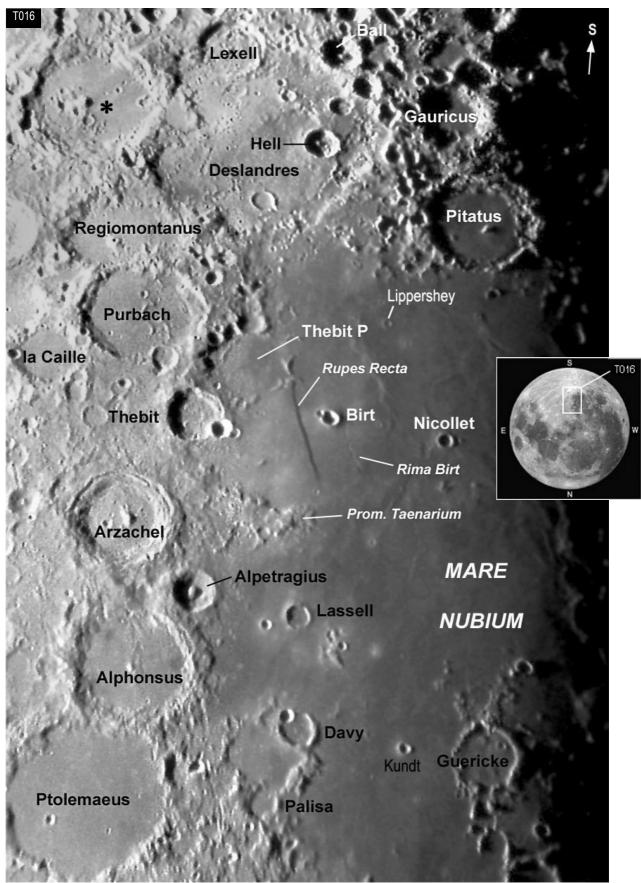
A heavily eroded crater, 79 km in diameter. Its wide wall is encircled by a ring of small craters. The northern floor is scarred with a nameless relief that resembles the shape of a water droplet.

Hesiodus 16.3⁰ W 29.4⁰ S (*Image T083 & T248*)

A 42-km flooded crater. The center of its floor is hit by a small crater *Hesiodus D*. The adjoined crater *Hesiodus A* (15 km) has double concentric walls. *Rima Hesiodus* is a linear rille running from Hesiodus into *Palus Epidemiarum*, 3 km wide, 256 km long.

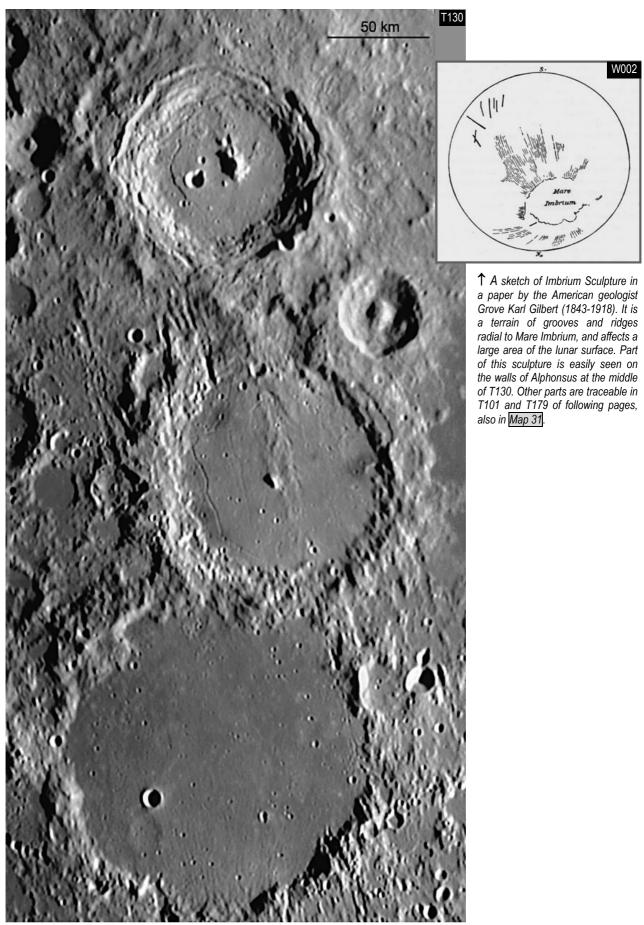
Hatfield 13, 9 Rükl 54, 55, 42, 43, 44

Ptolemaeus, Alphonsus, Purbach, Rupes Recta, Albategnius, Hipparchus, Fra Mauro



Ptolemaeus to Deslandres The ★ was crater Walter but now renamed as Walther. 2000.11.05 13:38 UT Age 9 days. FS128+LE12.5+QV2300

The prominent crater trio: Arzachel, Alphonsus and Ptolemaeus

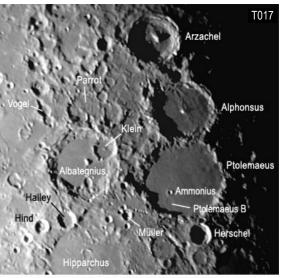


Arzachel, Alpetragius, Alphonsus and Ptolemaeus (mosaic from a batch of video clips) 2004.09.05 20:53 ~ 21:11 UT Age 21 days. Very misty sky. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam at 1/25 sec.

Ptolemaeus 1.9° W 9.3° S

Ptolemaeus is a prominent walled plain, 164 km in diameter. Its floor contains a mascon and appears flat, but numerous craterlets and pits are detectable at high powers. *Ammonius* (diameter 8 km) is a distinctive crater on the floor; it adjoins a saucer-shaped depression (*Ptolemaeus B*, 17 km). The floor also changes dramatically during a lunation. It is very bright during the full moon but appears quite dark at days close to the first and last quarters.

Ptolemaeus, Alphonsus (108 km) & **Arzachel** (96 km) form an interesting trio. The floor of Arzachel contains a prominent central peak and a system of sharp rilles (**Rimae Arzachel**, length 50 km). Alphonsus is characterized by ridged floor with dark



2001.09.25 12:49 UT Age 8 days. C9 + LE12.5 + CP990 1/2 sec

halo craters and rilles (*Rimae Alphonsus*) along its inner rim, more details in next page. The NASA Ranger 9 probe made a hard impact on Alphonsus in March 1965. Alphonsus is also an object of LTP (lunar transient phenomena).

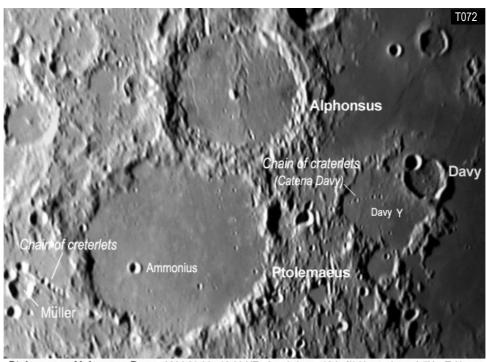
Note that in T130, the crater trio and their surroundings are modified by a radial pattern of grooves and ridges known as *Imbrium Sculpture*, formed from a hurricane of ejecta at low angles during the giant Imbrium impact. This marks the beginning of the *Imbrian* period in about 3.8 billion years ago.

Alpetragius 4.5° W 16.0° S

A bowl-shape crater, 39 km in diameter, 3900 m deep. It has a central mountain cone, probably oversized by post-volcanic eruptions inside the crater.

Davy 8.1° W 11.8° S (*Image T072*)

A crater, 34 km in diameter. The nearby chain of craterlets is *Catena Davy*, details in Map 31.



Ptolemaeus, Alphonsus, Davy 2004.06.26 13:32 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam

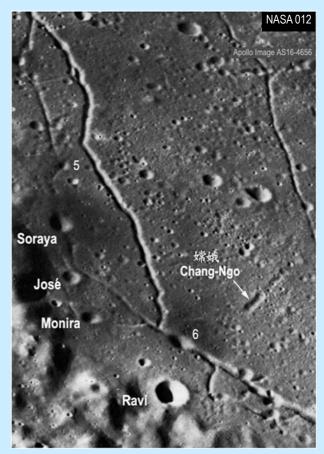
The craters inside Alphonsus

At least 10 *dark halo craters* are inside Alphonsus. Some of them along the eastern inner edge of Alphonsus are highlighted in the right image:

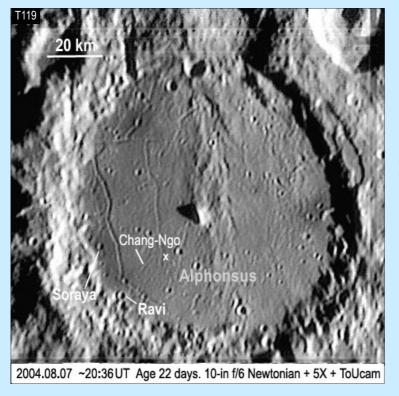
Ravi 1.9^{0} W 12.5^{0} S diameter 2.5 km Monira 1.7^{0} W 12.6^{0} S diameter 2 km José 1.6^{0} W 12.7^{0} S diameter 2 km Soraya 1.6^{0} W 12.9^{0} S diameter 2 km No. 5 and 6 bear no formal names.

These craters are volcanic according to a study report http://www.lpi.usra.edu/meetings/lpsc2005/pdf/2344.pdf. The dark halos around them are DMD (dark mantle deposits Map 9), and the adjacent connecting rilles are lava channels.

The arrow points to the elongated crater *Chang-Ngo* at 2.1°W 12.7°S, length 3 km. It is of impact origin, probably created by an impactor which orbited around Earth but then spiraled into the Moon region and hit the Moon at grazing angle. The floor of Chang-Ngo appears scalloped, possibly due to the "rubble-pile" nature of the impactor which disrupted into fragments on its way towards the Moon. Several of the fragments hit to form Chang-Ngo, other fragments hit to form the chain of craterlets next to Chang-Ngo.



Above: The craters and rilles inside Alphonsus. South is up.



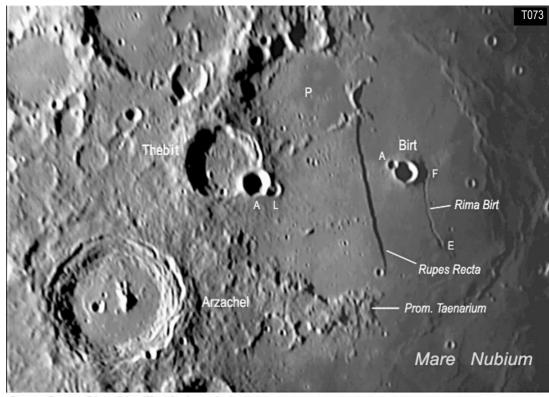
Left: Crater Chang-Ngo seen from a 10-inch telescope. It is named after a lady in a Chinese myth. The **X** indicates the impact site of Ranger 9 probe.

Rupes Recta 7.8° W 22.1° S

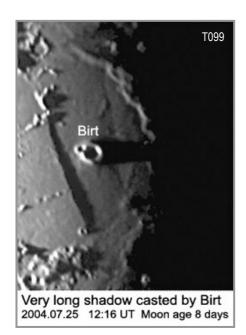
Also called the *Straight Wall*, 134 km long, 2~3 km in width. It casts striking shadow shortly after the first quarter. Rupes Recta is a fault possibly resulted from the subsidence of lava in Mare Nubium. Its western side slopes down by about 300 m. Indeed Rupes Recta is not a sharp cliff as appeared in telescopes. Its average gradient is under 10°. Its steepest slope is roughly 30°.

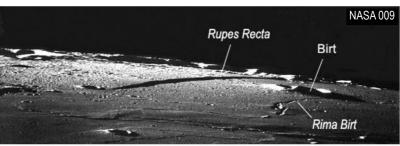
Rima Birt 9.0° W 21.0° S

A 50-km rille near crater *Birt* (diameter 16 km) and running in parallel with Rupes Recta. Its north end connects the small crater *Birt E*. Its south end connects *Birt F*.

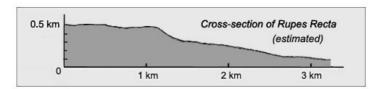


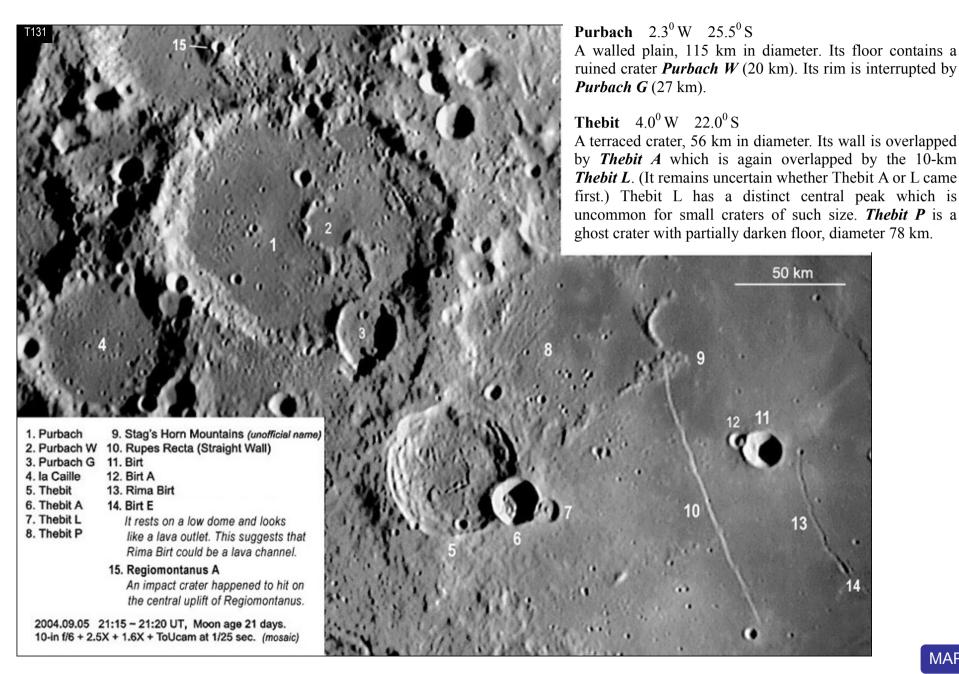
Rupes Recta, Rima Birt, Thebit, Arzachel 2004.06.26 13:59 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam





Oblique View from Apollo-16 Mission (Ap16-120-19224)





Burnham 7.3° E 13.9° S A 24-km crater with broken wall.

Albategnius 4.3° E 11.7° S A prominent ring mountain with central peak and flatten floor, 114 km in diameter. Its inner wall is heavily eroded with landslides, valleys and impact craters including *Klein* (44 km). The immediate north of Albategnius is Hipparchus.

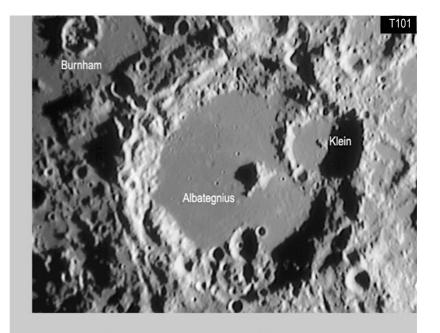
Hipparchus 5.2° E 5.1° S A vast walled plain, 138 km in diameter. The eastern wall is cut by a pair of deep clefts, which is part of the *Imbrium Sculture*. The western wall is fairly disintegrated, with a gap opened to *Rima Réaumur* (length 30 km). The flooded floor of Hipparchus contains small hills, ghost craters and *Horrocks*. See also Image

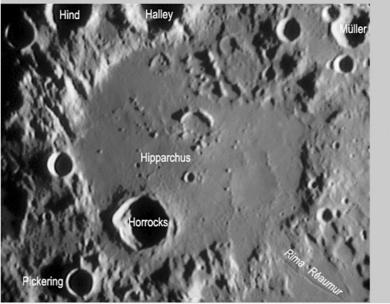
Image T179, next page:

T071 in Map 31.

Herschel 2.1° W 5.7° S A terraced crater with rough floor and central peak, diameter 40 km.

Lalande 8.6° W 4.4° S A 24-km rayed crater under high illumination.





Albategnius & Hipparchus 2004.09.05 ~21:49 UT Age 21 days. 10-in f/6 Newtonian + 4X + ToUcam

Mösting 5.9^{0} W 0.7^{0} S

A crater with terraced walls and rough floor, 24 km in diameter.

Sömmering 7.5° W 0.1° N

A ruined flooded crater, 28 km in diameter. Wide gaps exist on the north and south rims.

Flammarion 3.7° W 3.4° S

A walled plain, 74 km in diameter. Its northern wall is lava flooded and crossed by **Rima Flammarion** (length 80 km). Its western wall is interrupted by a 13-km crater **Mösting** A whose selenographic position (5^0 12' 39.6"W 3^0 12' 43.2"S) is a reference standard.

Rima Schröter 6.0°W 1.0°N

An inconspicous rille near crater *Schröter* (diameter 35 km), 40 km long.

$\textbf{Gyld\'en} \quad 0.3^{0}\,E \quad 5.3^{0}\,S$

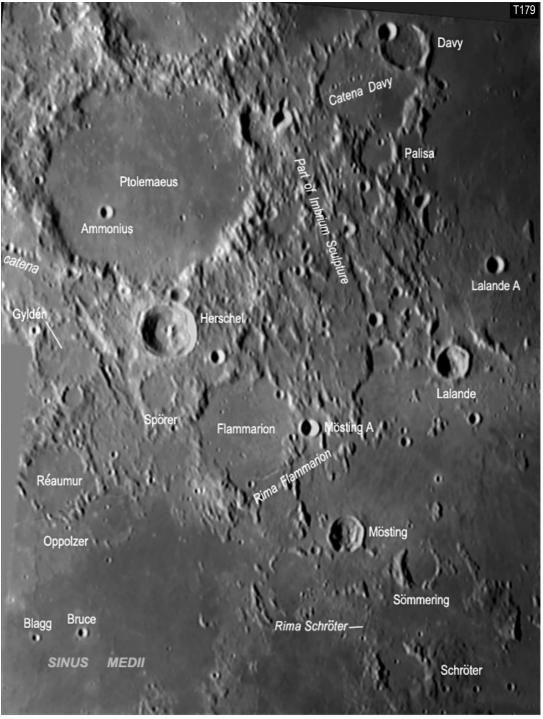
A disintegrated crater, 47 km in diameter. Its southwestern wall is interrupted by a valley which is part of the Imbrium Sculpture.

Réaumur 0.7° E 2.4° S

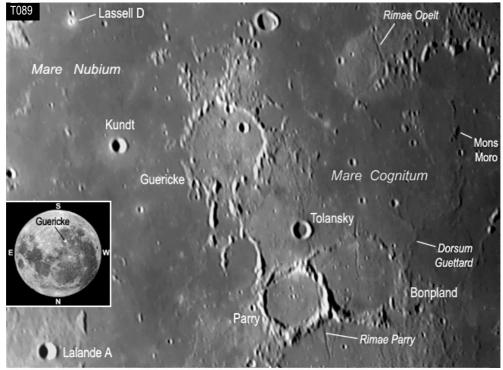
Remains of a crater, 52 km in diameter. See also T133, Map 13.

Oppolzer 0.5° W 1.5° S

Remains of a crater adjoining Réaumur, 40 km in diameter. Its southern wall is intersected by *Rima Oppolzer* (shown more prominently in T133, Map 13).



Ptolemaeus & northern vicinity 2005.04.18 ~13:49 UT Age 9.8 days. 10-in f/6 + 2.5X + ToUcam (mosaic)



Guericke, Tolansky, Parry and Bonpland 2004.06.27 13:30 UT Age 10 days. 10-in f/6 Newtonian + 2.5X + ToUcam

Lassell D 10.5° W 14.5° S (*Image T089*) A bright halo crater, 2 km in diameter.

Rimae Opelt $18.0^{9} \, \text{W}$ $13.0^{9} \, \text{S}$

A system of rilles, length 70 km. It is located on a dome-shaped plateau above the mare floor. Details in T258, Map 24.

Mons Moro 19.7° W 12.0° S A low hill on a wrinkle ridge, base size 10 km.

Guericke 14.1°W 11.5°S **Parry** 15.8°W 7.9°S

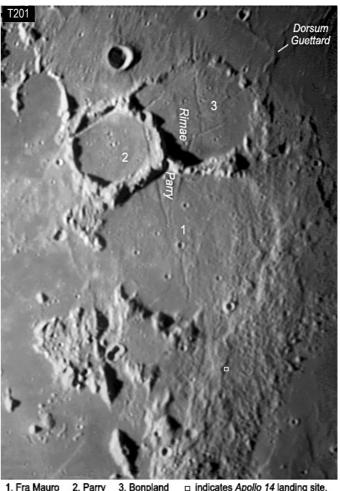
Guericke is the remains of a walled plain, 63 km in diameter. Together with another walled plain Parry (47 km), they form a *g*-shaped pair lying between Mare Nubium and Mare Cognitum. A wide system of rilles (*Rimae Parry*) intersects the southern and western rim of Parry.

$\textbf{Bonpland} \quad 17.4^{0}\,\mathrm{W} \quad 8.3^{0}\,\mathrm{S}$

A shallow walled plain, 60 km in diameter. Its floor is also crossed by Rimae Parry.

Fra Mauro 17.0° W 6.1° S

Remains of a walled plain, 101 km in diameter. Its floor is bisected by Rimae Parry. Apollo 14 landed on its northern vicinity on 1971.02.05.



1. Fra Mauro 2. Parry 3. Bonpland □ indicates Apollo 14 landing site. 2005.04.18 ~11:58 UT Age 9.8 days. 10-in f/6 + 4X + ToUcam, 85% resized.

Hatfield 1, 13 Rükl 33, 34, 44

Rima Ariadaeus, Rima Hyginus, Rimae Triesnecker, Agrippa



A rima is a rille, an open or slumped channel on the Moon's surface. Rilles are classified according to their appearance. *Sinuous rilles* are found mostly in maria (lava plains). They are thought to have been formed by running lava and hence become narrower as they flow downslope; fine examples are *Rima Hadley* in Map 14 and *Rima Marius* in Map 20. *Linear rilles* are straighter, and can cross mare and highland boundaries. They might be either collapsed lava tubes, or more likely, surface fractures where the ground to either side has been pulled slightly apart. An example of surface fractures is *Rimae Hippalus* in Map 25.

There are three prominent rille systems in this map, all visible in small telewscopes:

Rima Ariadaeus 14.0^oE 6.4^oN

A 250-km linear rille with nearly uniform width of about 5 km. It is a fault, a graben between two cliffs. A section of it is interrupted by a ridge extending from *Silberschlag* (diameter 13 km).

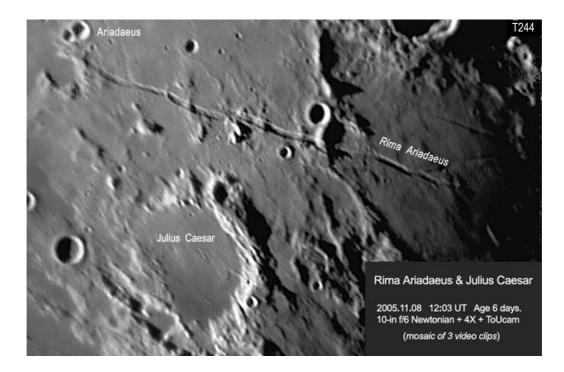
Rima Hyginus 7.8°E 7.4°N

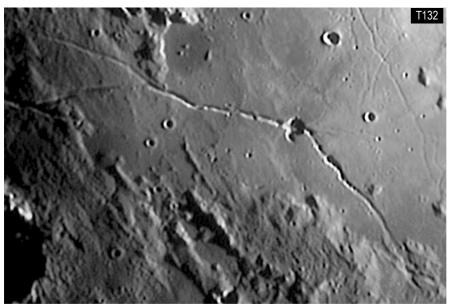
It is composed of two linear segments jointed at *Hyginus* (diameter 9 km), total length 220 km, $3 \sim 5$ km wide, 400 m deep. Presumably the rimless Hyginus is volcanic originated, the rille segments could be lava channels and the chain of craterlets inside the rille floor could be exploded lava bubbles formed by rapid escape of gases.

Rimae Triesnecker 4.6°E 4.3°N

A group of rilles spreading like the branches of a tree. It measures 210 km north-south. *Triesnecker* (diameter 26 km) happens to stick in vicinity.

In the north of Hyginus is a small spiral mountain resembling a rotated letter "e", as marked by the arrow in T164. Observers call it *Mount Schneckenberg*. In the east of this mountain is the disintergrated crater *Boscovich* (46 km) and *Rimae Boscovich* composed of short rilles. *Julius Caesar* (90 km) is a flooded crater with partially darkened floor; it has a heavily worn wall.





NASA005B

Craterlets on Rima Hyginus (cropped from Lunar Orbiter 4 - 4094)

Rima Hyginus 2004.09.05 21:23 UT Age 21 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam, 47 frames. The crater in the middle of the rille is Hyginus. It is rimless, has flat floor and hence appears volcanic rather than impact-created. Presumably Hyginus is volcanic, it would be a lava outlet and the rille would be a lava channel.

(Images in next page)

 $\textbf{Pallas} \quad 1.6^{0}\, W \quad 5.5^{0}\, N \qquad \textbf{Murchison} \quad 0.1^{0}\, W \quad 5.1^{0}\, N$

A pair of joined craters near Sinus Medii. They appear like the Greek alphabet Φ . Both have disintegrated walls. Pallas is 46 km in diameter and Murchison is 57 km with an internal dome.

Bode 2.4⁰ W 6.7⁰ N

A crater, 18 km in diameter. *Rimae Bode* (length 70 km) runs northwards from this crater.

Rhaeticus 4.9° E 0.0° N

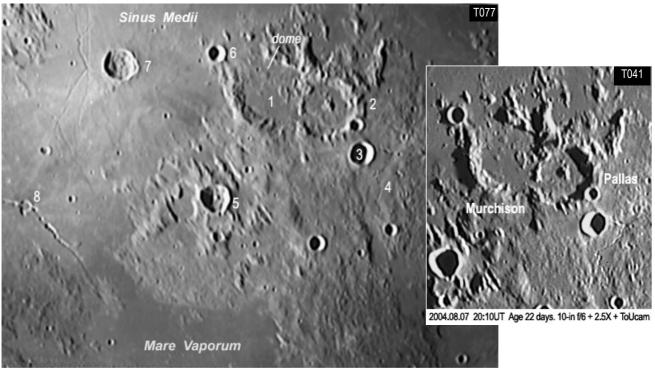
A crater with ruined wall, 45 km in diameter.

Bruce 0.4° E 1.1° N

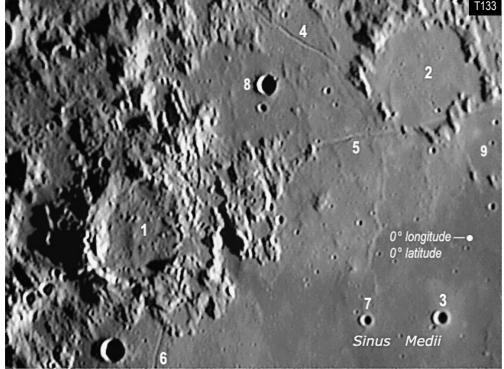
A bowl-shaped crater in Sinus Medii nearest to the zero-point coordinates, 6 km in diameter.

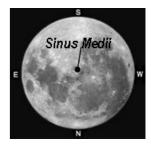
Réaumur 0.7° E 2.4° S

Remains of a crater, 52 km in diameter. Part of its rim is lava-flooded and interupted by *Rima Réaumur* (length 30 km) and *Rima Oppolzer* (length 94 km).

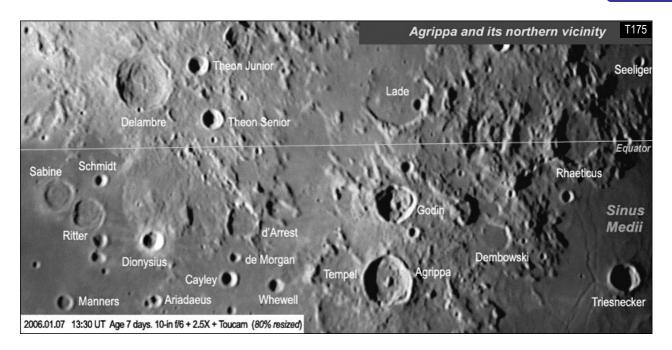


1. Murchison 2. Pallas 3. Bode 4. Rimae Bode 5. Ukert 6. Chladni 7. Triesnecker 8. Hyginus 2005.05.17 11:43 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam, 85 frames stacked, 90% resized.





Rhaeticus
 Réaumur
 Réaumur
 Rima Réaumur
 Rima Oppolzer
 Rima Triesnecker (partial)
 Rima Oppolzer
 Rima Oppolzer
 Rima Triesnecker (partial)
 Age 21 days. 10-in f/6 + 2.5X + 1.6X + ToUcam



Godin 10.2^{0} E 1.8^{0} N

A rayed crater under high illumination, 34 km in diameter. It is fairly irregular, with rough floor and a central peak.

Agrippa 10.5⁰ E 4.1⁰ N A crater with central peak, 44 km in dia.

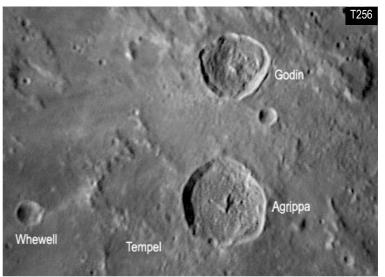
Tempel 11.9° E 3.9° N An irregular, disintegrated crater adjoining Agrippa, 45 km in diameter.

Lade 10.1° E 1.3° S A pentagonal flooded crater, 55 km in diameter. Its southern wall is nearly overwhelmed in lava. The Moon's equator is between Lade and Godin.

Dembowski 7.2° E 2.9° N A flooded crater, 26 km in diameter.

Dionysius 17.3° E 2.8° N A crater with a white halo, very bright during the full moon. It is 18 km in diameter. Close inspection reveals that an additional pattern of dark rays is beneath the white halo. One arm of the dark rays extends across Ritter to the outer rim of Sabine. See also Map 33.

Delambre, Sabine, Ritter See Map 8.



Godin & Agrippa 2006.03.09 13:56 UT Age 9.6 days. 10-in f/6 Newtonian + 4X + ToUcam

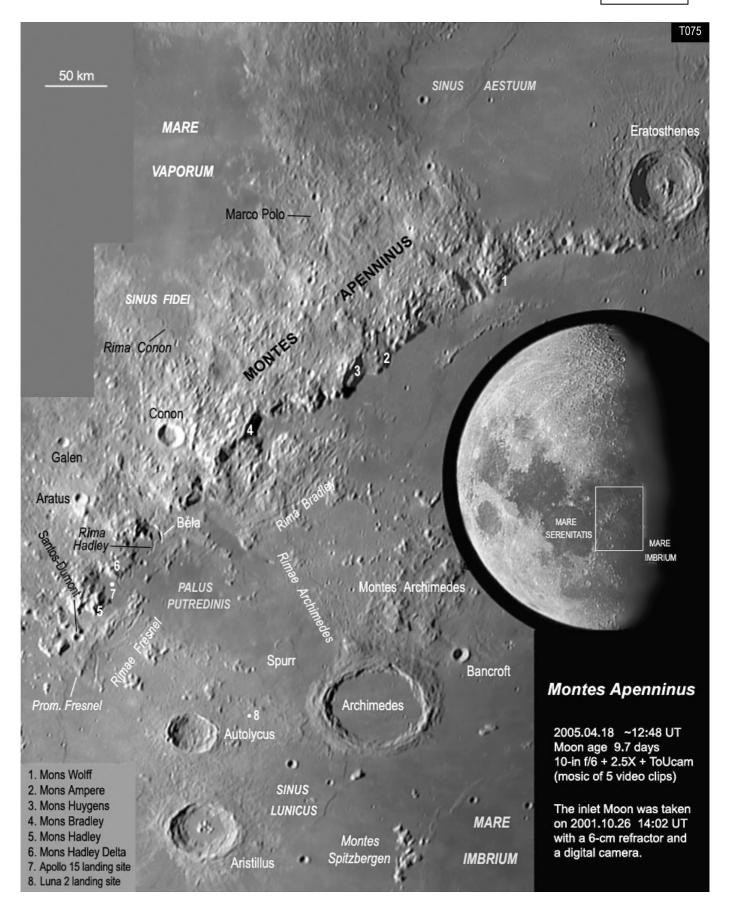


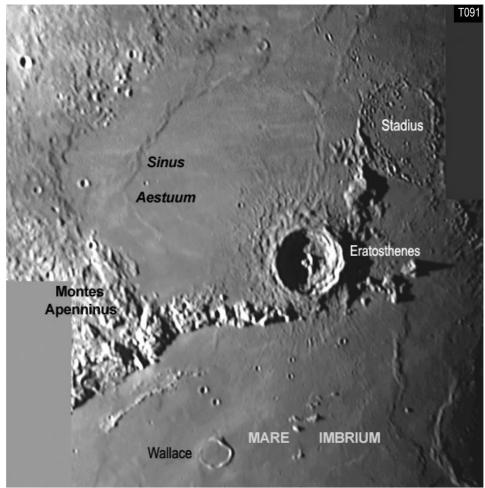
Dionysius with bright halo and dark rays 2006.08.12 20:27 UT Age 18 days. 10-in f/6 Newtonian + 4X + ToUcam



Hatfield 1, 5 Rükl 22, 21 12

Montes Apenninus, Rima Hadley, Archimedes, Aristillus





Sinus Aestuum & Eratosthenes 2005.05.17 ~12:30 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam

Montes Apenninus 3.7° W 18.9° N

The largest mountain range on the nearside of the Moon, named by the Polish astronomer and selenographer Hevelius (1611-1687). It is on the south-eastern edge of Mare Imbrium (Sea of Rains), and is part of the rising rim of the impact basin that holds the mare. Apenninus measures about 500 km end-to-end, 5000 m peak. The mountain slopes towards Mare Imbrium are rather steep (roughly 30°) but the back slopes towards south are gradual. The back slopes are believed massive deposits of the ejecta produced by the Imbrium impact. See also T257 in Map 33.

Montes Apenninus is very bright at days close to the full moon.

Sinus Aestuum 8.8° W 10.9° N

Sinus Aestuum (Bay of Billows) is a mare-like lowland where its eastern edge is the slopes of Montes Apenninus, 290 km in diameter. Its floor contains concentric wrinkle ridges.

Eratosthenes See Map 19.

Conon
$$2.0^{\circ}$$
 E 21.6° N

A prominent crater on Apenninus, 21 km in diameter. Some people guessed it could be an "oversized" secondary crater produced by the gigantic Imbrium impact. A sinuous rille (*Rima Conon*, length 30 km) is in the vicinity.

Macro Polo $2.0^{0} \, \text{W} \, 15.4^{0} \, \text{N}$

An irregular shallow crater on the southern slope of Montes Apenninus, 21 x 28 km.

Rima Bradley 1.2° W 23.8° N

A prominent linear rille running parallel with Montes Apenninus, length 160 km.

Rima Hadley $3.0^{\circ} \, \text{E}$ $25.0^{\circ} \, \text{N}$

A sinuous rille which begins at the elongated crater **Běla** (2 x 11 km). It is a typical lava channel, 80 km long, 1~2 km wide, 300 m deep. On 1971.07.30, Apollo 15 landed on the eastern side of this rille, near **Mons Hadley Delta**. See Image T137.

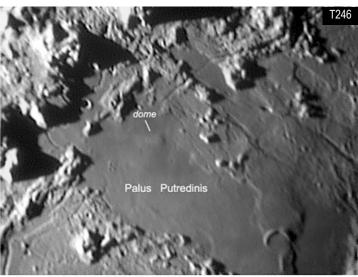
Rimae Fresnel 4.0° E 28.0° N

A system of rilles, length 90 km. A closer view is shown in T137. The main rille appears to be a continuation of Rima Hadley. It ends near the spiky cape *Promontorium Fresnel*.

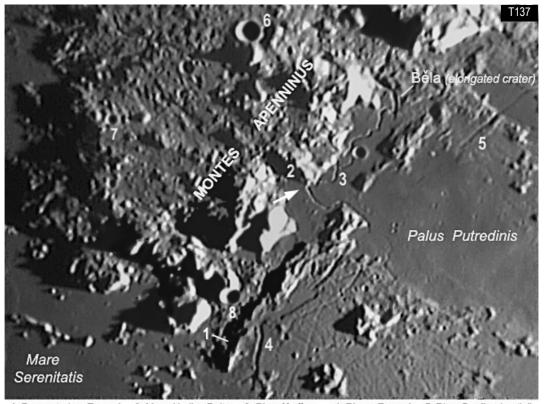
Montes Spitzbergen 5.0° W 35.0° N A group of adjoined mountains with peak height up to 1400 m, base 60 km.

Palus Putredinis $0.4^{\circ} 26.5^{\circ} N$

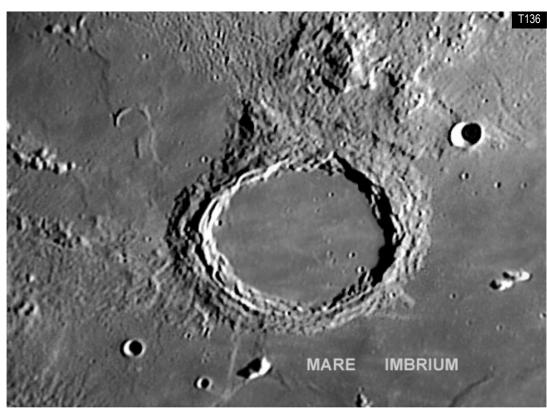
Palus Putredinis (Marsh of Decay) is a small mare facing Montes Apenninus, east-west span 160 km. It contains a dome, noticeable only under low sun angle.



Palus Putredinis 2005.11.09 12:41 UT Age 7 days. 10-in f/6 Newtonian + 4X + ToUcam



Promontorium Fresnel
 Mons Hadley Delta
 Rima Hadley
 Rimae Fresnel
 Rima Bradley (partial)
 Aratus
 Joy
 Santos-Dumont
 2004.09.05
 Gut Age 21 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam
 The arrow points to the landing site of Apollo 15.)



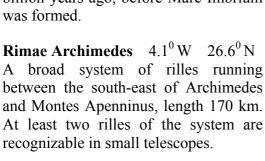
Archimedes 2004.09.05 21:40 UT Age 21 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam, 69 frames stacked.

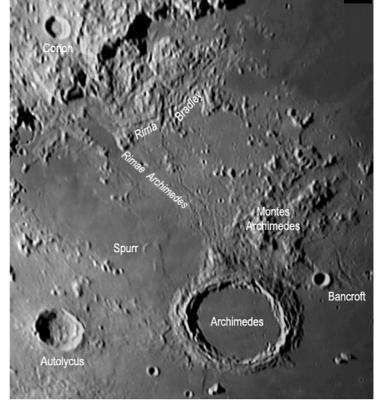
$\textbf{Archimedes} \quad 4.0^{0}\, W \quad 29.7^{0}\, N$

A flooded crater with terraced walls, 82 km in diameter, 2100 m deep. Its large size suggests central peaks once existed, but they were buried by post-flooding of lava on the floor. The ejecta blanket of Archimedes is also buried partially in lava. This makes the crater rim to look bulgy. A prominent triangular cape extends 30 km from the southeast rim.

Montes Archimedes 4.6° W 25.3° N A mountain range adjoining the south rim of Archimedes, length 160 km. It might be part of Montes Apenninus 3.8 billion years ago, before Mare Imbrium

Rimae Archimedes 4.1°W 26.6°N A broad system of rilles running between the south-east of Archimedes and Montes Apenninus, length 170 km. At least two rilles of the system are





2004.06.26 14:09 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam

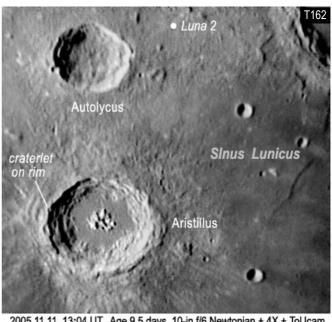
Spurr 1.2° W 27.9° N

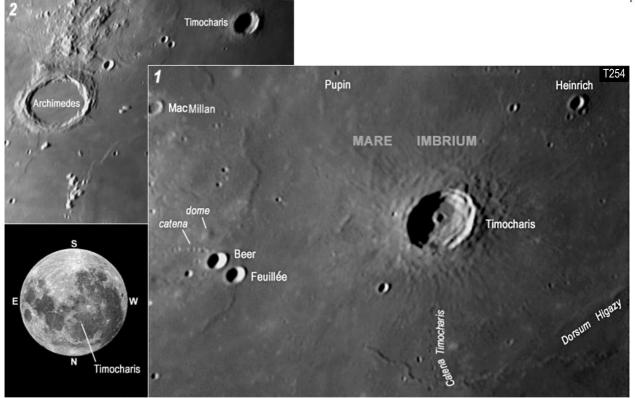
Remains of a flooded crater, 13 km in diameter.

Autolycus 1.5° E 30.7° N **Aristillus** 1.2° E 33.9° N

A prominent crater pair in the Apenninus region. Autolycus has a rough floor with disintegrated central peaks, 39 km in diameter. Aristillus has wide ejecta blanket, terraced inner walls and multiple central peaks, 55 km in diameter. A ghost crater is also beneath the ejecta blanket of Aristillus (shown in Image T120, Map 15.) Both craters are centers of bright rays under high illumination.

In 1959, the Russian Luna 2 probe hit the Moon near Autolycus and Sinus Lunicus (Bay of Luna). Luna 2 is the first man-made object to reach the Moon surface.





Timocharis and its vicinity 1. 2006.03.09 13:26 UT Age 9.6 days. 10-in f/6 + Newtonian + 4X + ToUcam 2. 2006.02.07 12:36 UT Age 8.9 days.

$13.1^{\circ} \text{W} \quad 26.7^{\circ} \text{ N}$ **Timocharis**

A sharp rim crater with terraced inner walls, 33 km in diameter. The central floor has a small crater that lies on a slight rise. Timocharis is a rayed center under high illumination.

Catena Timocharis 13.0° W 29.0° N

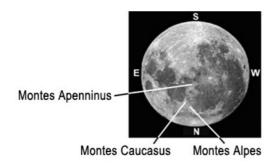
A chain of craterlets, about 50 km long. It is barely distinguishable in Image T254.

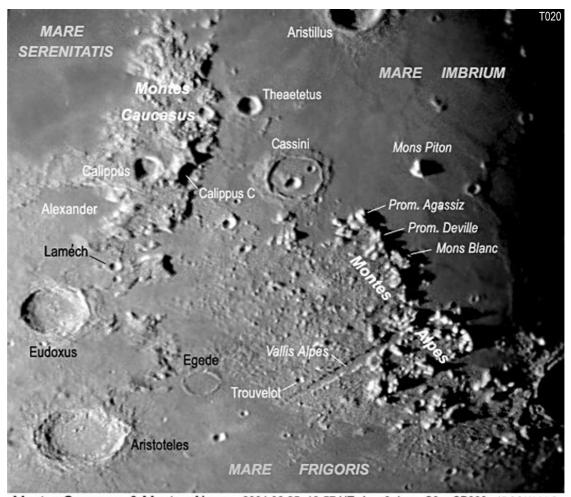
Beer 9.1° W 27.1° N **Feuillée** 9.4° W 27.4° N

A close pair of bowl-shaped craters, each about 9 km in diameter. Note the nearby dome and catena which are noticeable only under very oblique sunlight.

Hatfield 2 Rükl 13,12, 5, 4

Montes Caucasus, Montes Alpes, Vallis Alpes, Cassini, Aristoteles, Eudoxus



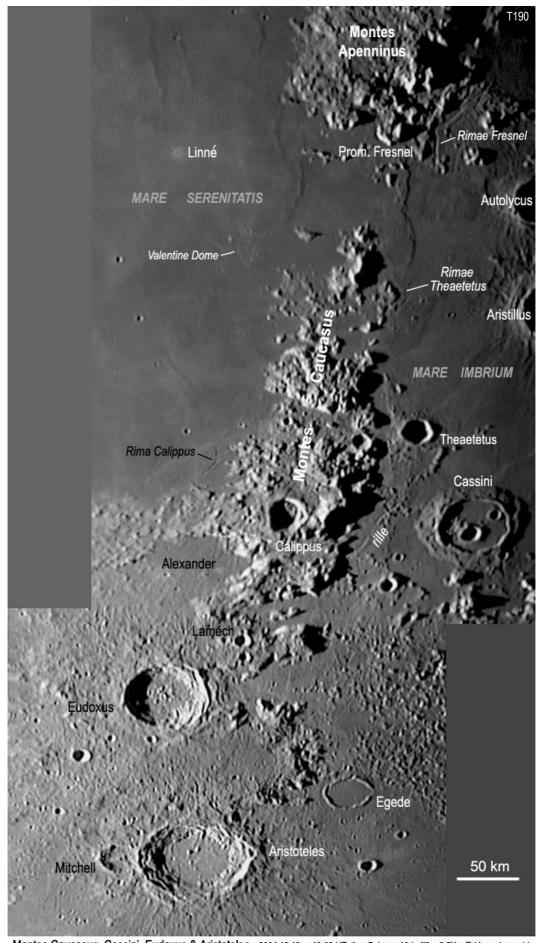


Montes Caucasus & Montes Alpes 2001.09.25 12:57 UT Age 8 days. C9 + CP990 (DSCN9804)

Montes Caucasus 10.0° E 38.4° N

A rugged mountain range between Mare Serenitatis in the east and Mare Imbrium in the west. The southern half of the range has several breaks intruded by mare lava. It measures 445 km north-south, height up to 6000 m. It is the highest montes on the nearside of the Moon. Standing on the highest peak, an observer could see distant land at least 140 km away*, including part of Cassini which has a raised floor. Montes Caucasus appears once united with Montes Apenninus but a channel of mare lava separated them subsequently, see Image T190 in next page.

^{*} Horizon radius ≈ square root of (altitude of eye-level x diameter of the Moon)



Montes Caucasus, Cassini, Eudoxus & Aristoteles 2004.12.19 ~13:09 UT Age 7 days. 10-in f/6 + 2.5X + ToUcam (mosaic)

Calippus $10.7^{\circ} E 38.9^{\circ} N$

A crater on the highlands of Montes Caucasus, 32 km in diameter. Its eastern wall looks linear. Its western wall is slided. *Calippus C* (40 km) is a bay-shaped crater facing Mare Imbrium.

Alexander 13.5° E 40.3° N

A heavily eroded walled plain, 81 km in diameter. Its northeastern wall is obliterated.

Montes Alpes $0.8^{0} \,\mathrm{W}$ $46.4^{0} \,\mathrm{N}$

A mountain range named by the Polish astronomer Hevelius (1611-1687) on the northeast edge of Mare Imbrium, length 280 km and average height 2400 m. Under low Sun angles, the mountain peaks cast a forest of spectacular spiky shadows. The southern end of Montes Alpes has two capes named *Promontorium Agassiz* and *Promontorum Deville*.

Mons Blanc (Mont Blanc) 1.0° E 45.0° N

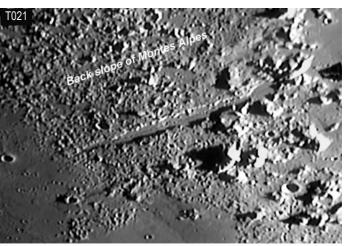
A mountain adjoining Montes Alpes, 3600 m high, base 25 km.

Mons Piton 1.1^{0} W 40.6^{0} N

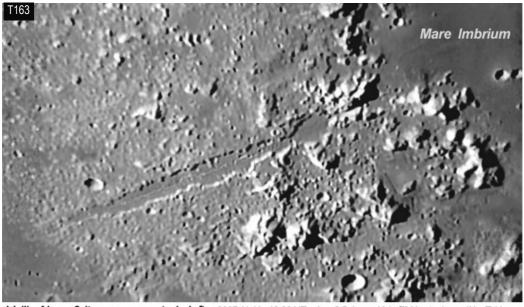
An isolated mountain, 2300m high, base 25 km. It casts long shadow under low Sun angles.

Vallis Alpes 3.2° E 48.5° N

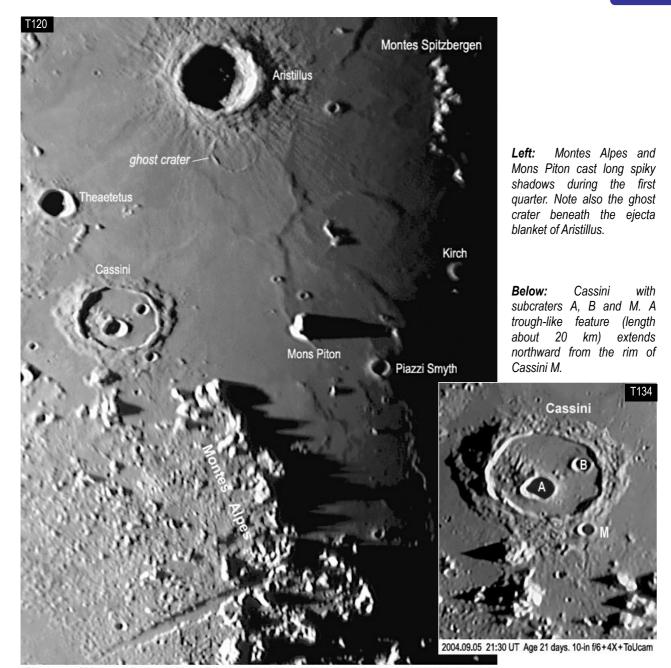
Vallis Alpes is a prominent landmark, length 166 km and width up to 11 km. It is radial to Mare Imbrium, appearing like a blade to bisect Montes Alpes. Under appropiate illumination and good seeing condition, a very narrow central cleft can be spotted with an 8-inch telescope. Vallis Alpes is a graben (sunken area between faults) produced at the time of the Imbrium basin-forming impact. The valley was subsequently filled by volcanic material. The central cleft is less than 500 m in width and could be a lava channel running downhill along the back slope of Alpes.



Vallis Alpes 2004.09.05 21:31 ~ 21:33 UT Age 21 days. 10-in f/6 + 2.5X + 1.6X + ToUcam



Vallis Alpes & its narrow central cleft. 2005.11.11 13:22 UT Age 9.5 days. 10-in f/6 Newtonian + 4X + ToUcam



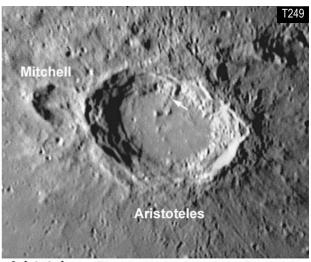
Shadows of Montes Alpes and Mons Piton 2005.11.09 12:00 UT Age 7.4 days. 10-in f/6+2.5X+ToUcam

Cassini 4.6° E 40.2° N

A flooded crater with bulging outer slopes, diameter 56 km. The floor appears slightly raised and is stuck by two distinct craters *Cassini A & B. Cassini M* is on the outer rim. A broken rille is located between Cassini & Calippus (Image T190).

Aristoteles 17.4° E 50.2° N

A crater with terraced walls, 87 km in diameter. Its eastern wall adjoins crater *Mitchell* (30 km). A triangular landslide is on the western wall. The southern wall is crossed by a chain of craterlets which appears only under appropriate illumination.



Aristoteles The arrow points to a chain of craterlets. 2005.11.09 11:04 UT Age 7.4 days. 10-in f/6 Newtonian + 2.5X +1.6X + ToUcam

Eudoxus 16.3°E 44.3°N

A crater with terraced walls and small irregularties on the floor, 67 km in diameter. It is often described with Aristoteles as a twin.

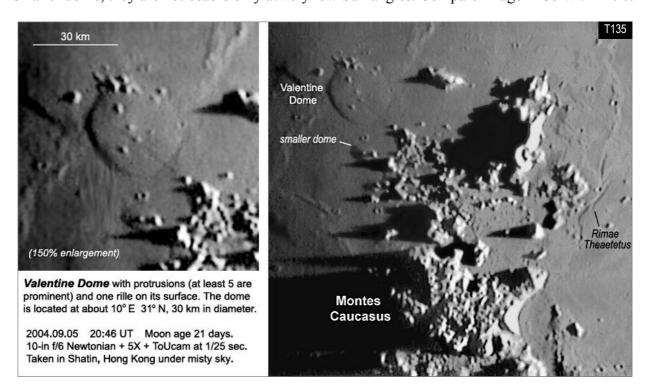


1. Aristoteles 2. Eudoxus 3. Bürg 2004.10.03 21:15 UT Age 19 days. 10-in f/6 + 2.5X + ToUcam, 10 frames.

Rimae Theaetetus 6.0°E 33.0°N Inconspicuous rilles, length about 50 km. See Image T190.

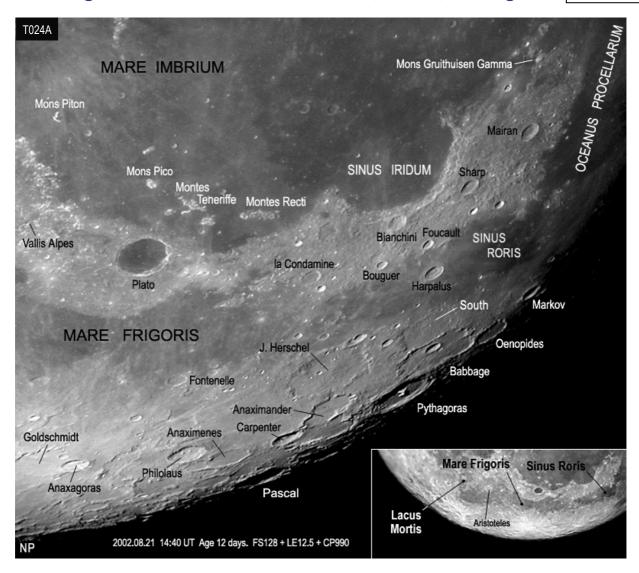
Valentine Dome (nickname) 10.2°E 30.5°N

A raised, circular plateau near the southern end of Montes Caucasus. Together with the nearby smaller dome, they are noticeable only at very low Sun angles. Compare Image T135 with T190.

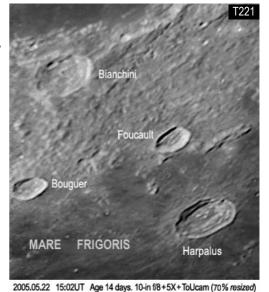


Hatfield 6 Rükl 4, 3, 2, 11

Mare Frigoris, Plato, Mons Pico, W. Bond, Meton, NP Region



Mare Frigoris (Sea of Cold) 1.4°E 56.0°N While lunar maria generally tend to be circular in shape, Mare Frigoris is not. It extends roughly 300 km north-south and 1,600 km east-west between Lacus Mortis and Sinus Roris, see the inlet of Image T024A. The formation of Mare Frigoris is not ascertained. Some geologists suggested that it could be part of the lava-filled depression that belongs to the outmost circumference of the gigantic Imbrium Impact; the other parts of depression including Mare Vaporum, Sinus Aestuum and perhaps, the eastern portion of Oceanus Procellarum. There is no notable crater within Mare Frigoris except *Aristoteles* (diameter 87 km) in the east and *Harpalus* (39 km) in the west.

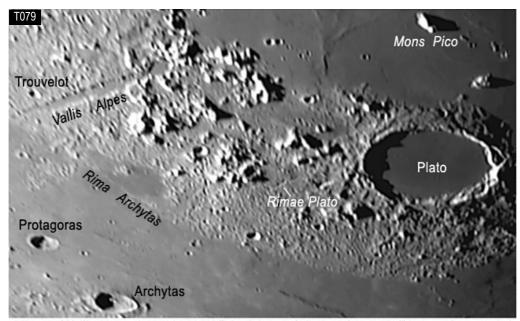


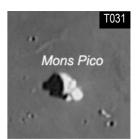
Sinus Roris (Bay of Dew) 56.6° W 54.0° N

A dark lava plain between Mare Frigoris and Oceanus Procellarum, size up to about 200 km.

Plato 9.4°W 51.6°N

Plato is a walled plain, 109 km in diameter, 1000 m in depth. Hevelius of the 17th century called it "The Great Black Lake". It is one of the darkest surface features, even in the full moon. Its lava floor looks flat and blank, but tens of tiny craterlets are detectable using big telescopes under good seeing. At Moon age of about 9 days, the eastern walls of Plato cast spiky shadows on the floor. The western walls also cast similar shadows at Moon age of about 21 days. There are two triangular landslides on Plato's rim; similar landslides also exist in Aristoteles Map15 and Gassendi MAP 25. An oval ghost ring, nicknamed *Ancient Newton*, exists between the southern wall of Plato and Mons Pico. It was first noted by Schröter in 18th century while "Newton" refers to a crater near the lunar south pole, Map 11.

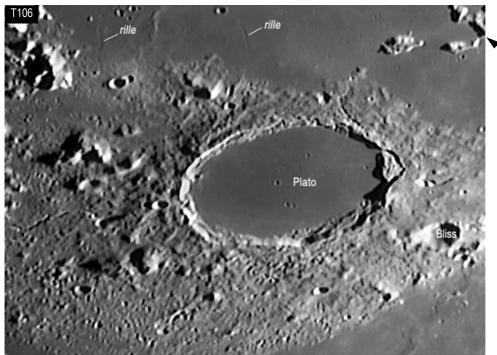




2004.08.07 Age 22 days

Mons Pico is an isolated mountain, height 2400 m, base 15x25 km.

Plato and Vallis Alpes 2004.06.26 14:15 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam, 35 frames stacked.



Plato 2004.09.05 21:34 UT Age 21 days. Misty sky. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam at 1/25 sec.

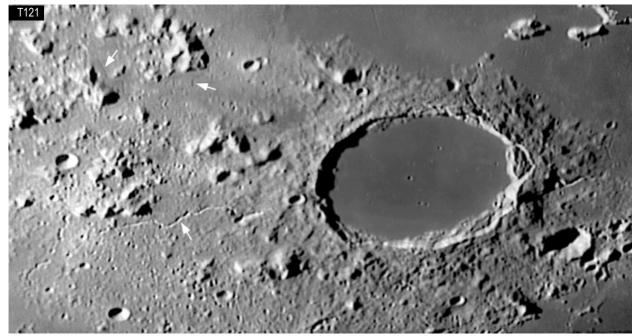


2004.06.27 Age 10 days

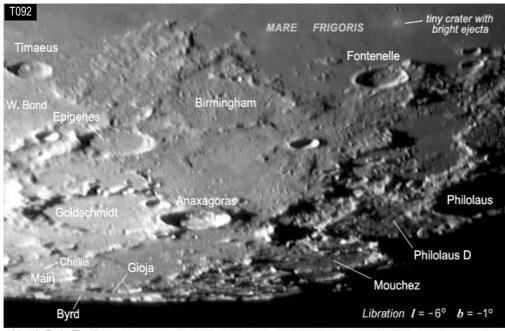
Montes Teneriffe is a group of mountains, individual peak height up to 2400 m.

Rimae Plato 3.2° W 52.9° N

A system of rilles east of Plato. It contains three isolated sections as indicated by arrows in T121. The main section, which is nearest to Plato, is 87 km long.



Plato and Rimae Plato (arrows) 2005.11.11 13:08 ~ 13:10 UT Moon Age 9.5 days. 10-inch f/6 Newtonian + 2.5X + 1.6X + ToUcam (mosaic)



North Pole Region 2004.06.27 14:25 UT Age 10 days. 10-in f/6 Newtonian + 2.5X + ToUcam, 3 frames stacked.

Fontenelle 18.9° W 63.4° N

A 38-km crater with notched rim and small peaks. It looks oval due to foreshortening.

 $\textbf{Birmingham} \quad 10.5^{0}\,W \quad 65.1^{0}\,N$

A heavily ruined crater, 92 km in diameter.

Epigenes 4.6° W 67.5° N

A crater with off-centered peaks, 55 km in diameter.

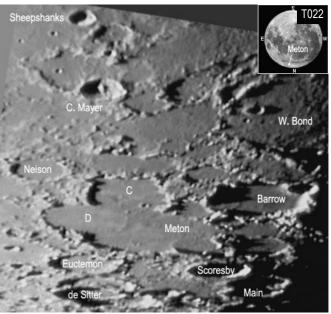
(Image T022 & T223)

Meton 18.8° E 73.6° N Remains of a vast walled plain, 130 km in diameter. It overlaps with 2 flooded craters, Meton C (77 km) and Meton D (78 km).

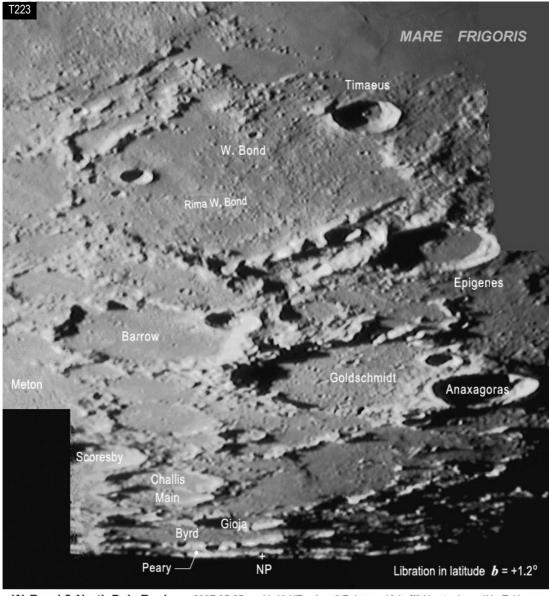
W. Bond 4.5^{0} E 65.4^{0} N A vast walled plain, 156 km in diameter. Its rough floor contains a faint thin rille.

Anaxagoras 10.1° W 73.4° N A 50-km crater. At high illumination, it emits bright rays up to Plato (Image T024A).

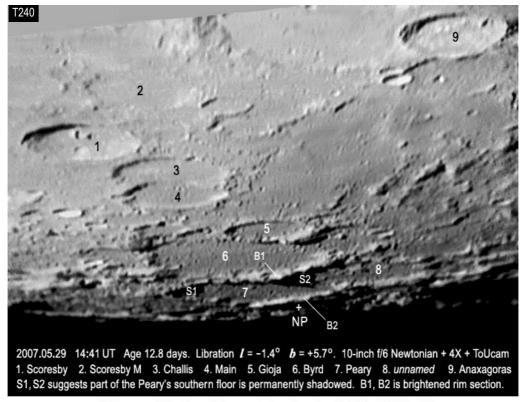
Goldschmidt 3.8° W 73.2° N A 113-km crater interrupted by Anaxagoras. Its outer walls are very rugged.



Meton 2004.12.19 13:15 UT Age 7 days. 10-in f/6 Newtonian + 2.5X + ToUcam



W. Bond & North Pole Region 2007.05.25 ~11:43 UT Age 8.7 days. 10-in f/6 Newtonian + 4X + ToUcam.



(Reference: http://www.lpi.usra.edu/meetings/lpsc2004/pdf/1387.pdf)

Scoresby $14.1^{\circ} E 77.7^{\circ} N$

A 55-km crater with two low hills and a small crater inside the floor. Scoresby M (54 km) is a shallow crater in the south-west vicinity.

Gioja 2.0^{0} E 83.3^{0} N

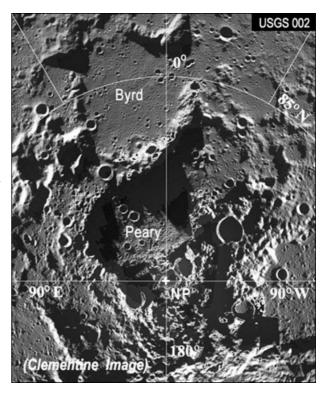
A 41-km crater. Its western rim is heavy eroded.

Byrd 9.8⁰ E 85.3⁰ N

A 93-km walled plain connecting Gioja. It eastern and western walls are heavily eroded. Its floor is peppered with craterlets.

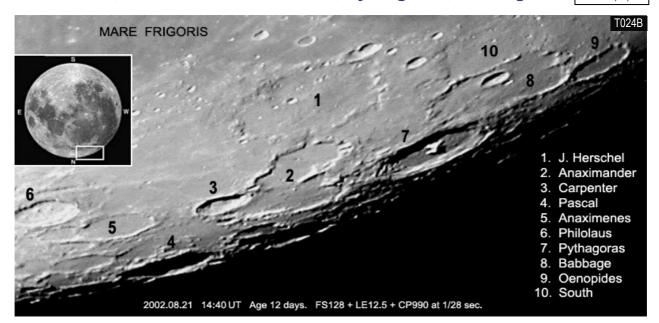
Peary 33.0°E 88.6°N

A 73-km crater nearest to the north pole, resolvable only during favorable libration. Peary is in fact circular but looks much elongated due to extreme foreshortening. A wide portion of its southwestern circumference is opened to an unnamed feature (T240, No. 8). Part of Peary's southern floor remains in permanent shadow (S1, S2). Two sections of its rim (B1, B2) seem to be brightened during the full season of the lunar summer. This is because the Moon's axial tilt is as small as 1.5°, hence the Sun illuminates Peary at grazing angles most of the time. Compare T240 with the Clementine image at right.



Hatfield 6 Rükl 3, 2, 1

J. Herschel, Anaximander, Philolaus, Pythagoras, Babbage



J. Herschel 42.0^{0} W 62.0^{0} N Remains of a walled plain with small craters on the floor, 165 km in diameter.

Anaximander 51.3° W 66.9° N A 67-km broken crater between two larger craters *Anaximander B & D.* Details in T157, next page. The formation connects with *Carpenter* (59 km).

Pascal 70.3° W 74.6° N A 115-km crater, visibility subject to libration.

Anaximenes 44.5° W 72.5° N An 80-km crater with worn walls and flat floor.

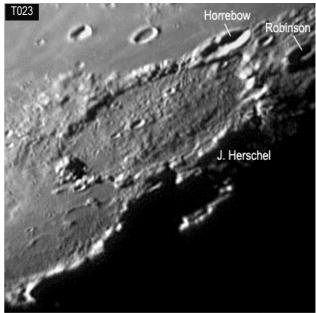
Philolaus 32.4° W 72.1° N A crater with terraced walls and double central peaks, 70 km in diameter.

Pythagoras 63.0° W 63.5° N A 142-km crater with conspicuous central peak.

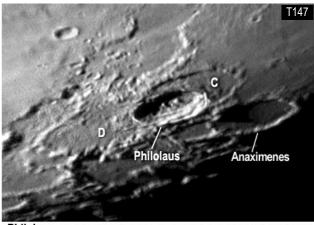
Babbage 57.1° W 59.7° N A 143-km walled plain. Its floor contains a bowl-shaped crater (*Babbage A*, 32 km).

Oenopides 64.1° W 57.0° N A 67-km crater with few tiny craters on the rim.

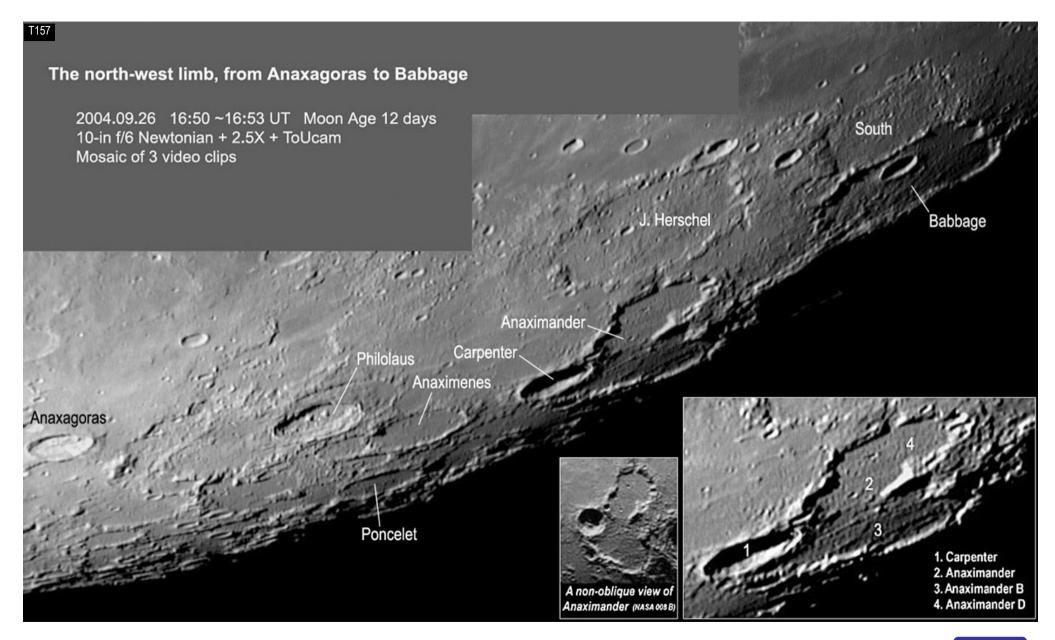
South 50.8° W 58.0° N Remains of a ruined crater, 104-km in diameter.



J. Herschel 2004.09.25 14:10 UT Age 11 days. 10-in f/6 + 2.5X + ToUcam



Philolaus 2004.09.25 14:12 UT Age 11 days. 10-in f/6 + 2.5X + ToUcam

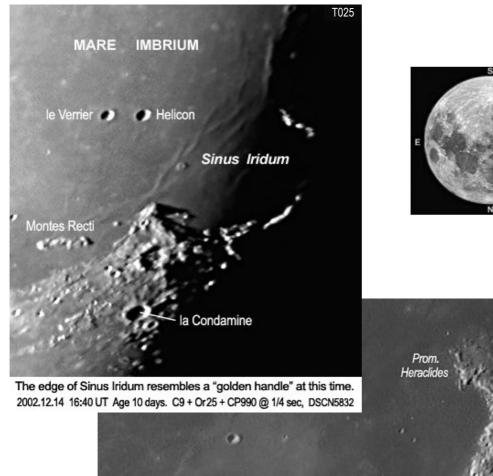


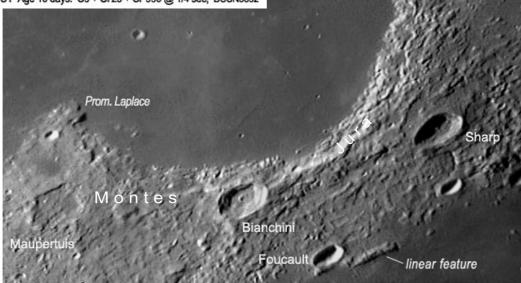
Hatfield 6 Rükl 10, 11, 20

T026

Sinus Iridum

Sinus Iridum, Montes Recti, Bianchini, Sharp, Maupertuis



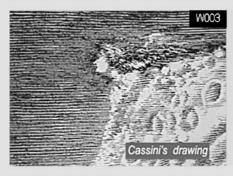


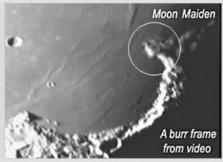
Sinus Iridum 2002.12.16 14:02UT Age 12 days. 10-in f/6 Royce mirror + 2.5X + ToUcam, 2 frames stacked.

Sinus Iridum (Bay of Rainbows) 31.5° W 44.1° N

Sinus Iridum is a distinct landmark on the north-western edge of Mare Imbrium (Sea of Rains). It measures 230 km between two capes named *Promontorium Laplace* (height 2600 m) and *Promontorium Heraclides* (height 1700 m). Its origin is believed a vast crater but large part of the walls is overwhelmed by Mare Imbrium. Under low Sun angle, the floor of Sinus Iridum is crossed by wrinkle ridges, and *Montes Jura* (the semicircular mountain range along the shore) resembles a "golden handle" of a teapot. In the 17th century, the western cape of Sinus Iridum was nicknamed the "Moon Maiden" by the French astronomer Cassini.

The Moon Maiden When the Italian-born French astronomer Cassini observed Sinus Iridum in the 17th century, he depicted Promontorium Heraclides (circled) as the "Moon Maiden", complete with face and waving hair. Cassini's "Moon Maiden" is in fact an illusion and may not show up all the time. The trick to knowing it is to view it on a night when seeing is not that good; this exaggerates the illusion!

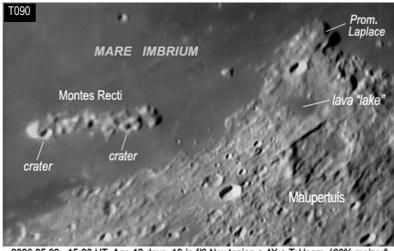




Bianchini 34.3° W 48.7° N **Sharp** 40.2° W 45.7° N Crater Bianchini (38 km) and Sharp (39 km) resemble a pair of "eyes" guarding Sinus Iridum.

Maupertuis 27.3° W 49.6° N A pentagon-shaped disintegrated crater close to Promontorium Laplace, 45 km across. A small lava "lake" is just in the south.

Montes Recti 20.0° W 48.0° N A straight range of mountains close to Sinus Iridum, 20 x 90 km and up to 1800 m high. A small crater lies near the eastern and western end of this range respectively.



2006.05.09 15:03 UT Age 12 days. 10-in f/6 Newtonian + 4X + ToUcam (80% resized)

Image T065, next page:

Lambert 21.0°W 25.8°N

A crater with terraced walls, 30 km in diameter. Its immediate south is the ghost crater *Lambert R* (55 km). See also Image T177 in Map 19.

C. Herschel 31.2° W 34.5° N

A 13-km crater named after Caroline Herschel, the sister of the German-born English astronomer William Herschel who discovered Uranus in 1781. She assisted her brother lifetime and was the first woman to discover a comet.

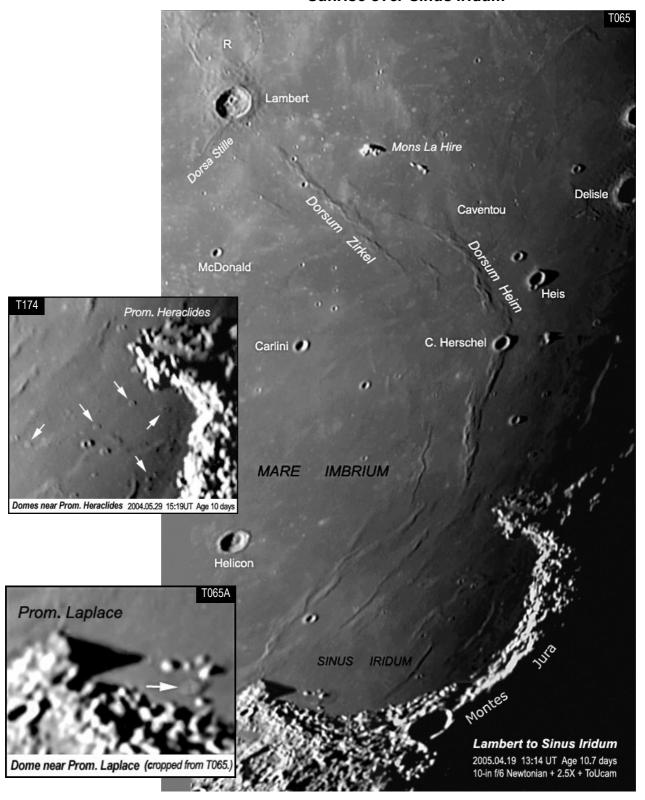
Mons La Hire 25.5° W 27.8° N

An isolated mountain, base about 11 x 25 km, peak height 1500 m. It is a highland remnant partially submerged in lava. A closer view from the Apollo-15 mission is given in Map 1.

Dorsum Zirkel 23.5°W 28.1°N **Dorsum Heim** 29.8°W 32.0°N

They are wrinkle ridges on the western side of Mare Imbrium. Dorsum Zirkel is 190 km long. Dorsum Heim is nearly 150 km long, followed by few more unnamed wrinkle ridges that extend northwards into Sinus Iridum.

Sunrise over Sinus Iridum

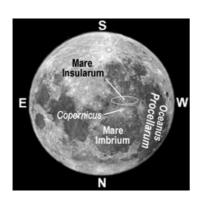


The wrinkle ridges on the floor of Sinus Iridum are particularly prominent when the terminator passes over them. To emphasize the profile of these ridges, Montes Jura (the mountain range under illumination) is inevitably over-exposed in Image T065. Sunlight comes from the east, suggesting that an observer on the shore of Sinus Iridum would experience sunrise at this time.

Helicon is a crater resembling a bowl, 24 km in diameter and 1900 m deep. The cape-like feature that casts triangular shadow is Promontorium Laplace. It rises 2600 m high and has an indistinctive dome in the west (T065A). Other domes exist near Promontorium Heraclides (T174), but they are noticeable only under very low illumination angles.

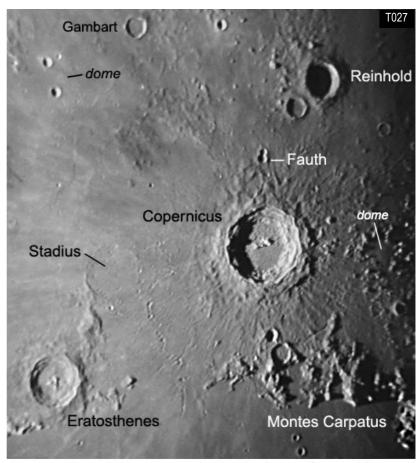
Hatfield 5 Rükl 32, 31, 30, 20, 19

Copernicus, Eratosthenes, Stadius, Montes Carpatus, Euler, Lambert, Hortensius, Milichius



(Image T027)

Copernicus 20.1° W 9.7° N Copernicus is a fine example of a young ring mountain, formed about 800 million years ago. It is located between the south of Mare Imbrium and the north of a loosely bounded plain named *Mare Insularum* (Sea of Isles). Copernicus is 93 km in diameter, with a group of central peaks and terraced walls 3700 m above the floor. The depth-diameter ratio



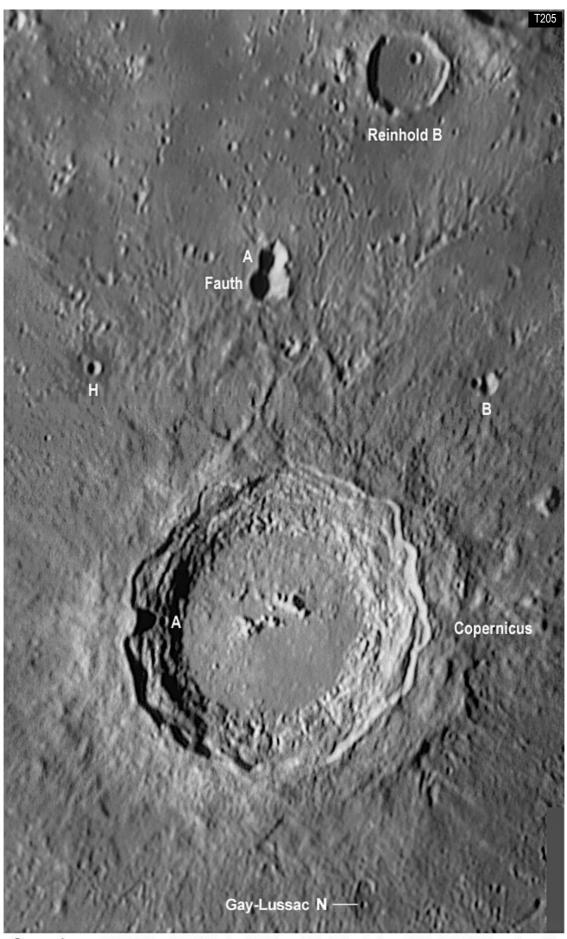
2002.11.14 14:58UT Age 9 days. C9+LE12.5+CP990 1/7 sec DSCN5818

of Copernicus is 1:25; this makes the crater to resemble a pie pan rather than a bowl. The Copernicus region is rich in observation details. At Moon age of $9 \sim 10$ days, a faint dome is barely notable about one diameter west of the crater. Numerous secondary craterlets and pits also spread like raisin holes in the north-east vicinity. Extensive bright rays emit from the crater at days close to the full moon.

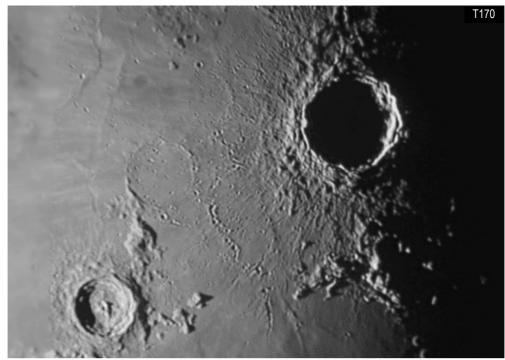
The number of central peaks in Copernicus is a challenge to observation. Three peaks of height up to 1200 m are obvious in small telescopes. Large telescopes may spot additional small "bumps". Images from spacecraft, however, reveal even more peaks. The terraced walls look somewhat hexagonal. The radial scars around the outer walls are the ejecta blanket resulted from an asteroid-like impact. The two small overlapping craters in the south of Copernicus are *Fauth* (12 km) and *Fauth A* (10 km); they are good indicators to align an image's north-south orientation.

(Image T205, next page)

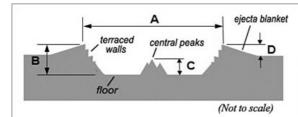
Outside the rim of Copernicus are two small craters surrounded by dark halo --- Copernicus H, diameter 5 km and Gay-Lussac N, diameter 2 km. Presumably these craters formed from secondary impact, the dark halo could be the deposits of mare basalt excavated from the impact site. The impact was supposed not too energetic, so only the top-most layer of dark basalt was excavated but the deeper underground of light-colored anorthosite remained intact.



Copernicus 2005.04.19 ~12:39 UT Age 10.7 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam (mosaic)



Copernicus on the terminator 2007.10.20 12:57 UT Age 9.4 days. 10-in f/6 Newtonian + Meade 2X + ToUcam



Cross-section of Copernicus

Diameter A = 93 km Height
Depth of floor B = 3700 m Heigh

Height of central peaks C = 1200 m Height of outer walls D = 1400 m

Small impact craters (diameter less than about 15 km) do not have central peaks. They tend to have simple bowl shape whereas in a large crater like Copernicus, slumping of material off the inner walls helps to flatten the crater floor. Note also that B is greater than D, and the inner walls are always steeper than the outer ejecta blanket.

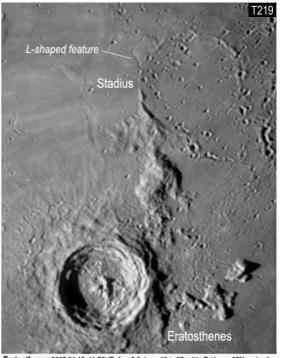
Image T219:

Eratosthenes 11.3°W 14.5°N

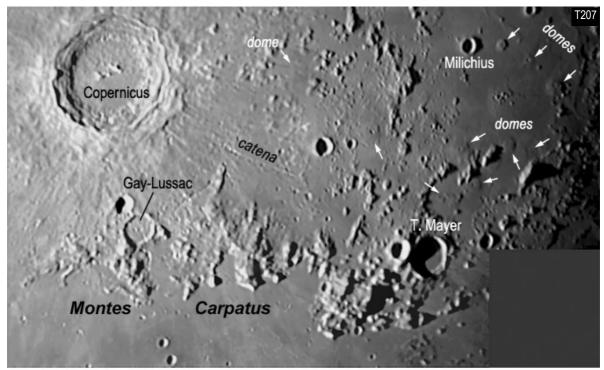
An impact crater between Copernicus and the south end of Montes Apenninus, 58 km in diameter and 3600 m deep. It has a sharp rim, terraced walls and 3 central peaks. Eratosthenes changes in appearance during a lunation. At full moon it almost disappears. The lack of bright rays around the crater suggests that the rays were washed out by space weathering, so Eratosthenes must be older than Copernicus and is determined to have formed 3.2 billion years ago (the beginning of the *Eratosthenian* period). The adjacent land relief is interesting; it resembles an elephant with an upward swirling nose.

Stadius 13.7°W 10.5°N

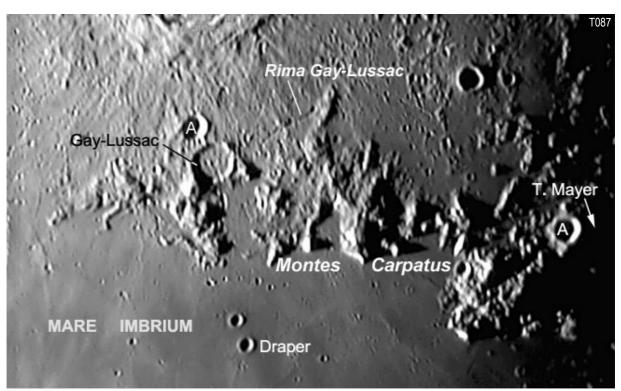
A ghost depression with incomplete low walls, 69 km in diameter. It is peppered with secondary craterlets and pits. A L-shaped feature (possibly composed of a catena and a rille) extends from the southeast rim. The height of the northeast wall is 650 m.



Eratosthenes 2005.04.18 11:53UT Age 9.8 days. 10-in f/6+4X+ToUcam, 85% resized.



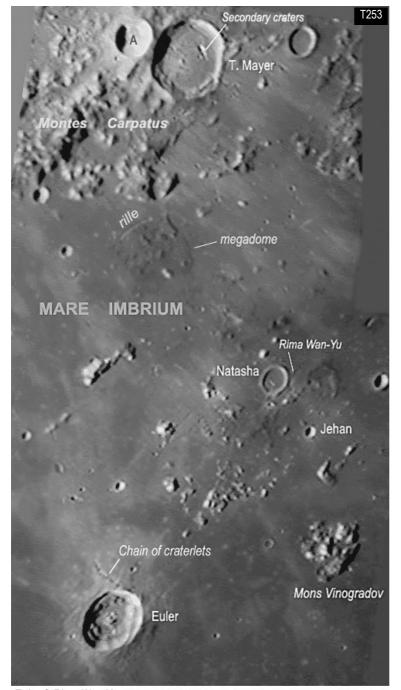
Montes Carpatus & Copernicus 2005.04.19 13:40 UT Age 10.7 days. 10-in f/6 Newtonian + 2.5X + ToUcam

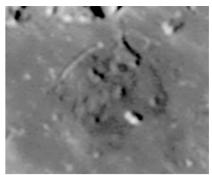


Montes Carpatus (north of Copernicus) 2004.06.27 13:47 UT Age 10 days. 10-in f/6 Newtonian + 2.5X + ToUcam, 11 frames.

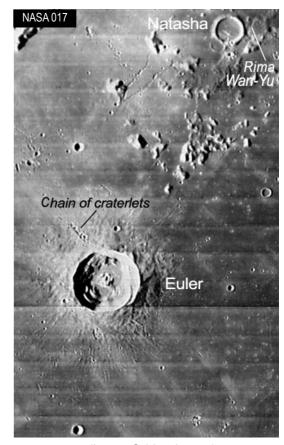
Montes Carpatus 24.4° W 14.5° N

A mountain range, length 360 km with peak height 2300 m. It is one of the montes that form the rising rim of Mare Imbrium. It holds crater *T. Mayer* (diameter 33 km), *Gay-Lussac* (26 km), and one rille (*Rima Gay-Lussac*, length 40 km) that runs across the ejecta blanket of Copernicus. Short chains of craterlets and a megadome (low elevated plateau) can be spotted in the northern vicinity, see T253 in next page.





The **megadome** north of of T. Mayer (Enlargement from T253)



(Lunar Orbiter image)

Euler & Rima Wan-Yu 2006.05.09 13:37 UT Age 12 days. 10-in f/6 + 5X + ToUcam (88% resized)

Image T253:

Euler 29.2° W 23.3° N

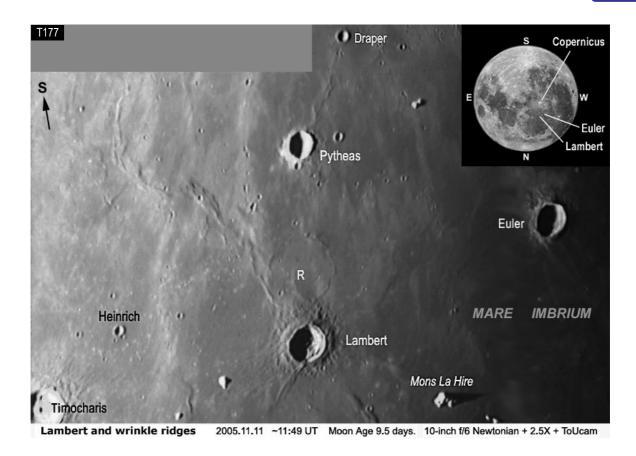
A terraced crater with central peak, 27 km in diameter. A short catena (chain of craterlets) runs almost tangential to the south rim of Euler.

Mons Vinogradov 32.4° W 22.4° N

An irregular mountain rising up to 1400 m, base width 25 km.

Natasha 31.3° W 20.0° N

An inconspicous crater, 12 km in diameter. *Rima Wan-Yu* $(31.5^{\circ} \text{ W} 20.0^{\circ} \text{ N}, \text{ length } 12 \text{ km})$ is an elusive rille very close to the west rim of Natasha.



Lambert 21.0° W 25.8° N (*Image T177*) A terraced crater, 30 km in diameter. It adjoins the ghost crater *Lambert R* (55 km) which is almost buried beneath the mare floor. In the southeast of Lambert is a nameless network of wrinkle ridges.

Pytheas 20.6° W 20.5° N A crater with sharp rim, 20 km in diameter.

Gambart 15.2^{0} W 1.0^{0} N (*Image T178*) A ring-shaped flooded crater, 25 km in diameter. To the south of Gambart are two opposing spiky mountains that cast triangular shadows. A dome (~ 10 km) is located close to *Gambart B* and *C*. The arrow points to another skeptical dome.

Turner 13.2° W 1.4° N A crater, 11 km in diameter, 2600 m deep.

Lalande 8.6° W 4.4° S A bright rayed crater under high illumination, 24 km in diameter. It is probably less than 2.8 billion years old. See also T179 in Map 12.

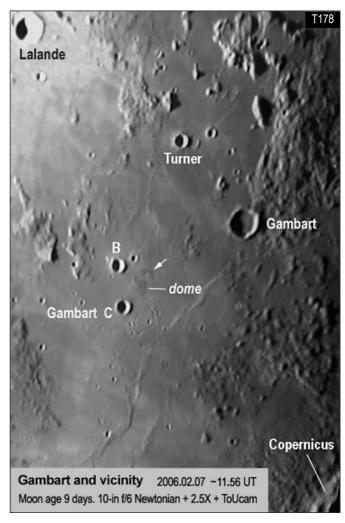


Image T199:

Lansberg 26.6° W 0.3° S A terraced crater with multiple central peaks, 38 km in diameter.

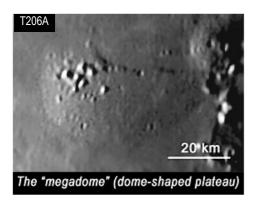
Reinhold 22.8° W 3.3° N

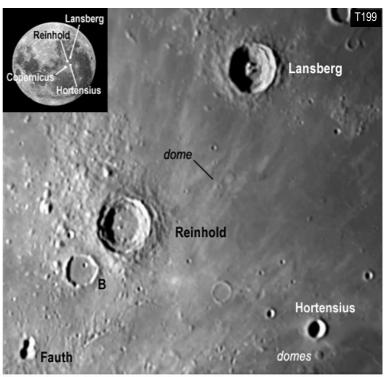
A terraced crater with a small central peak, 42 km in diameter. Between this crater and Lansberg is a volcanic dome that has a summit pit.

Reinhold B 21.7° W 4.3° N

A flood crater with a conspicuous craterlet on the floor, 26 km in diameter. Although it is close to Reinhold, its interior is completely different from Reinhold. See larger image in T205, previous page.

In T206, Copernicus is beyond the left edge of the frame. Hortensius (dia. 14 km) and Milichius (12 km) are well-known for the clusters of volcanic domes in their vicinity. These domes range from about 5 to 15 km in diameter and are few hundred meters high. They are visible only under very low Sun angles. The summits of some domes have single or even double pits. Six domes are clustered at the immediate north of Hortensius, and at least ten domes spread in the region between Milichius and T. Mayer. Note also nameless rille and the "megadome" marked in T206.





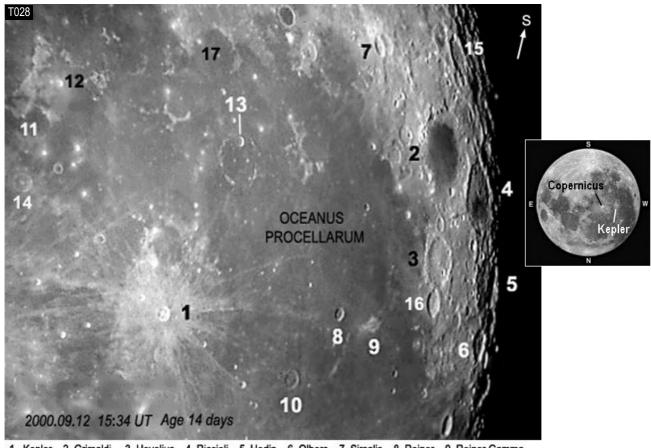
Reinhold & Lansberg 2005.04.19 13:36 UT Age 11 days. 10-in f/6 Newtonian + 2.5X + ToUcam



Domes near Hortensius & Milichius 2005.04.19 ~12:35 UT Age 10.7 days. 10-in f/6 + 5X + ToUcam (mosaic).

Hatfield 7, 11 Rükl 30, 29, 28, 40, 41, 42

Oceanus Procellarum (Kepler, Marius, Montes Riphaeus, Flamsteed, Letronne, Reiner Gamma)



Kepler 2. Grimaldi 3. Hevelius 4. Riccioli 5. Hedin 6. Olbers 7. Sirsalis 8. Reiner 9. Reiner Gamma
 Marius 11. Montes Riphaeus 12. Euclides 13. Flamsteed 14. Lansberg 15. Rocca 16. Cavalerius 17. Letronne

Kepler 38.0° W 8.1° N

A terraced crater with central peaks, 31 km in diameter. It is also a center of prominent bright rays. A faint dome is barely visible in the northwest of Kepler.

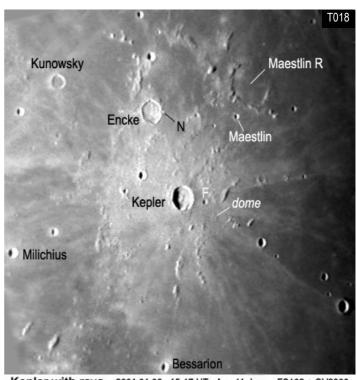
Encke 36.6° W 4.6° N

A slightly polygonal crater with uneven floor, 28 km in diameter. Its rim is interrupted by craterlet *Encke N*. During the full moon, Encke is overwhelmed by the bright rays from Kepler.

Image T233:

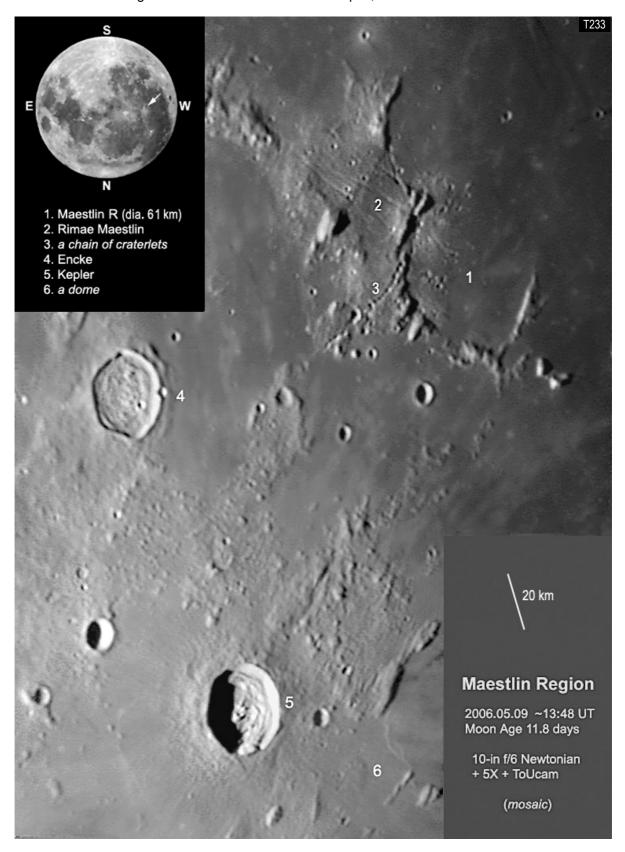
Maestlin R 41.5° W 3.5° N

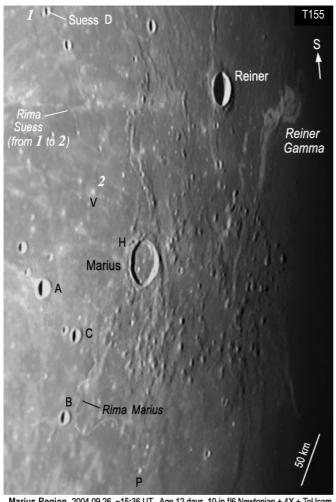
A disintegrated walled plain, 61 km in diameter. A chain of craterlets extends outward from the east wall of Maestlin R. A system of rilles (*Rimae Maestlin*, length 80 km) passes through the southeast wall.

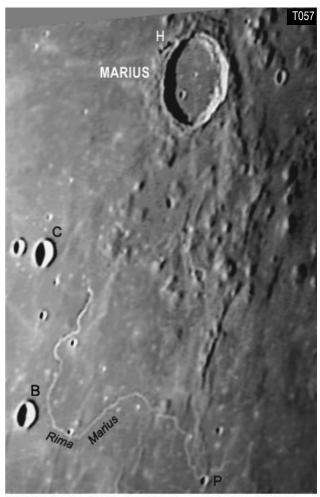


Kepler with rays 2001.01.06 15:17 UT Age 11 days. FS102 + QV2300

The Maestlin Region appears as a low elevated plateau (megadome) that holds Maestlin R, Rimae Maestlin and a nameless chain of craterlets. It is located on the eastern edge of Oceanus Procellarum near Kepler, size about 100 km north-south.







Marius Region 2004.09.26 ~15:36 UT Age 12 days. 10-in f/6 Newtonian + 4X + ToUcam

2005.04.21 14:17UT Age 12.5 days. 10-in f/6+4X+ToUcam

$50.8^{\circ} \text{W} \quad 11.9^{\circ} \text{N}$ Marius

A crater in the middle of Oceanus Procellarum. It has a flat floor, 41 km in diameter. Its rim is stuck by a small elongated crater *Marius H*. The vicinity of Marius is rich in wrinkle ridges and dome-like hills, best seen at Moon age of about 12 days. About 300 hills of few hundred meters high were estimated in this area. They are believed to form from concentrated rise of magma within the lunar crust at the later stages of lunar volcanism (roughly 3.2~3.5 billion years ago). The bright streaks at the left edge of T155 are rays radiated from *Kepler*.

Rima Marius 48.9° W 16.5° N

A sinuous rille in the north of Marius. It is shown more clearly in T057. Rima Marius begins near crater *Marius C*, where its width is about 2 km. At *Marius B*, the rille turns west and ends about 40 km west of *Marius P*, where it is less than 1 km wide. This rille measures 120 km south-north, 250 km in total length. Rima Marius is a lava channel. It runs long distance because lunar lava is less viscous and the Moon's surface gravity is only 1/6 of the Earth. Compare Rima Marius with the lava channel in Hawaii in the right.

Rima Suess 48.2° W 6.7° N

A faint, narrow sinuous rille (from position 1 to 2 in T155) meandering between small crater Suess D and Marius V, length



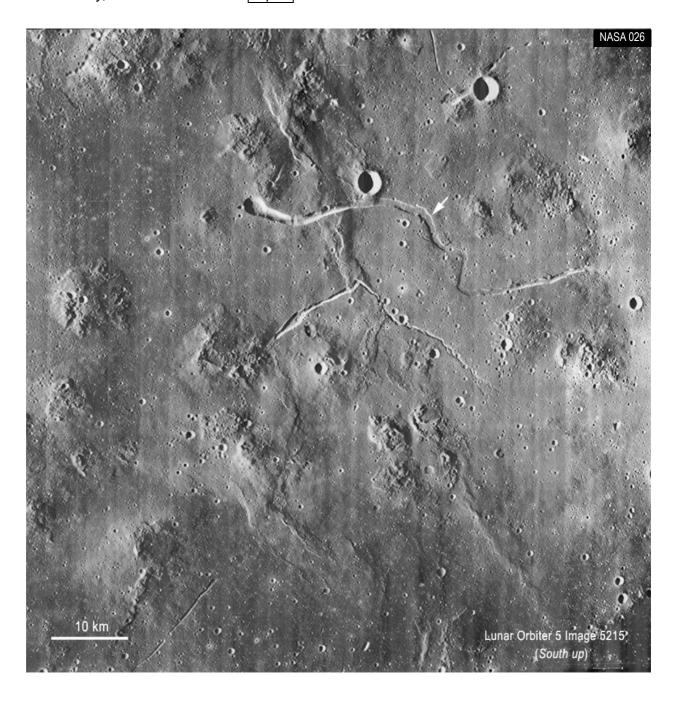
A lava channel on Kilauea Volcano, Hawaii, in 1986. It is about 4 meters wide, much smaller than a lunar volcanic rille. The cone in the distance is Pu'u O'o. the source of the lava. (University of Hawaii)

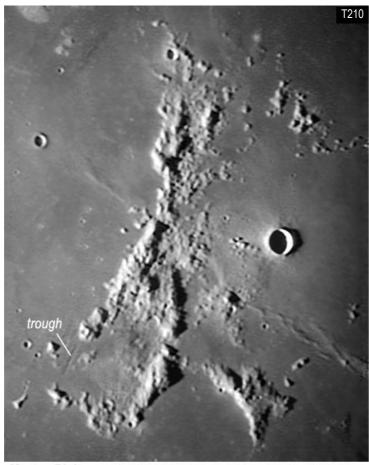
165 km. It is a low contrast feature, barely noted even in steady seeing with 10-inch telescope.

The Marius region

This image, taken by Lunar Orbiter 5 at an altitude of 110 km, shows a complex of wrinkles ridges, rilles and dome hills in the northwest of Marius. The arrow points to a nameless sinuous rille located at about 57° W 14° N. It is a lava channel where the lava outlet is a crater. It penetrates the wrinkle ridge because running lava is hot and pushing to erode rocky obstacles ahead.

Sinuous rilles are distinctly different from rivers on Earth. For example, they usually start in a small crater and become narrower instead of larger as they flow downslope. They may have abrupt breaks and sometimes splits, e.g. Rimae Herigonius in Map 25. Sinuous rilles were first seen on the Moon and later on Mars and Venus. Their intrinsic nature had not been ascertained until the Apollo 15 astronaults visited Rima Hadley, another sinuous rille in Map 14.



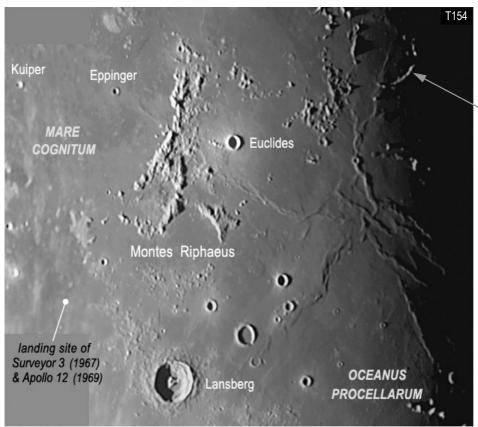


Montes Riphaeus 2005.04.19 12:58 UT Age 11 days. 10-in f/6 + 5X + ToUcam

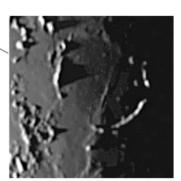
Image T210:

Montes Riphaeus 28.1° W 7.7° S A mountain range between Oceanus Procellarum (Ocean of Storms) and Mare Cognitum (Known Sea), length 190 km, peak height about 1000 m. It consists of several long narrow mountains, giving the impression that resembles a hunter armed with a spear (wrinkle ridge) and a torch when viewed with south up. The "torch" is the bright rayed crater *Euclides*, 11 km in diameter. An inconspicuous trough (length 40 km) is located on the north-east end of Montes Riphaeus.

Image T154 shows the landing site of the American unmanned probe *Surveyor 3* (April 1967). The manned *Apollo 12* visited the same site in November 1969, about 360 m away from Surveyor 3. The network of wrinkle-ridges in the west of Montes Riphaeus looks like an alien creature fighting with the "hunter".







← The wrinkle ridges in Oceanus Procellarum become prominent near the terminator. Note also the ghost ring formation at the picture corner.



Flamsteed & vicinity 2004.09.25 ~14:44UT Age 11 days. 10-in f/6 + 2.5X + ToUcam

Flamsteed 44.3° W 4.5° S

A crater, 20 km in diameter. It is just inside the ghost ring formation *Flamsteed P*. This ring has incomplete wall of diameter 112 km, and is believed an ancient impact crater flooded by lava during the formation of Oceanus Procellarum.

$42.5^{\circ} \text{W} \quad 10.8^{\circ} \text{S}$ Letronne

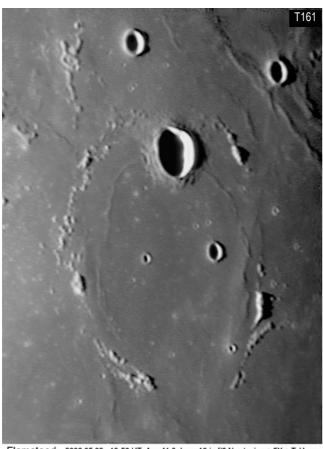
Remains of a flooded crater, 116 km in diameter. It appears like a bay which opens to Oceanus Procellarum. Three small central peaks and a white halo craterlet are distinguishable on the floor. Letronne B (5 km) is also a white halo crater. A trough feature is in the immediate south of Letronne.

Winthrop 44.4° W 10.7° S

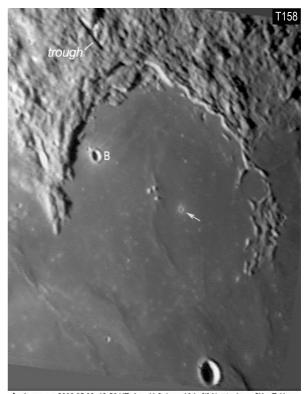
Remains of a flooded crater lying on the western rim of Letronne, 17 km in diameter.

Dorsa Rubey 42.0° W 10.0° S

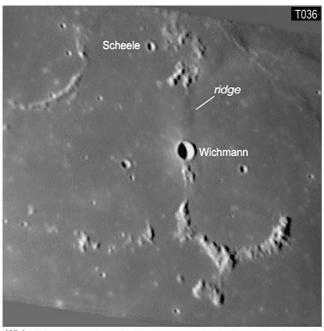
A system of wrinkle ridges extending outward from Letronne, length 100 km.



Flamsteed 2006.05.09 13:50 UT Age 11.8 days. 10-in f/6 Newtonian + 5X + ToUcam



Letronne 2006.05.09 13:56 UT Age 11.8 days. 10-in f/6 Newtonian + 5X + ToUcam The arrow points to a white halo craterlet close to three central peaks. Letronne B is also a white halo crater, diameter 5 km. Its rim adjoins a craterlet.



Wichmann 2006.05.09 14:40 UT Age 12 days. 10-in f/6 Newtonian + 4X + ToUcam

Image T036:

Wichmann 38.1° W 7.5° S

A bowl-shaped crater, 10 km in diameter. Its northern rim connects to an arc-shaped mountain. Its southern rim is linked to an irregular mountain through a ridge.

Scheele 37.8°W 9.4°S A 4-km bowl-shaped crater.

Image T069:

Reiner 54.9° W 7.0° N

An isolated crater in the middle of Oceanus Procellarum, with central peak and fairly rough floor, 29 km in diameter. It is circular shape but appears oval due foreshortening.

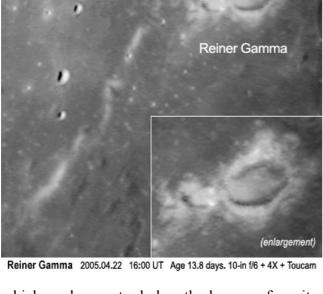


A swirling deposit of bright material near Reiner on Oceanus Procellarum. It measures about 70 km east-west, with the central part resembling an oval dome. Together with the adjacent bright tail formation, Gamma resembles the head of a white snake. Visually the snake has two tails, but only one tail prominent at a time. The "east tail" is shown in T069 (Moon age 14 days); the "west tail" is shown in T155 of previous page (Moon age 12 days).

In general the lunar surface is lack of magnetic field, but Reiner Gamma is one of the few known exceptions. A model suggests that the early Moon still preserved a weak magnetic field. It just happened some fragments of a low-density comet fell on the Moon and ploughed up the regolith. Their interaction strengthened the local magnetic field while the global magnetic field faded more quickly in time. As magnetic field deflects the charged particles in solar wind

which are known to darken the lunar surface, it may account for the high albedo (brightness) of Reiner Gamma against the dark mare background. Another model proposed that shock waves produced from a meteoroid impact on the farside of the Moon may have forced lighter materials to the location of Reiner Gamma. At present the puzzle of lunar swirls remains unanswered.

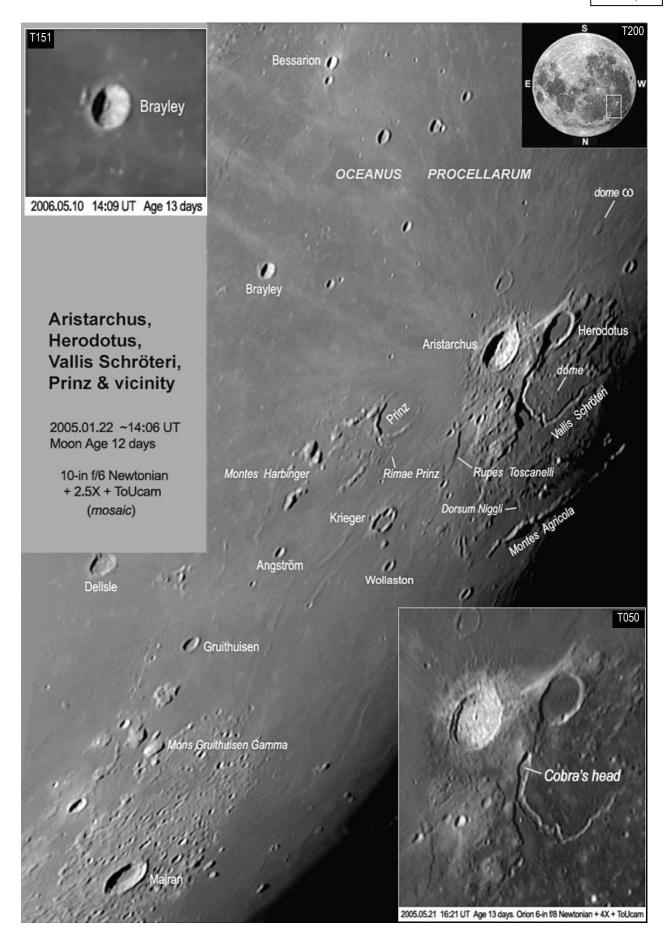
T069



Remark: Other bright swirls were reported to locate on the nearside crater Airy Map 31, plus a few more on the farside. http://science.nasa.gov/headlines/y2006/26jun_lunarswirls.htm

Hatfield 8 Rükl 18, 19

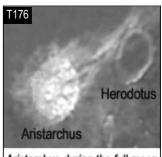
Aristarchus, Herodotus, Vallis Schröteri, Prinz



Aristarchus, Herodotus and Vallis Schröteri form an interesting feature group on a diamond-shaped plateau in Oceanus Procellarum (Ocean of Storms). Near the terminator shortly before the full Moon, the feature resembles the face of a cat (or an owl) viewed with south up.

Aristarchus 47.4° W 23.7° N

A rayed crater with terraced walls and small central peak, diameter 40 km. Its depth is 3000 m, deep enough to expose the bright anorthosite rock of the lunar crust. Indeed its brightness is even detectable in the earthshine portion of a Moon crescent, Event 3. Aristarchus is very young, formed about 500 million years ago. The Aristarchus region is a site of LTP (lunar transient phenomena) glows, probably caused by gases released from decay of radioactive elements. The Apollo-15 and Lunar Prospector flyover also detected the radioactivity of radon gas. The inner walls of Aristarchus are shaded with radial dark bands near the full Moon (T176).



Aristarchus during the full moon on 2005.04.23. Radial dark bands extend up the inner terraced walls of the crater.

Herodotus 49.7° W 23.2° N

A flooded crater with flat floor, 34 km in diameter. A dome is in the south of Herodotus (T200).

Vallis Schröteri (Schröter's Valley) 50.8° W 26.2° N

This is the largest sinuous valley on the Moon. It starts about 30 km north of Herodotus on a diamond-shaped plateau (Aristarchus plateau), then bends through nearly 180° to the west before opening out onto Oceanus Procellarum. The starting end joins with a 6-km diameter crater; nicknamed the *Cobra's head*. Vallis Schröteri is 168 km long, up to 11 km wide and 1000 m deep. Current theory suggests that the entire valley, including the head, is a lava channel or collapsed lava tube. Note the dome with summit craterlet in the west of Vallis Schröteri, T159.

Rupes Toscanelli 47.5⁰ W 27.4⁰ N A fault, length 70 km.

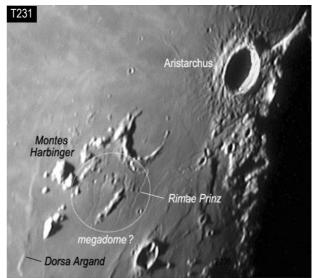
Montes Agricola 54.2° W 29.1° N A straight narrow mountain range, 140 km long.

Prinz 44.1 W 25.5 N (*Image T231*)

The remains of a flooded crater, about 46 km in diameter. A wide system of rilles (*Rimae Prinz*, 80 km) emerges northward from the crater wall.

Montes Harbinger 41.0° W 27.0° N

A group of isolated mountains spanning 90 km south-north, peak height 2500 m. Some observers speculated that the Harbinger region is a "megadome" (large uplifted piece on lunar mare) similar to the diamond-shaped Aristarchus plateau.



Aristarchus (in shadow) 2005.10.14 14:14 UT Age 11 days. 10-in f/6+2.5X+ToUcam

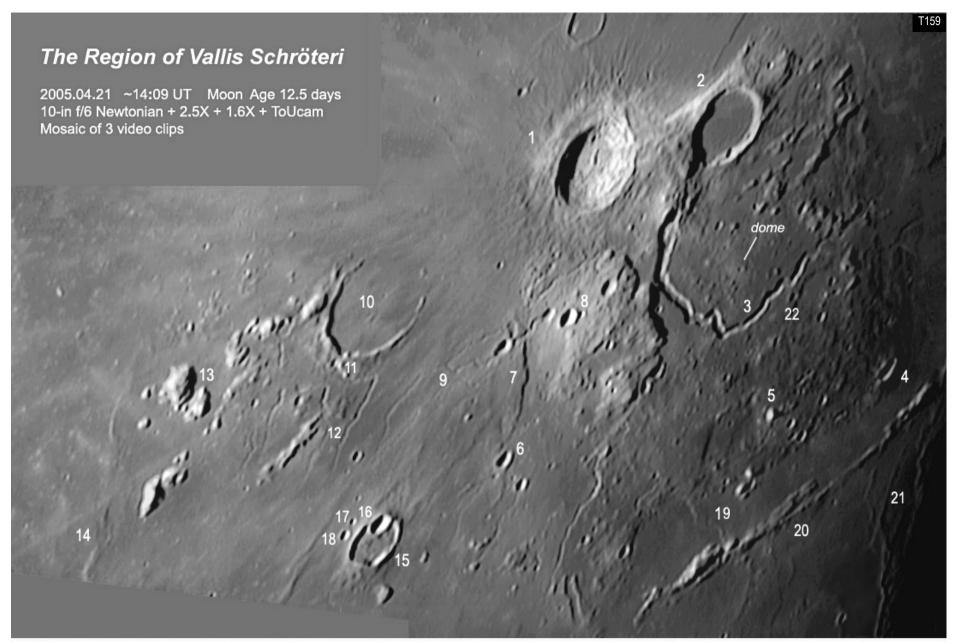
However this remains unconfirmed because its very low elevation is elusive to observe.

Rimae Aristarchus 47.5° W 26.9° N

A wide system of rilles near Aristarchus, length 120 km. The longest rille runs beyond Prinz.

Brayley 36.9° W 20.9° N (*Image T151, previous page.*)

A bowl-shaped crater, diameter 14 km. Its depth is as great as 1/5 of the diameter. Like Aristarchus under high illumination, the inner walls of Brayley are shaded by radial dark bands.



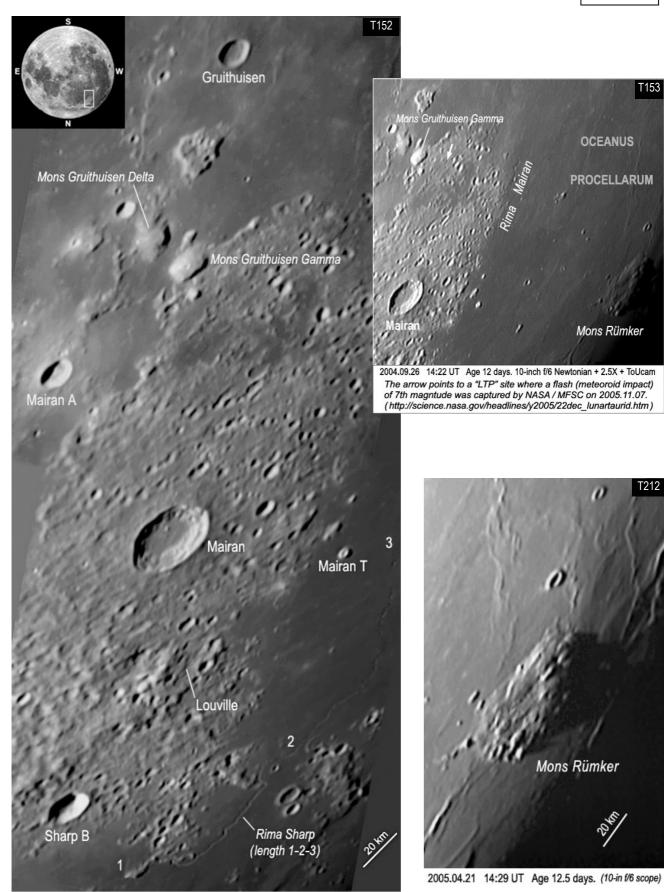
1. Aristarchus 2. Herodotus 3. Vallis Schröteri 4. Raman 5. Mons Herodotus 6. Toscanelli 7. Rupes Toscanelli 8. Väisälä 9. Rimae Aristarchus 10. Prinz 11. Vera 12. Rimae Prinz 13. Montes Harbinger 14. Dorsa Argand 15. Krieger 16. Van Biesbroeck 17. Ruth 18. Rocco 19. Dorsum Niggli 20. Montes Agricola 21. Dorsa Burnet 22. Freud

Mons Gruithuisen Gamma, Mons Rümker, Mons Delisle

Hatfield 8 Rükl 9, 8, 19

T153

T212



Mairan Region 2006.05.10 15:06 UT Age 12.8 days. 10-in f/6 Newtonian + 4X + ToUcam

Mairan 43.4° W 41.6° N

A 40-km crater with sharp rim and a tiny off-centered peak. *Mairan T* (3 km) is a small bright dome with a summit craterlet. *Rima Mairan* (90 km) is a faint rille south of Mairan T. In the north of Mairan is *Louville*, a 36-km heavily ruined crater; it is difficult to distinguish from the surrounding rugged terrain.

Rima Sharp 50.5° W 46.7° N

A faint narrow rille, length 190 km. (IAU gives 107 km.)



Mons Gruithuisen Gamma 40.5° W 36.6° N

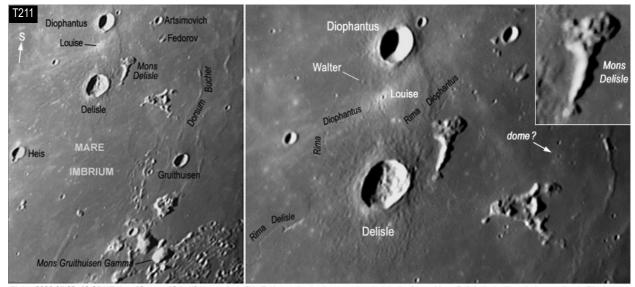
A dome mountain in the south of Mairan, base 20 km, height about 1 km. Its summit has a very shallow pit and a craterlet around 1 km in diameter. They are good tests for the resolution of 10-inch telescopes. Compare this lunar dome with Novarupta dome on Earth. On 2005.11.07, NASA captured a flash west of Mons Gruithuisen Gamma (T153).

Mons Gruithuisen Delta 39.5° W 36.0° N

A mountain similar to Mons Gruithuisen Gamma in nature but irregular in shape, base 20 km.

Mons Rümker 58.1° W 40.8° N

A volcanic complex of dome mountains on Oceanus Procellarum, base 70 km, height 500 m. Its top contains a shallow depression sculptured by clefts and craterlets. At low Sun angles, wrinkle ridges are seen in the vicinity.



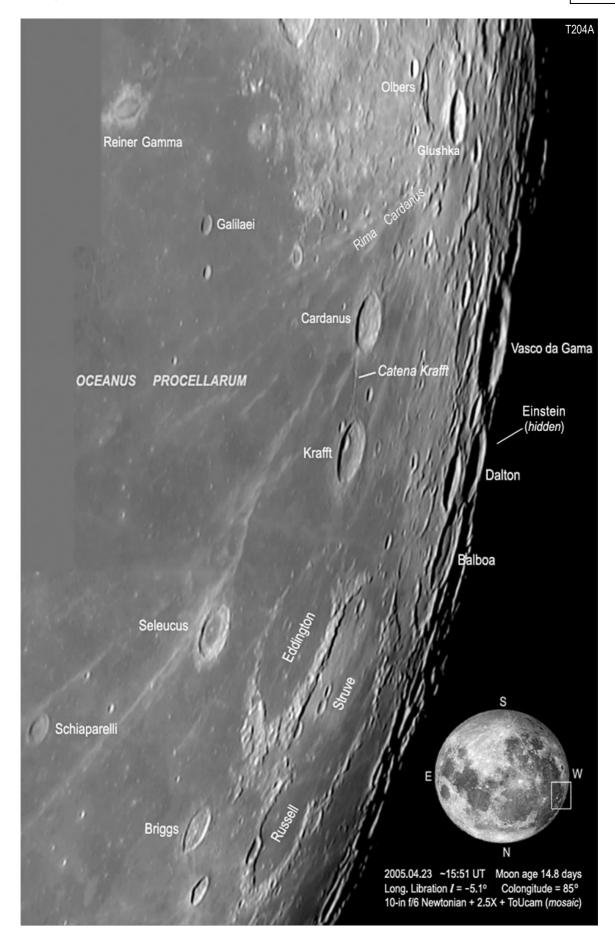
Right: 2006.05.09 13:31 UT Age 12 days. 10-in f/6 Newtonian +5X+ToUcam. Louise is a rayed craterlet, dia. 1 km. Mons Delisle looks like a baby crawling to Diophantus.

Delisle 34.6° W 29.9° N **Diophantus** 34.3° W 27.6° N (*Image T211*)

A pair of craters, diameter 25 and 17 km respectively. Delisle has uneven floor with a central broken craterlet. *Mons Delisle* is an interesting isolated mountain which runs 30 km south-north. It has a bulgy southern head but narrows down to a "fish-tail" at the other end. *Louise* is a tiny rayed crater, 0.8 km in diameter. Two faint narrow rilles *Rima Diophantus* (length 150 km) and *Rima Delisle* (60 km) are in the close vicinity. Both rilles are difficult to spot. *Walter* (1 km) is an obscure craterlet near Diophantus; it is named by IAU but this gives confusion mentioned in Map 11. The arrow in the picture points to a skeptical dome.

Hatfield 7 Rükl 17, 28

Eddington, Struve, Russell, Seleucus, Olbers, Einstein



Eddington 72.2°W 21.3°N, **Struve** 77.1°W 22.4°N, **Russell** 75.4°W 26.5°N These are fine examples of remains of flooded walled plains, named to honor three astrophysicists in the early 20th Century. They are located near the north-west limb, visible as long as lunar libration is favorable. Their diameters are 118 km, 164 km and 103 km respectively. The longitude of 80°W passes through Struve's western rim.

Seleucus 66.6° W 21.0° N

A crater with terraced walls and a small central peak, 43 km in diameter. Its rim is interrupted by a bright ray originated from the ejecta of the distant crater *Glushko* (formerly *Oblers A*, 43 km).

Schiaparelli $58.8^{\circ} \,\mathrm{W}$ $23.4^{\circ} \,\mathrm{N}$

A crater, 24 km in diameter, named after the 19th century Italian astronomer whose description of "canali" (channels) on Mars was misinterpreted as "canals" by other astronomers of his times.

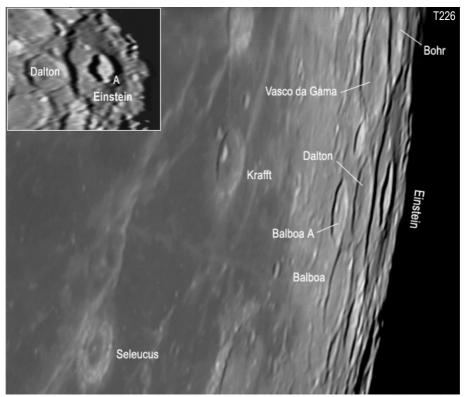
Briggs 69.1° W 26.5° N A 37-km crater with ridged floor.

Olbers 75.9° W 7.4° N

A 74-km crater with fairly flat floor. Its wall is interrupted by Glushko. Both craters are rayed centers under high illumination. The long rays of Glushko extend far beyond Schiaparelli.

Dalton 84.3°W 17.1°N **Einstein** 88.7°W 16.3°N

Dalton is 60 km in diameter. Its western wall adjoins the concentric crater Einstein which is visible only at very favorable libration. Einstein is truly circular in shape, diameter 198 km and has a central 51-km crater (*Einstein A*) as shown in Image T226. Spacecraft mapping indicates that Einstein A has a small central peak, but the peak does not appear in T226 due to inappropriate illumination.



Einstein 2005.05.23 14:52 UT Age 15 days. 10-ln f/6+2.5X+ToUcam. Insert is a rescaled projection. This image was taken at fairly favorable libration of $l = -4.7^{\circ}$ $b = 4.1^{\circ}$.

Vasco da Gama 83.9° W 13.6° N (*Image T204A*) A crater with a small central peak, 83 km in diameter.

Rima Cardanus 71°W 11°N (*Image T204A*)

A linear rille in the northeast of Olbers and Glushko, length about 170 km. It is indistinctive, especially when the bright rays of Glushko happen to sweep over it.

(Image T225)

Cardanus 72.5° W 13.2° N

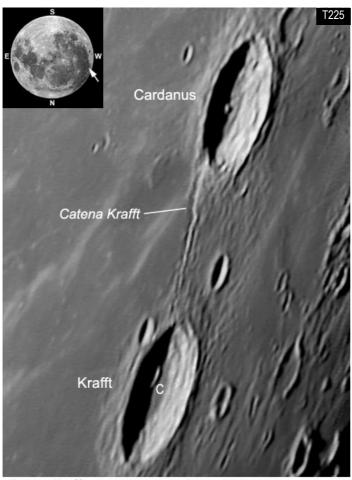
A sharp-rimmed terraced crater with a small central peak, 49 km in diameter. A skeptical ghost ring just lies outside the northeast rim of Cardanus.

Krafft 72.6° W 16.6° N

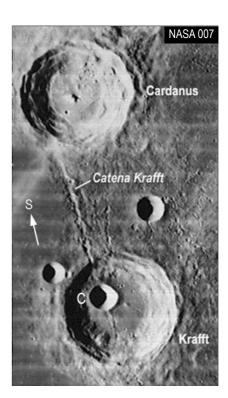
A sharp-rimmed terraced crater, 51-km in diameter. It contains a small internal crater *Krafft C* (13 km). Apparently Krafft and Cardanus look like a twin.

Catena Krafft 72.0° W 15.0° N

A chain of tiny, eroded overlapping craters which connects Cardanus and Krafft. In Image T225, foreshortening of the Moon's limb makes the chain not as distinctive as the flyover view of Lunar Orbiter (NASA 007). Actually, the catena crosses into Krafft's floor and bisects Krafft C, total length 60 km. The width of Catena Krafft is tapered from south to north.







Hatfield 9 Rükl 53, 52, 63

Capuanus, Ramsden, Marth, Bullialdus, Kies, Opelt

This map covers the west zone of *Mare Nubium* (Sea of Clouds). The complete mare is irregular in shape and does not have definite boundary traceable to a typical impact basin. Probably it is an extension of lava flooding that had spread over vast surface including Mare Cognitum, Mare Insularum and perhaps as far as Oceanus Procellarum. (Maria are shown in T001 of Map 1.)

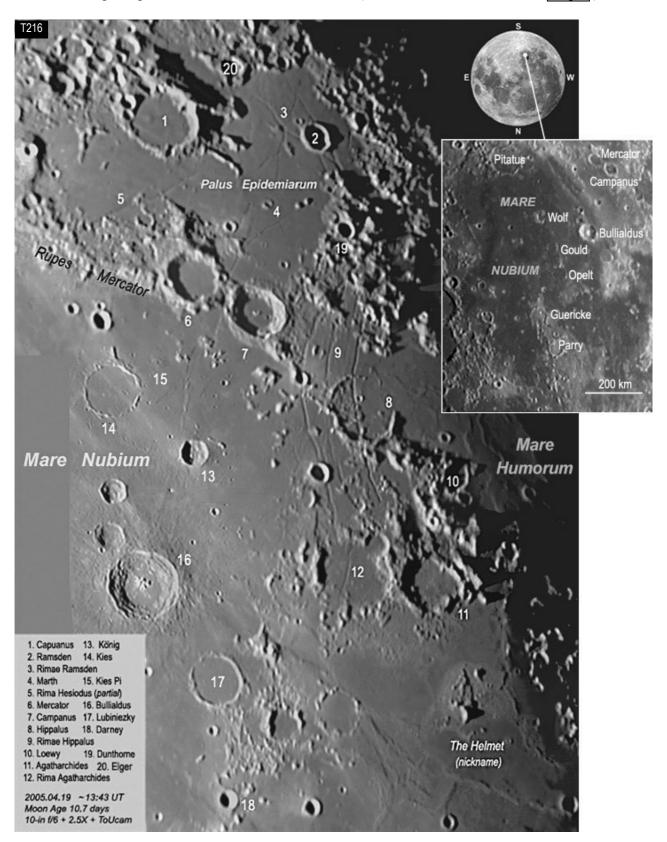


Image T216, previous page:

Capuanus 26.7°W 34.1°S

A flooded crater, 59 km in diameter. Its floor contains low ridges and dome-like features.

Mercator 26.1° W 29.3° S **Campanus** 27.8° W 28.0° S

Adjoining craters of almost same size (46~48 km). The twin resembles a pair of spectacles. Campanus has a small, arc-shaped central peak. Two segments of inconspicuous rilles extend south-north from the junction wall between Mercator and Campanus.

Ramsden 31.8° W 32.9° S

A 24-km crater in the irregular plain *Palus Epidemiarum* (Marsh of Epidemics). It sits on a wide system of rilles (*Rimae Ramsden*, 110 km).

Marth 29.3° W 31.1° S

A double-walled crater in Palus Epidemiarum, 6 km in diameter.



Marth 2004.04.30 14:05UT Age 11 days

Rimae Hippalus 29.2° W 25.5° S

A spectacular system of wide rilles at the boundary between Mare Nubium and Mare Humorum, length 190 km. It cuts through the ruined crater *Hippalus* (57 km).

Rima Hesiodus 20.0° W 30.0° S A linear rille, 250 km long. Part of it enters into Palus Epidemiarum. See also T083 in Map 11.

Rupes Mercator 22.3° W 31.0° S A fault on the southern edge of Mare Nubium, length about 100 km. An adjacent nameless rille runs in parallel.

Image T081:

Bullialdus 22.2° W 20.7° S

A terraced crater with multiple central peaks and radial ejecta blanket outside the rim, 60 km in diameter, 3500 m deep. It looks like a "small version" of Copernicus, Map 19.

Kies 22.5° W 26.3° S

A flooded crater with a spiky cape, 45 km in diameter. The volcanic dome with summit craterlet (*Kies* π) is in the immediate west. Pi is about 12 km across.

König 24.6⁰ W 24.1⁰ S A crater, 23 km in diameter, fairly deep (2400 m).



2005.11.11 12:43 UT Age 9.5 days. 10-in f/6 Newtonian + 4X + ToUcam, 85% resized (mosaic)



Wolf, Gould & Opelt 2006.02.07 ~12:00 UT Age 9 days. 10-in f/6 Newtonian + 2.5X + ToUcam

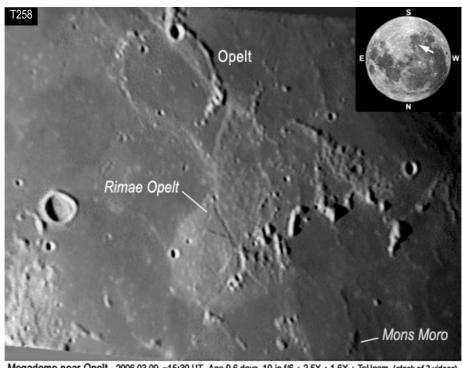
Image T252 & T258:

Wolf 16.6° W 22.7° S Remains of a flooded crater, 25 km in diameter. Its southern wall is overlaid with Wolf B (the small crater shadowed in T252).

Gould 17.2° W 19.2° S Remains of a flooded crater, 34 km in diameter. Its western rim appears as a curved ridge.

Opelt 17.5° W 16.3° S Remains of a flooded crater, 48 km in diameter. Its northern wall adjoins a circular dome-shaped plateau, diameter about 60 km and height possibly few hundred meters. Its top is sculptured by a system of rilles Rimae Opelt (length 70 km, details in T258). This plateau, together with crater Opelt, Gould and Wolf, form an interesting quartet on the terminator.

Guericke 14.1°W 11.5°S A 63-km crater with "horns" at the rim, see Map 12.

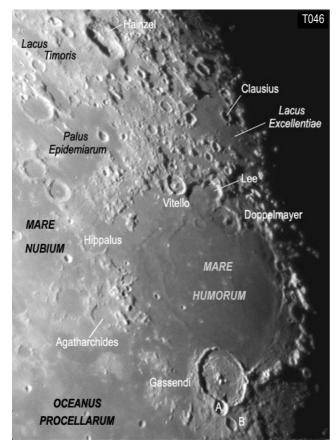


Megadome near Opelt 2006.03.09 ~15:30 UT Age 9.6 days. 10-in f/6 + 2.5X + 1.6X + ToUcam (stack of 3 videos)

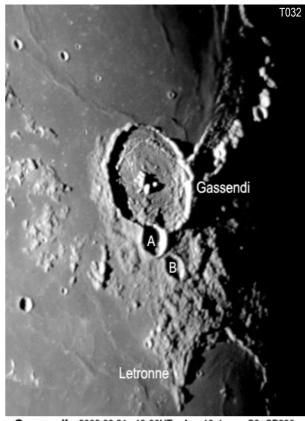
Hatfield 11 Rükl 52, 51, 62

Mare Humorum, Gassendi, Lacus Excellentiae, Rimae Hippalus, Vitello, Mersenius





Mare Humorum 2000.12.07 14:16UT Age 11 days. QV2300-20001207-0002



Gassendi 2002.06.21 13:30UT Age 10 days. C9+CP990

Mare Humorum 38.6° W 24.4° S

Mare Humorum (Sea of Moisture) is a fairly small lava plain, about 400 km in diameter. It is inside an impact basin. Geologic study suggests that the impact occurred $3.8 \sim 3.9$ billion years ago. The mare contains a mascon and could be thicker than 3 km at the floor

center. It has concentric wrinkle ridges along the inner circumference. *Palus Epidemiarum* (Marsh of Epidemics), *Lacus Excellentiae* (Lake of Excellence) and *Lacus Timoris* (Lake of Fear) are in the southern vicinity.

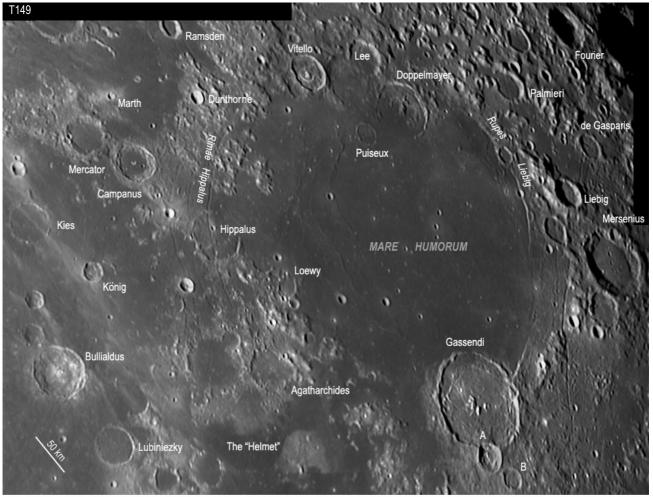
Gassendi 40.1° W 17.6° S

Gassendi is a prominent impact crater on the edge of Mare Humorum, 101 km in diameter. Much of its floor was lava-flooded during the formation of the mare, leaving behind the crater rim and a jumble of central peaks. The floor is fractured by a wide system of rilles (*Rimae Gassendi*, T261) due to post-volcanism. The western wall of Gassendi is broken by a triangular landslide. The northern wall is interrupted by a smaller crater, *Gassendi A*. This crater is 33 km in diameter, 3600 m deep while the depth of Gassendi is just 2000 m. *Gassendi B* is 26 km in diameter.

Letronne 42.5° W 10.8° S

A semi-circular relief just north of Gassendi. It is the remains of a large flooded crater, 116 km in diameter. Letronne together with Gassendi resemble a "lobster". Details in T158, Map 20.

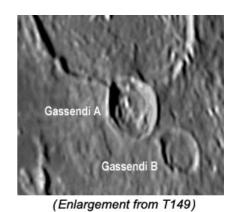
Full view of Mare Humorum



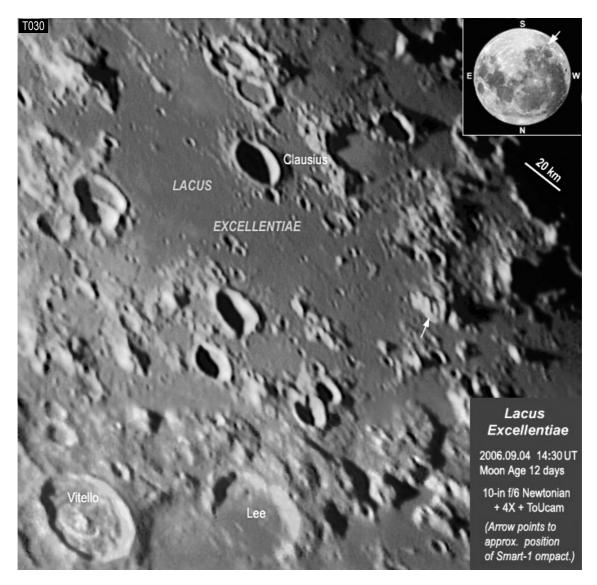
Mare Humborum and vicinity 2005.01.22 15:45~15:49 UT Age 12.1 days. 10-inch f/6 Newtonian + 2.5X + ToUcam at 1/25 sec. (mosaic of 4 video clips)



Gassendi 2006.05.09 14:02 UT Age 11.8 days. 10-inch f/6 Newtonian + 5X + Toucam



Gassendi – The most prominent feature in the Humorum region.



Lacus Excellentiae (Lake of Excellence) 44.0° W 35.4° S

An irregular strip of mare among the rugged terrain of the Southern Highlands, maximum length 180 km. *Clausius* (diameter 24 km) is the only notable crater in this region. On 2006.09.03, the European lunar orbiter Smart-1 ended its mission with a controlled impact on the northern end of Lacus Excellentiae.

(Image T068, next page):

Rimae Hippalus 29.2° W 25.5° S

A spectacular system of wide rilles crossing the ruined crater *Hippalus*, length 190 km. The system is dominated by three rilles, each about 2 km wide and visible in small telescopes. They appear as concentric fractures along the outer circumference of Mare Humorum, and are caused by the subsidence of immense lava masses in the Humorum Basin. See also T216, Map 24.

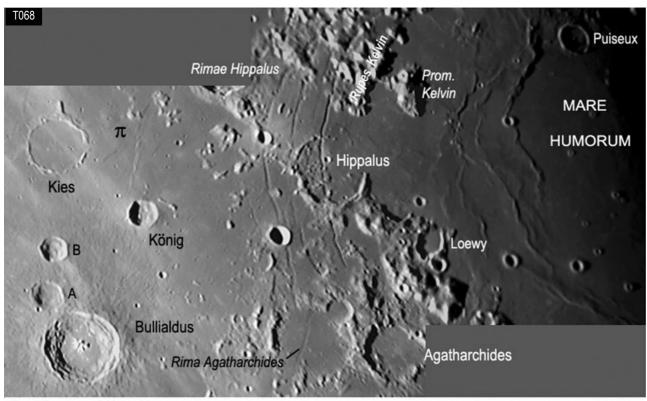
Promontorium Kelvin 33.0° W 27.0° S

A cape almost detached from *Rupes Kelvin*, base width 50 km.

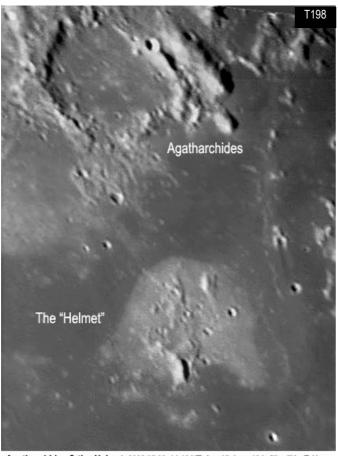
Loewy 32.8° W 22.7° S **Puiseux** 39.0° W 27.8° S

Both craters are 24 km in diameter. They are named after the co-authors of the *Atlas Photographique de la Lune*, first published by Paris Observatory in 1896-1910.

Rimae Hippalus and wrinkle ridges in Mare Humorum



East Region of Mare Humorum 2004.04.30 13:06~13:27 UT Age 11 days. 10-in f/6 Newtonian + 2.5X + ToUcam (mosaic)



Agatharchides & the Helmet 2006.05.09 14:10 UT Age 12 days. 10-in f/6 + 5X + ToUcam

Agatharchides 30.9° W 19.8° S A ruined-wall flooded crater, 48 km in diameter. In its east is *Agatharchides P* (66 km) crossed by *Rima Agatharchides* (length 50 km).

The Helmet 31.5° W 16.7° S A fairly bright dome-shaped plateau (megadome) nicknamed by the Apollo-16 crew, size about 60 km. Its top is ridged and cratered.

Image T150:

Rimae Herigonius $37.0^{0} \,\mathrm{W}$ $13.0^{0} \,\mathrm{S}$

A system of sinuous rilles meandering on the southern edge of Oceanus Procellarum, 100 km long. Note the rectangular depression and plateau feature between Rimae Herigonius and Gassendi A. The plateau top appears rugged and somewhat depressed.

Image T059 & T123:

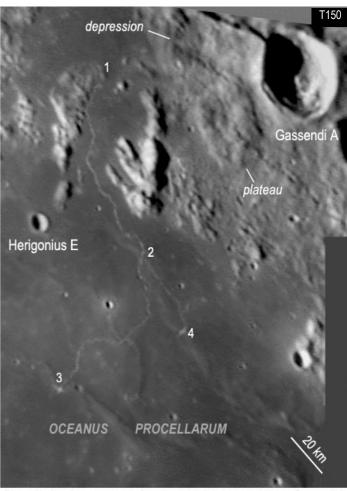
Vitello 37.5° W 30.4° S

A crater on the southern edge of Mare Humorum, 42 km in diameter. Its central peak is encompassed by a C-shaped cleft, giving the impression of a rope-jumping rabbit in a Chinese myth. A short chain of caterlets (catena) is in close vicinity.

Lee 40.7° W 30.7° S, Remains of a flooded crater, diameter 41 km. Its wall shares with *Lee M* (77 km).

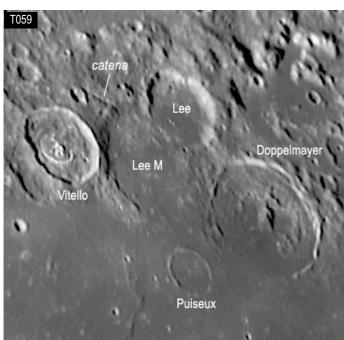
Doppelmayer 41.4° W 28.5° S

A ruined crater with fairly large central peak, diameter 63 km. An inconspicuous system of rilles (*Rimae Doppelmayer*, length 160 km) runs in the vicinity. The arrow in T123 points to a skeptical dome.

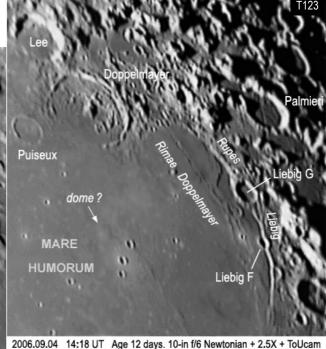


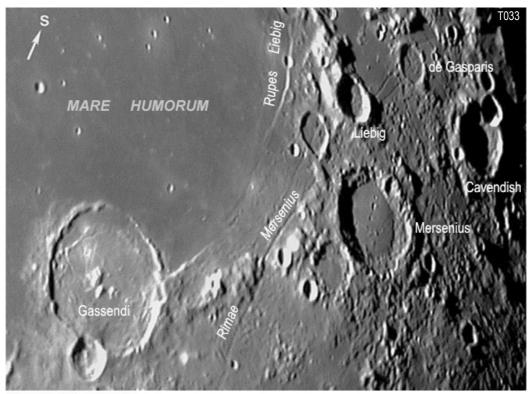
Rimae Herigonius, composed of section 1-2-3 & 2-4, length 100 km. Gassendi A (dia. 33 km) is at top corner. 2006.05.09 14:14UT Age 12 days. 10-in f/6+5X+ToUcam

Palmieri See Map 28.

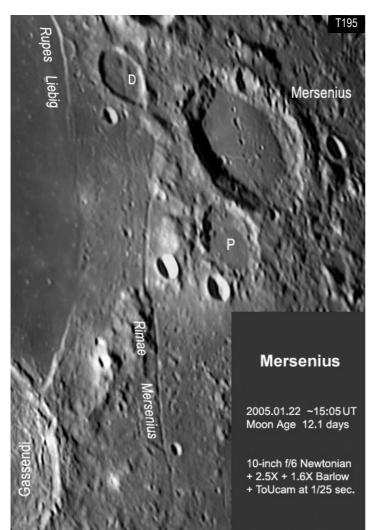


Vitello. Lee & Doppelmayer 2005.01.22 15:10 UT Age 12 days. 10-in f/6 + 4X + ToUcam





West of Gassendi 2002.12.16 15:12 UT Age 12 days. 10-in f/6 Royce mirror + 2.5X + ToUcam, 7 frames stacked.



Images T033 & T195:

Cavendish 53.7^{0} W 24.5^{0} S A 56-km worn crater. Its rim is interrupted by crater *Cavendish A* (10 km) and *Cavendish E* (24 km).

de Gasparis 50.7° W 25.9° S A 30-km flooded crater. Its floor is crossed by a wide system of straight rilles (*Rimae de Gasparis*, 90 km).

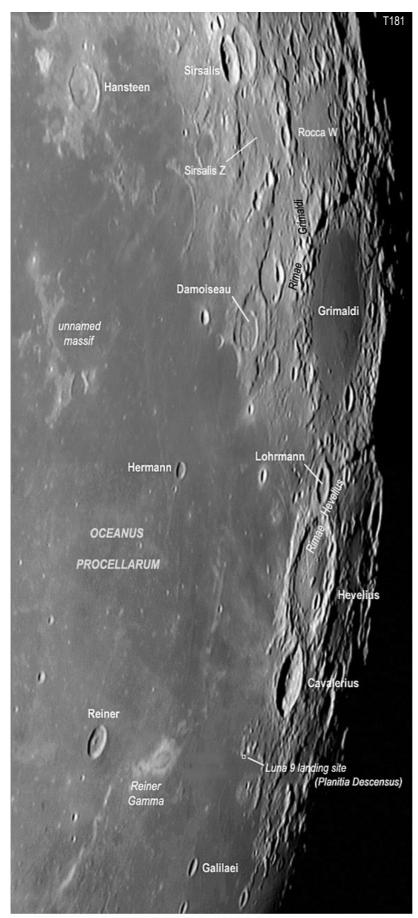
Mersenius 49.2^{0} W 21.5^{0} S An 84-km flooded crater. Its floor is somewhat convex and contains tiny craters and a group of faint rilles. Its wall adjoins the smaller flooded crater *Mersenius P* (42 km).

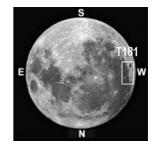
Rimae Mersenius 46.5° W 20.0° S A notable system of rilles, length 300 km. It runs through *Mersenius D* (34 km).

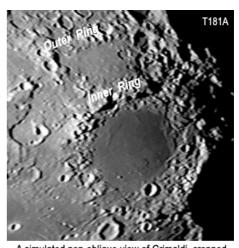
Rupes Liebig 46.0° W 25.0° S A scarp at the edge of Mare Humorum, length 180 km. Its middle section is interrupted by craters including *Liebig G* (20 km) and F (9 km), see Image T123.

Hatfield 7 Rükl 39, 28

Grimaldi, Hevelius, Cavalerius, Riccioli, Hedin

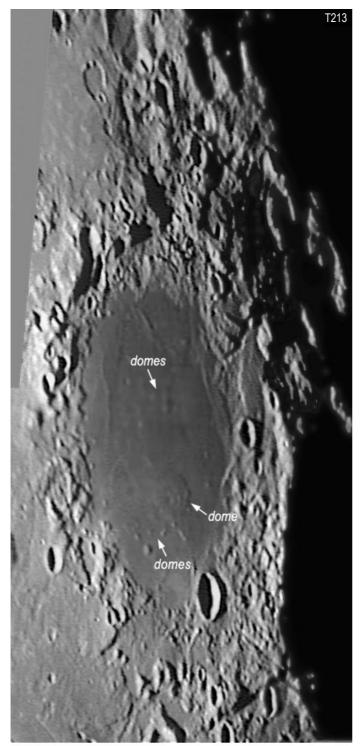




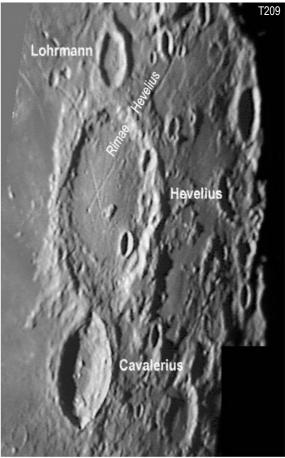


A simulated non-oblique view of Grimaldi, cropped from T181 and rescaled horizontally. Note the concentric ring mountains around the lava floor.

Grimaldi to Reiner Gamma 2004.11.25 16:42-16:45 UT Age 13 days. 10-in f/6 Newtonian + 2.5X + ToUcam



Grimaldi 2005.04.22 16:32UT Age 14 days. 10-in f/6+4X+ToUcam (mosaic)



2005.04.22 ~16:25 UT Age 13.8 days. 10-in f/6 + 4X + ToUcam (mosaic)

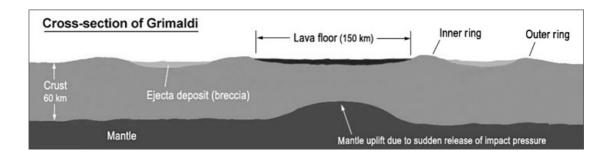
Hevelius 67.6° W 2.2° N A walled plain with small central peak, 115 km in diameter. Its floor is cratered and crossed by an X-pattern of rilles (*Rimae Hevelius*, length 180 km).

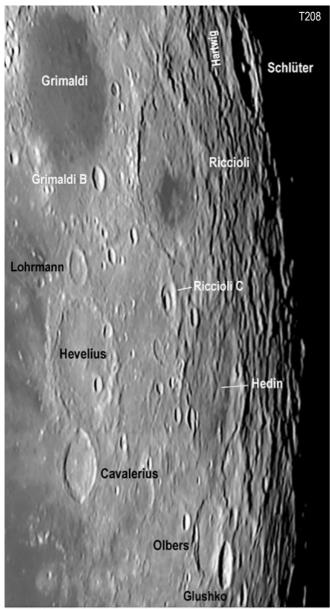
Cavalerius 66.8° W 5.1° N A 57-km crater adjoining Hevelius, 3000 m in depth. It has a tiny central peak. The inner walls are terraced.

Lohrmann 67.2° W 0.5° S A 30-km crater. It floor has several low hills.

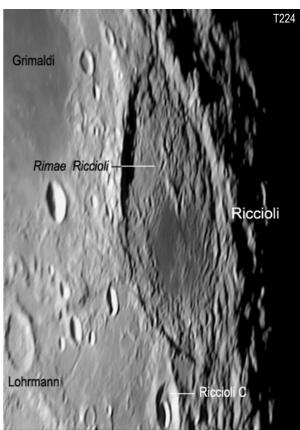
Grimaldi 68.3⁰ W 5.5⁰ S

Grimaldi looks like a lava-flooded impact basin more than a crater. It is encircled by two concentric mountain rings, see Image T181A and the cross-section diagram in next page. The outer ring is partially ruined, about 400 km across. The inner ring is 200 km and the lava floor is 150 km. The nominal diameter of Grimaldi is 172 km. An inconspicuous system of rilles (*Rimae Grimaldi*, length 230 km) adjoins the south-east wall. A blade of dark shadow appears to cut along the northern rim. In T213, a dome with summit pits is found on the northern part of the floor; few smaller domes are also found under good seeing. Grimaldi contains a mascon which is probably the mantle uplift caused by sudden release of the impact pressure.





2005.04.23 ~15:38 UT Age 14.8 days. 10-in f/6 + 2.5X + ToUcam (mosaic)



Riccioli 2005.05.22 ~14:31 UT Age 14.3 days. 10-in f/6 + 5X + ToUcam

Riccioli 74.6° W 3.3° S

A walled plain near the limb, 139 km in diameter. The Moon's equator crosses its northern outer wall. The southern floor of Riccioli is crossed by a system of rilles (*Rimae Riccioli*, 400 km). The northern floor is lava-flooded. *Riccioli C* is a 31-km crater in which the floor is stuck by another crater.

Hedin 76.5° W 2.0° N

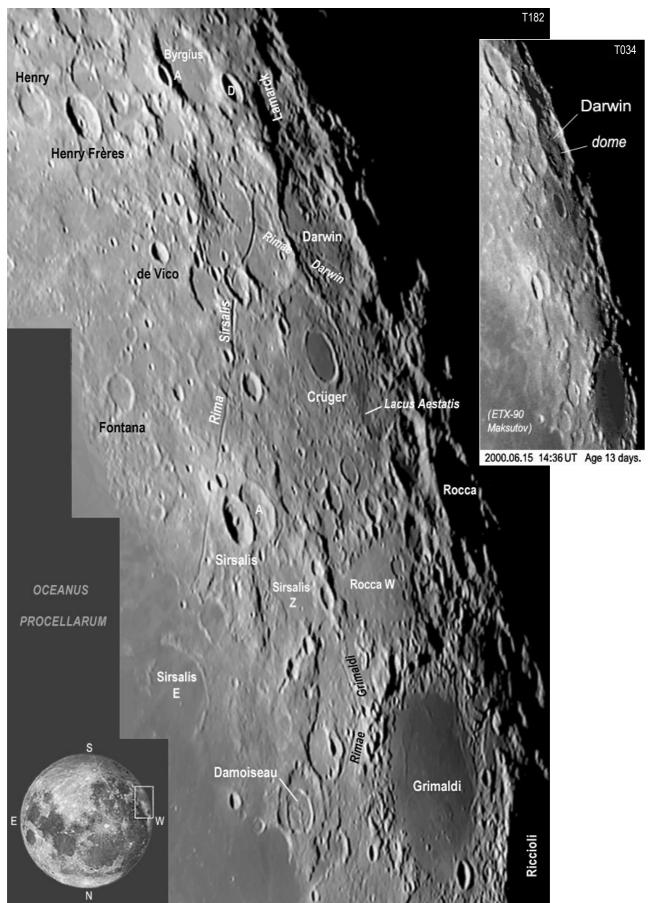
A heavily obliterated walled plain, diameter 150 km. It possibly formed in the impact event that created Mare Orientale on the farside.

Schlüter 83.3⁰ W 5.9⁰ S

An 89-km crater with terraced walls and central peaks. It is flanked by *Hartwig* (79 km).

Hatfield 11 Rükl 50, 39, 40

Darwin, Byrgius, Rimae Sirsalis, Crüger, Billy, Hansteen



2005.04.22 ~16:09 UT Age 13.8 days. Longitudinal libration *I* = -5.3°. 10-in f/6 Newtonian + 2.5X + ToUcam (*mosaic*)

Darwin 69.5° W 20.2° S

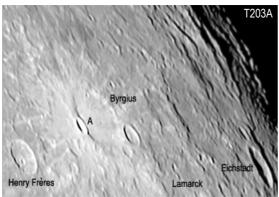
Darwin is a complex disintegrated walled plain, 120 km in diameter. A cluster of smaller craters is located on its southern floor. Its northern floor is crossed by *Rimae Darwin* (length 140 km) and contains a weird dome hill which is visible only under appropriate illumination, see Image T034. When Darwin is near the terminator, it resembles one wing of a butterfly while the other wing is an unnamed feature.

Lamarck 69.8° W 22.9° S

A disintegrated, rugged crater sharing the walls with Darwin, 100 km in diameter.

Byrgius 65.3° W 24.7° S

Byrgius is an 87-km crater. Its floor is fairly flat and white because of the ejecta splashed from the bright rayed *Byrgius A* (19 km) on the rim.



Byrgius A with bright rays 2005.04.23 16:02 UT Age 14.8 days. 10-in f/6 Newtonian

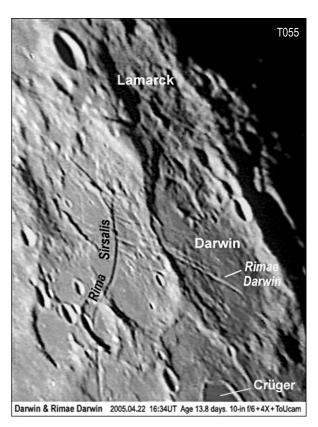
Sirsalis $60.4^{0} \,\text{W}$ $12.5^{0} \,\text{S}$

A 42-km crater with small central peak. It is a rayed center under high Sun angles. Sirsalis intersects the rim of *Sirsalis A* (once known as *Bertaud*, diameter 49 km). A trough is just outside Sirsalis A.

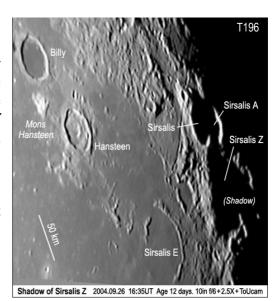
In Image T196, Sirsalis is shadowed by the terminator and hence appears like a black hole. A strip of ridge extends from the northern rim of Sirsalis. This ridge forms the eastern rim of the irregular crater *Sirsalis Z* (91 km); it casts a weird triangular shadow around Moon age of 12 days.

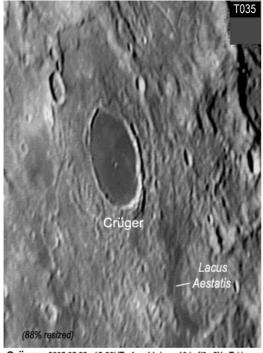
Rimae Sirsalis 61.7° W 15.7° S

A system of rilles, length 426 km. The most prominent section is *Rima Sirsalis* which runs between Sirsalis and Byrgius, see Image T182. It looks like a fracture, probably caused by the Orientale impact on the farside.













Damoiseau 2005.05.22 15:44UT Age 14 days. 10-in f/6+5X+ToUcam

Crüger 66.8° W 16.7° S

A flooded crater with a central craterlet on the dark-flat floor, 45 km in diameter. In its immediate north is *Lacus Aestatis* (Summer Lake), a curved strip of dark lava, size about 90 km.

Damoiseau 61.1° W 4.8° S

A shallow crater with rough ridged floor, 36 km in diameter. It is encompassed by crater **Damoiseau K** and **Damoiseau M**.

Image T037, next page:

Billy
$$50.1^{\circ}$$
 W 13.8° S

A dark-floor crater almost identical to Crüger, 45 km in diameter; but Billy does not have a central craterlet. *Rima Billy* (length 70 km) is in the south-east.

Hansteen 52.0° W 11.5° S

A crater with fractured floor and internal hills, diameter 44 km. It is flanked by the short rille *Rima Hansteen* (length 25 km).

Mons Hansteen 50.0° W 12.1° S

A triangular hand-shaped mountain, base 30 km. Very bright.

Zupus 52.3⁰ W 17.2⁰ S

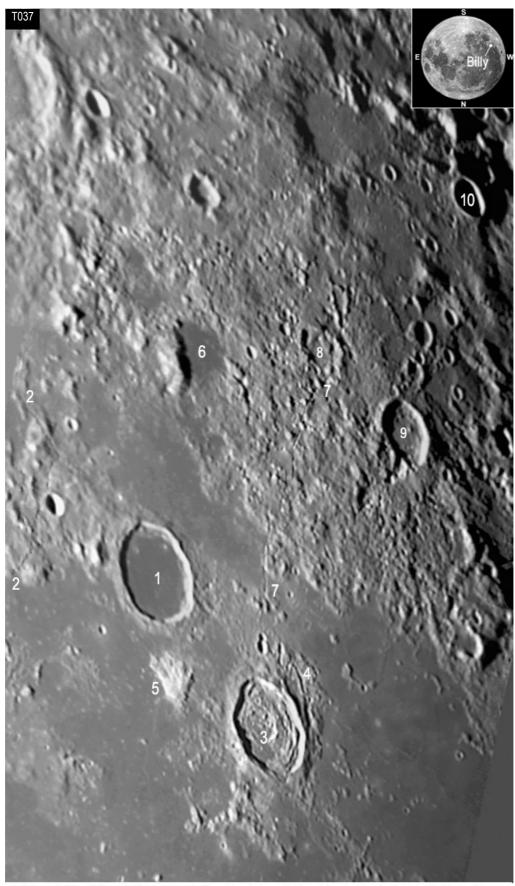
Remains of a lava-flooded craters, 38 km in diameter. Its floor is darkened and featureless. Its eastern rim looks straight and is considerably higher than the western surroundings.

Rimae Zupus 53.0° W 15.0° S

A system of thin rilles, 120 km long. It runs between **Zupus** C and Hansteen, difficult to spot.

A 31-km crater with an internal low hills. Its northeastern rim is interrupted by small craters.

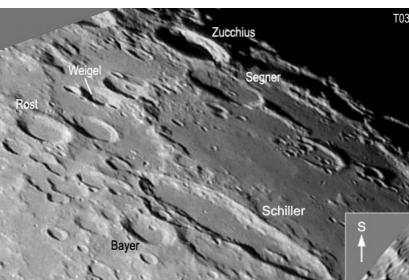




1. Billy2. Rima Billy3. Hansteen4. Rima Hansteen5. Mons Hansteen6. Zupus7. Rimae Zupus8. Zupus9. Fontana10. de Vico2006.05.1014:52 UTAge 13 days. 10-in f/6 Newtonian + 4X + ToUcam

Hatfield 10, 12 Rükl 71, 70, 62, 61

Schiller, Schickard, Phocylides, Wargentin, Piazzi





Schiller 2002.12.16 !5:17UT Age 12 days. 10-in f/6 Newtonian + 2.5X + ToUcam,

Schiller 39.0° W 51.9° S

A truly elongated crater, about 70 x 180 km. The southern half of the floor is fairly flat but the northern half is rough and contains two mountain peaks. It seems Schiller is the fusion of two adjoined near-sized craters which formed at the same time. An alternative proposal based on NASA laboratory experiment is that Schiller was created by a grazing impactor, which could be an orbiting debris spiraling into the Moon and hitting the Moon at very low angle (few degrees measured from ground).

(Other examples of elongated craters in Map 3, 4, 6, 12, 14 & 20.)

Segner 48.3° W 58.9° S A shallow crater with rough floor, 67 km in dia.

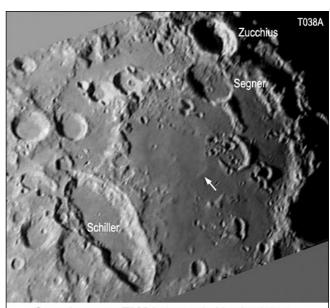
Zucchius 50.3° W 61.4° S A terraced crater, diameter 64 km, depth 3200 m.

Schiller-Zucchius Basin

The territory between Schiller and Zucchius is an impact basin characterized by two concentric mountain rings. The inner ring (dia. 200 km) intersects Segner; the outer ring (dia. 330 km) intersects Zucchius. There is also the hint of a third ring almost buried beneath the mare floor, as marked by arrow in Image T038A. This basin contains a mascon.



A simulated non-oblique view of Schiller. The picture center line is 40° W. 2005.04.21 13:56UT Age 12.5 days. 10-in f/6+4X+ToUcam, 65 frames stacked.



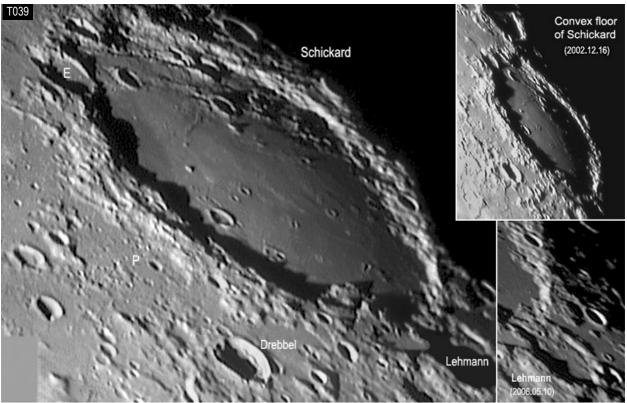
Same image as T038 but rescaled to simulate a non-oblique view of the Schiller-Zucchius Basin.

Schickard 55.3° W 44.3° S

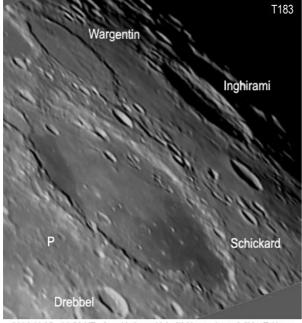
A prominent vast walled plain with internal craters, 206 km in diameter. Its rim is fairly worn. A large part of the floor is lava flooded and darkened, especially the southeast portion and the northern half. Quite often the floor looks convex with spiky shadows cast by the inner walls.

$68.8^{\circ} \text{W} \quad 47.5^{\circ} \text{ S}$ Inghirami

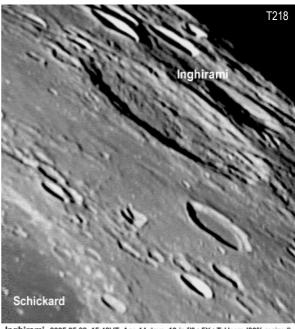
A 91-km crater. Its floor was modified by the Orientale impact event. See NASA003 Farside map.



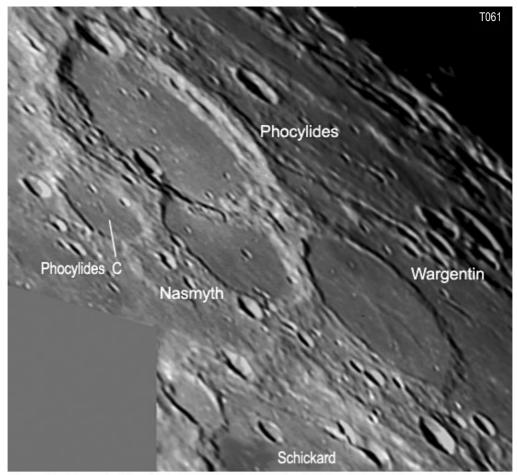
2005.01.22 15:17~15:20 UT Age 12.1 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam at 1/25 sec (mosaic, south-up)



2004.11.25 14:52 UT Age 13 days. 10-in f/6 Newtonian + 2.5X + ToUcam



Inghirami 2005.05.22 15:42UT Age 14 days. 10-in f/6+5X+ToUcam (80% resized)



Wargentin, Nasmyth, Phocylides 2005.04.22 16:41 UT Age 13.8 days. 10-in f/6+4X+Toucam, 85% resized.

Image T061:

Wargentin $60.2^{0} \,\text{W}$ $49.6^{0} \,\text{S}$

A rare type of "plateau crater", 84 km in diameter. It is filled up with solidified dark lava almost to the top of the rim. The floor is raised 400 m above the surrounding, and is crossed by wrinkle ridges formed when lava cooled. A craterlet with dark halo is found on the southern floor.

Phocylides 57.0° W 52.7° S

A flooded crater, 121 km in diameter, 2100 m in depth. Its eastern wall is eroded and adjoins *Phocylides C* (46 km).

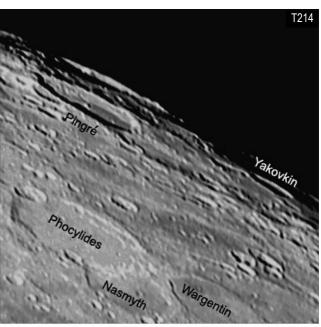
Nasmyth $56.2^{0} \, \text{W}$ $50.5^{0} \, \text{S}$

A flooded crater, 76 km in diameter. Part of its rim is ruined by Phocylides.

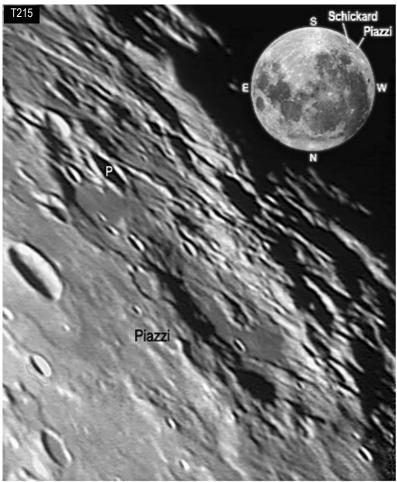
Image T214:

Pingré 73.7° W 58.7° S **Yakovkin** 78.8° W 54.5° S

Both craters are quite close to the limb and hence best seen in favorable libration. Pingré is 88 km in diameter, Yakovkin is 37 km.



2005.04.23 16:08 UT Age 14.8 days (99% full Moon). 10-in f/6 + 2.5X + ToUcam



Piazzi & Piazzi P 2005.05.22 17:17UT Age 14 days. 10-in f/6 Newtonian + 4X + ToUcam

Image T215 & T184:

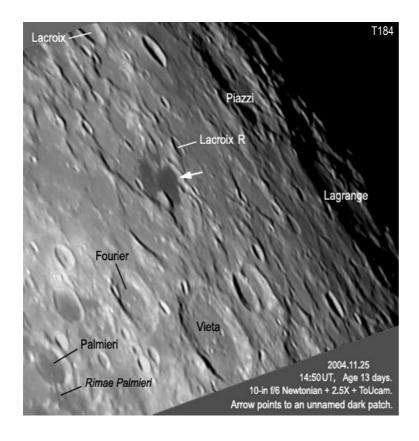
Piazzi 67.9° W 36.6° S A 134-km crater heavily modified by the ejecta from the Orientale impact. (See NASA003 in Farside map.)

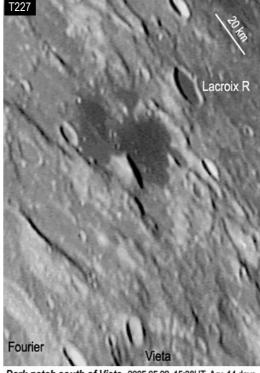
Lagrange 72.8° W 32.3° S A 225-km crater adjoining Piazzi.

Vieta 56.3⁰ W 29.2⁰ S A 87-km crater. In its south is an unnamed, isolated dark patch, roughly 40 km across. The irregularity of the patch suggests this might be magma leaked out through the local crust fractures. darkened floor of Lacroix R might be similar magma leak but trapped by the crater walls. Details in T227.

Fourier 53.0° W 30.3° S A 51-km crater. Its wall is fairly wide.

Palmieri 47.7° W 28.6° S A 40-km flooded crater. Its floor is crossed by a system of narrow rilles (*Rimae Palmieri*, length 150 km).

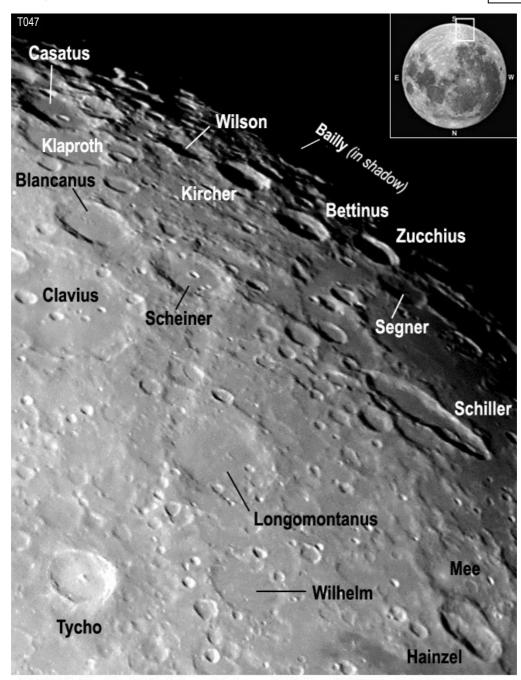




Dark patch south of Vieta 2005.05.22 15:38UT Age 14 days 10-in f/6 Newtonian + 5X + ToUcam, 88 frames stacked, 85% resized.

Hatfield 12 Rükl 71, 72, 63, 64

Bailly, Longomontanus, Wilhelm, Mee, Hainzel



2000.05.15 14:15 UT Age 11 days. FS102 + LE12.5 + CP950 1/40 sec.

Image T047 & T139

Casatus 29.5° W 72.8° S

A flooded crater with internal craters, 108 km in diameter. Its western rim rises higher than the rest.

 $\textbf{Klaproth} \quad 26.0^0\,W \quad 69.8^0\,S$

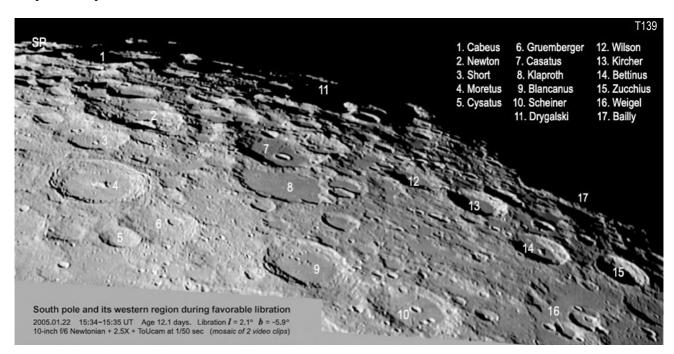
A flooded walled plain sharing the wall with Casatus, 119 km in diameter.

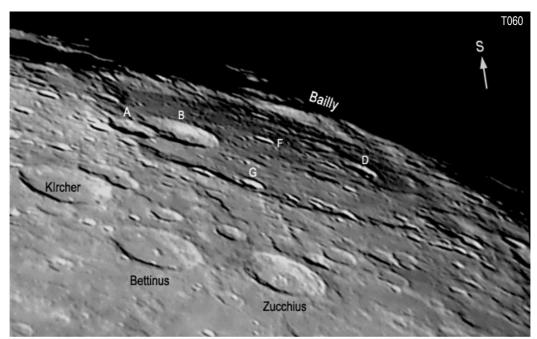
Blancanus 21.4° W 63.8° S

A crater with fairly flat floor, 117 km in diameter.

Scheiner 27.5° W 60.5° S

A crater, 110 km in diameter. Its floor contains a small but conspicuous central crater, no central peak. Its southern wall is intersected by two straight ridges. In T047 of previous page, one arm of Tycho's rays hits on the western wall of Scheiner.





Bailly 2004.01.06 15:03 UT Age 14 days. Libration $I = -2.5^{\circ}$ $b = -4.7^{\circ}$ 10-in f/6 + 2.5X + ToUcam, 48 frames.

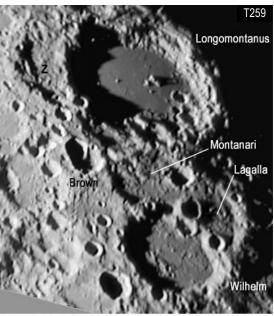
Bailly 69.1°W 66.5°S

The largest crater (walled plain) on the nearside of the Moon, 287 km in diameter. It is best seen during favorable libration. Bailly is truly circular but looks oval due to limb foreshortening. The floor is scattered with craters, the largest being **Bailly A** (38 km) and **Bailly B** (65 km). By geologic classification, Bailly is a "small" impact basin but it has not undergone lava flooding.

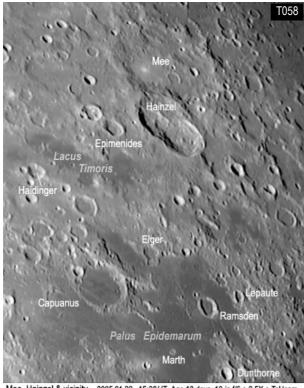
Kircher 45.3°W 67.1°S Diameter 72 km **Bettinus** 44.8° W 63.4° S Diameter 71 km **Zucchius** 50.3° W 61.4° S Diameter 64 km These craters have roughly same size. They form a prominent trio outside the rim of Bailly, especially when Bailly is hidden in shadow (Image T047).

Longomontanus 21.8° W 49.6° S An eroded crater with off-centered peaks, 157 km in diameter and interrupting *Longomontanus Z* (95 km).

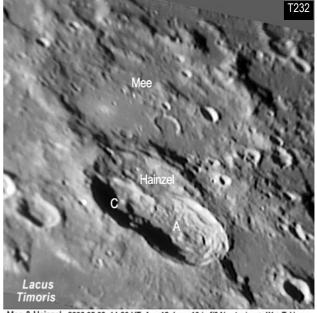
 43.4° S Wilhelm 20.4° W An eroded crater with fairly rough floor, 106 km in diameter. It intrudes on two smaller eroded craters Lagalla (85 km) and Montanari (76 km).



Longomontanus & Wilhelm 2006.03.09 14:08 UT Age 9.6 days. 10-in f/6



2005.01.22 15:38 UT Age 12 days. 10-in f/6 + 2.5X + ToUcam



Mee & Hainzel 2006.05.09 14:28 UT Age 12 days. 10-in f/6 Newtonian + 4X

Mee 35.3° W 43.7° S

A heavily eroded crater, 126 km in diameter. Its floor contains a bright spot, probably caused by the ejecta of the Tycho impact.

Hainzel 33.5° W 41.3° S

A crater adjoining Mee, 70 km in diameter. It is overlapped by *Hainzel A* (53 km) and *Hainzel C* (38 km). The trio formation resembles the shape of a peanut shell.

Palus Epidemiarum28.2° W32.0° S(Marsh of Epidemics, width 286 km)Lacus Timoris27.3° W38.8° S(Lake of Fear, width 117 km)

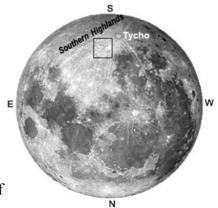
These are irregular lava plains. See also Map 24 & 25.

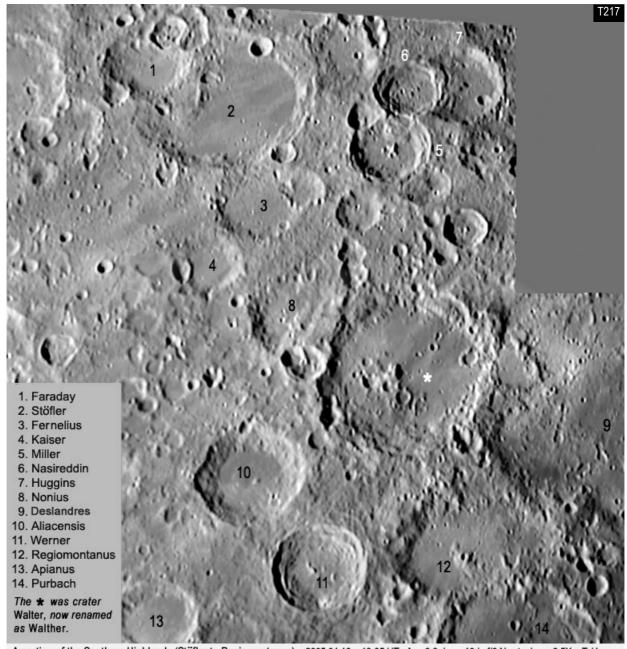
Hatfield 14, 16 Rükl 66, 65, 74, 75

Southern Highlands (Maurolycus, Stöfler, Boussingault)

The Southern Highlands is a vast, heavily cratered region where no mare exists. It includes Tycho and its vicinity, the south polar zone, and the broad bright terrain in the southeast quadrant. This region is high because it rises few kilometers above the maria level. It is bright because the lands are dominated by light-colored anorthosite, the most ancient type of Moon rocks briefed in Map 1.

T217 shows a portion of the Southern Highlands. Note that some crater floors are splashed by the deposits of light-colored ejecta, which are traceable to the Tycho impact occurred 110 million years ago. Tycho is an impact crater located beyond the top right corner of this frame.





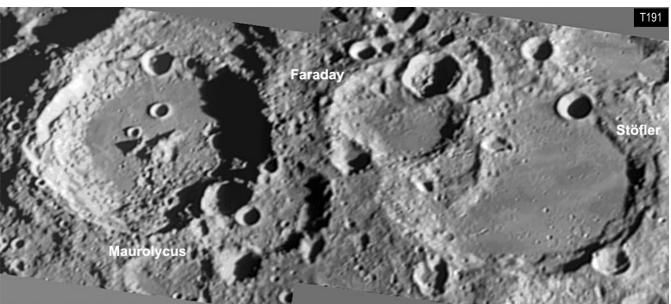
A portion of the Southern Highlands (Stöfler to Regiomontanus) 2005.04.18 ~13:35 UT Age 9.8 days. 10-in f/6 Newtonian + 2.5X + ToUcam



Maurolycus,
Faraday & Stöfler Tycho

Left: A chaos of craters in the Southern Highlands

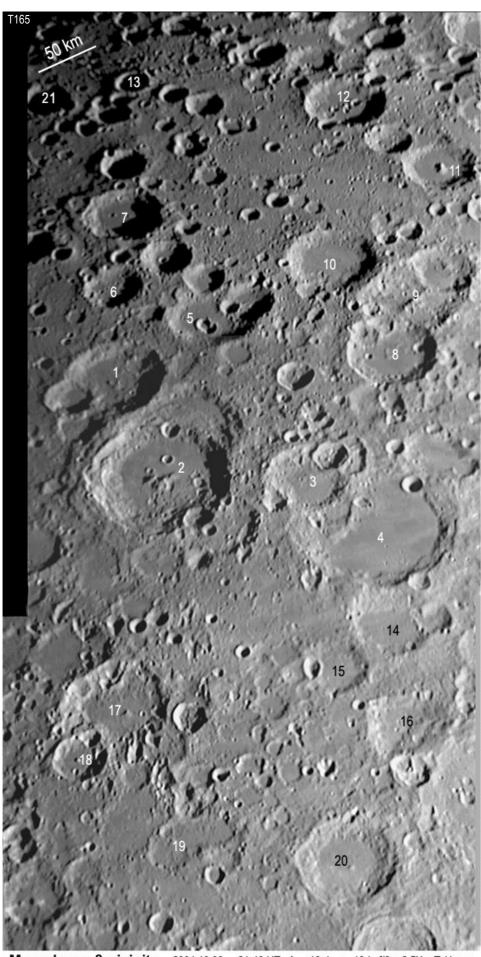
Tycho, Maurolycus, Stöfler 2004.06.26 15:03 UT Age 9 days. 10-in f/6 Newtonian + ToUcam



Crater Trio: Maurolycus, Faraday & Stöfler 2004.09.04 ~19:08 UT Age 20 days. 12.5-in f/6 Newtonian + 4X + ToUcam. (mosaic of 2 video clips, 88% resized.)

These are often depicted as a trio feature in the Southern Highlands. Maurolycus is a typical crater with central mountains and terraced walls, 114 km in diameter, 4700 m deep. The shadow in Image T191 tells that Maurolycus must be the deepest of the trio. Its walls and floor are interrupted by smaller craters. Faraday lies in the middle of the trio, 69 km in diameter, 4000 m deep. Its walls are also interrupted by three conspicuous craters. Stöfler is a vast walled plain peppered with secondary craterlets, 126 km in diameter and 2700 m deep. A large portion of Stöfler's floor is flat, but the eastern portion is mountainous suggesting it could be the remains of a crater which was ruined by the Faraday impact. The light-colored strips on Stöfler's floor are the ejecta deposits from the Tycho impact.

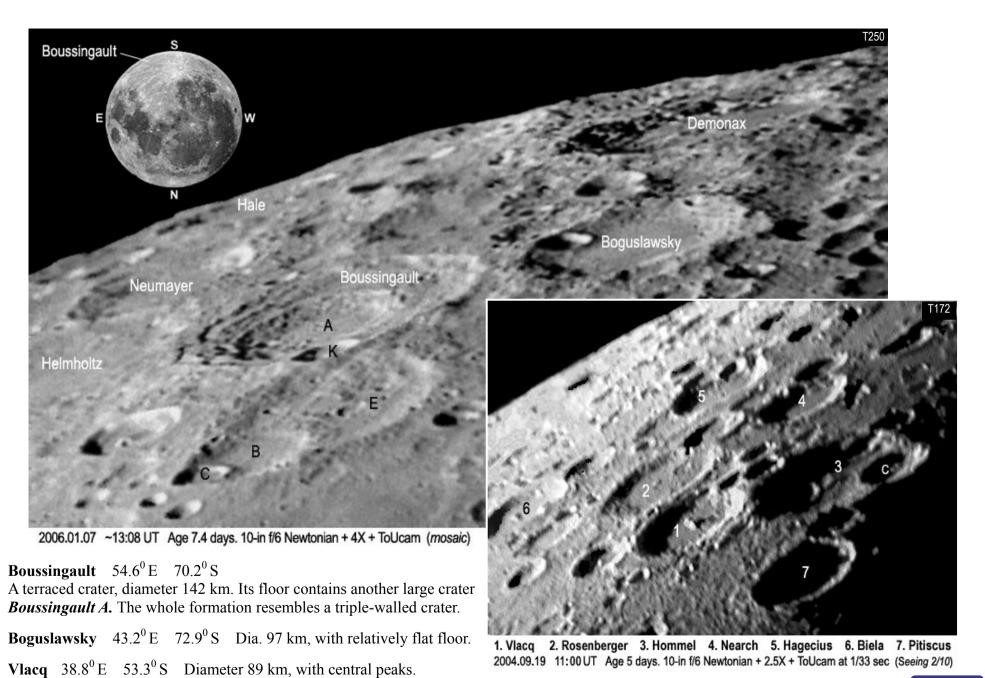
This trio is a fine example to demonstrate a chaos of craters battering at other pre-existing craters.



Maurolycus & vicinity 2004.10.03 ~21:49 UT Age 19 days. 10-in f/6 + 2.5X + ToUcam

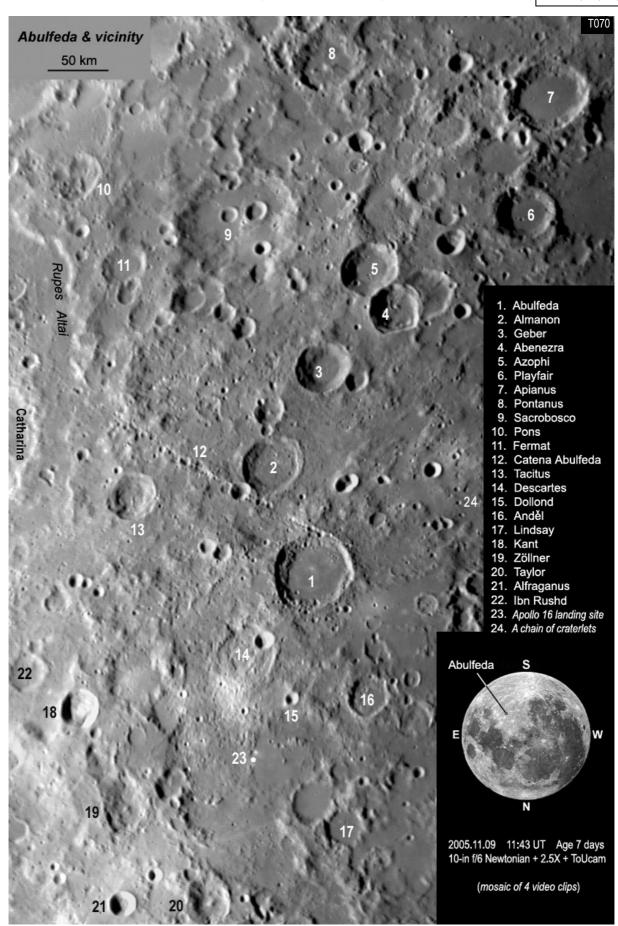
- 1. Barocius (Dia. 82 km)
- 2. Maurolycus (114 km)
- 3. Faraday (69 km)
- 4. Stöfler (126 km)
- 5. Clairaut (75 km)
- 6. Breislak (49 km)
- 7. Baco (69 km)
- 9. Heraclitus (90 km)
 10. Cuvier (75 km)
 11. Lilius (61 km)
 12. Jacobi (68 km)

- 13. Tannerus (28 km)
- 14. Fernelius (65 km)
- 15. Kaiser (52 km)
- 16. Nonius (69 km)
- 17. Gemma Frisius (87 km)
- 18. Goodacre (46 km)
- 19. Poisson (42 km) 20. Aliacensis (79 km) 21. Asclepi (42 km)



Catena Abulfeda, Catena Davy, Crater Arrays

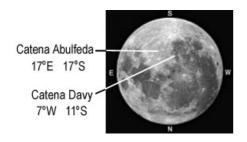
Hatfield 13 Rükl 56, 55, 45, 44, 43



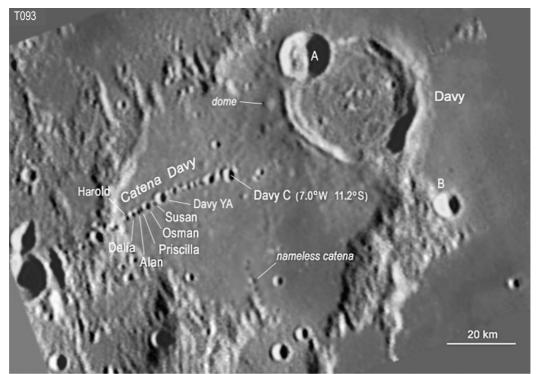
Catena is a chain of small craters, generally resulted from secondary impacts, or from fragmental impacts of a tidally disrupted meteoroid/asteroid. An exception is the chain of tiny craters inside Rima Hyginus Map 13, which appears to be volcanic rather than impact-originated.

The most known crater chain is *Catena Abulfeda* shown in the middle of Image T070, length 210 km. At low power, it resembles a thin, bright line running from the rim of *Abulfeda* (diameter 65 km) to the northern end of Rupes Altai. At high power, it resolves to over 20 craterlets in a chain. A short, loose chain of craterlets is also shown by *Label 24* in T070. Note the interesting arc array of craters from *Abulfeda* to *Apianus* (*Label 1 to 7*), the irregular crater *Sacrobosco* (*dia. 98 km, Label 9*) and the bright patch just north of *Descartes* (*Label 14*).

Another crater chain, *Catena Davy*, is shown in T093. It requires high power to spot. This chain consists of 23 craters from 1 to 3 km in diameter, 50 km long. It is likely caused by fragmental impacts of a tidally disrupted "rubble pile" meteoroid/asteroid, because most craters in the chain do not overlap. To the north of *Davy C* (diameter 3.4 km) is another catena but it is nameless.







Davy and Catena Davy 2004,09,05 ~20:12 UT Age 21 days. 10-in f/6 Newtonian + 5X + ToUcam (150% resized)

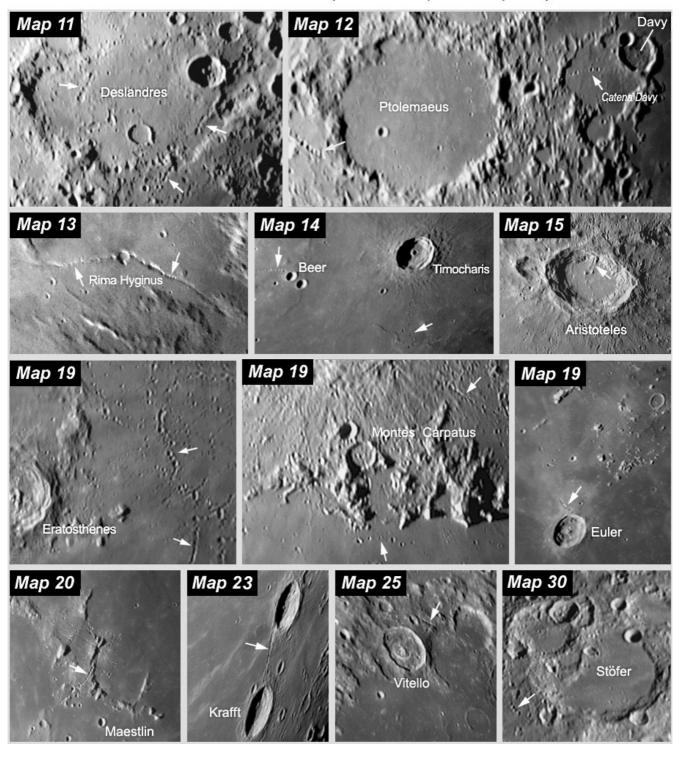
In T093, a dome is recognized outside the rim of Davy. Six IAU-named craters are marked along the eastern section of Catena Davy:

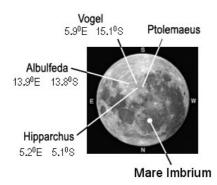
 Harold
 $(6.0^{\circ}W)$ $10.9^{\circ}S$ 2 km Alan
 $(6.1^{\circ}W)$ $10.9^{\circ}S$ 2 km Osman
 $(6.2^{\circ}W)$ $11.0^{\circ}S$ 2 km

 Delia
 $(6.1^{\circ}W)$ $10.9^{\circ}S$ 2 km Priscilla
 $(6.2^{\circ}W)$ $10.9^{\circ}S$ 1.8 km Susan
 $(6.3^{\circ}W)$ $11.0^{\circ}S$ 1 km

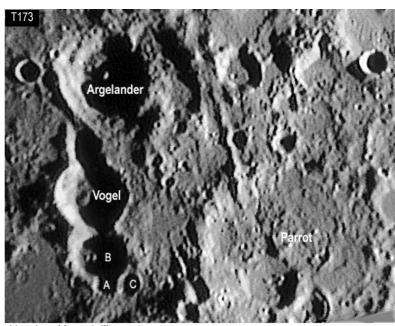
Other chains of craterlets are found close to Deslandres, Ptolemaeus, Rima Hyginus, Timocharis, Aristoteles, Eratosthenes, Montes Carpatus, Euler, Maestlin, Krafft, Vitello and Stöfler. They are marked by arrows in the guide maps below. Most of them are nameless.

Chain of Craterlets (Refer to the Map No. for full picture.)



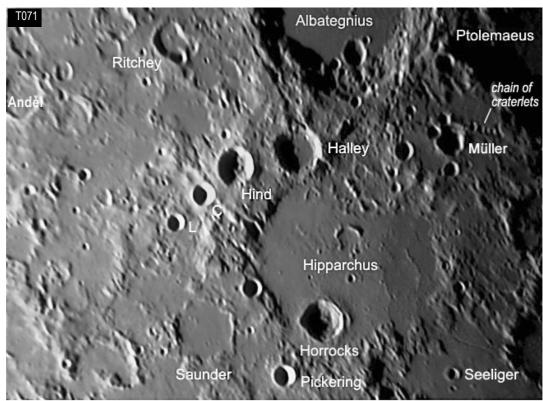


T173 shows a gourd-like crater array composed of *Vogel*, its satellite craters A, B and C. Vogel can be spotted with the larger map in next page. It is 26 km in diameter.

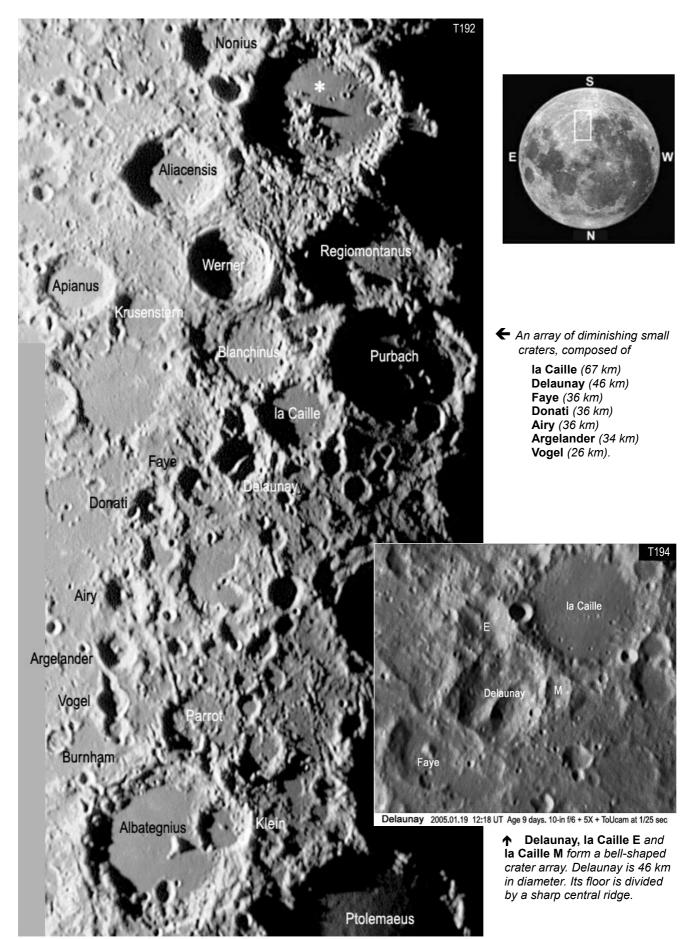


Vogel and its satellite craters 2004.09.05 20:27 UT Age 21 days. 10-in f/6 + 5X + ToUcam

T071 shows a row of diminishing craters, composed of *Halley, Hind, Hipparchus C* and *Hipparchus L*. Hipparchus is a vast walled plain, 138 km in diameter, Map 12. Its walls are modified by a pattern of grooves and ridges known as "*Imbrium Sculpture*". This pattern is radial to Mare Imbrium, which affects the lunar surface for more than 1000 km from Imbrium. The same pattern can be seen in the middle of T173. *Horrocks* (30 km) is a younger crater within Hipparchus. *Pickering* (15 km) is named after E. C. Pickering, the former director of Harvard College Observatory. [Remark: Messier A of Map 6] was once named as Pickering (after W. H. Pickering, the smaller brother of E. C. Pickering), but this W. H. Pickering was removed from crater nomenclature since 1964.]



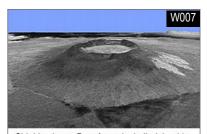
Hipparchus & vicinity 2004.06.25 12:47 UT Age 8 days. 10-in f/6 Newtonian + 2.5X + ToUcam, 6 frames stacked.



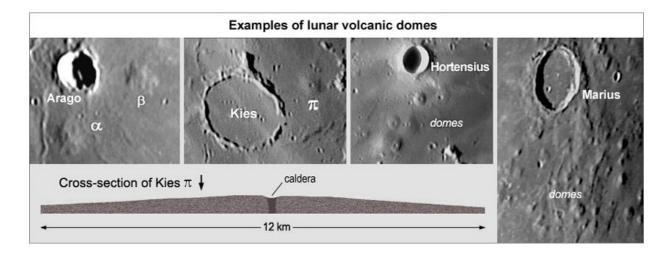
2004.12.19 12:41UT Age 7 days. 10-in f/6+2.5X+ToUcam. The ★ was crater Walter, now renamed as Walther.

Domes

Domes refer to small, rounded low elevation found mostly on lunar maria. They swell up from ground level to slope $1^0 \sim 5^0$ and are believed to form during the later stages of lunar volcanism, when the rate of lava extrusion had decreased. Lunar domes are similar to the shield volcanoes on Earth. Sometimes they have calderas, visible as summit pits or craterlets in telescopes. However the **megadome**, which is a large uplifted piece of the crust (diameter more than 30 km), is more complex in nature. Lunar domes and megadomes located near a known feature are highlighted in the following maps; they require very oblique sunlight to be seen.



Shield volcano **Darwin** on Isabella Island in Pacific Ocean. It has an exceptionally large summit caldera, dia. 5 km, height 1330 m. (Image made from radar data & elevation data)



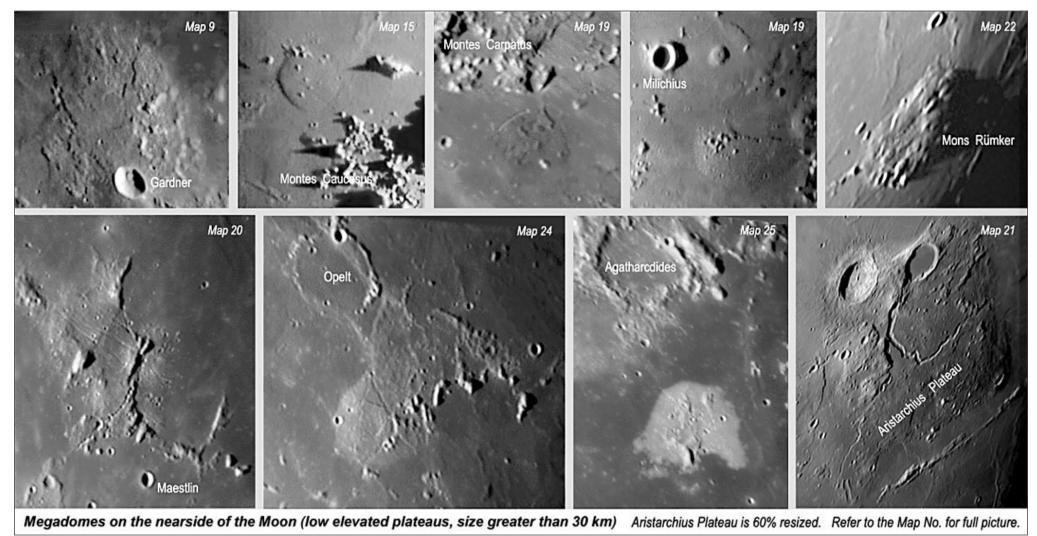
Map of Lunar Domes (nearside) S 10 w 11 2 17 6 7 8 18 12 15 1 14 9

- 1. Cauchy & Lucian, Map 6.
- 2. Arago, Maclear & Ross Map 8.
- 3. Davy, Map 31.
- 4. Kies & Capuanus, Map 24.
- 5. Gambart & Reinhold, Map 19.
- 6. Copernicus, Hortensius & Milichius, Map19.
- 7. Kepler, Map 20.
- 8. Marius, Map 20.
- 9. Gruithuisen, Mairan T & Mons Rümker, Map 22.
- 10. Grimaldi, Map 26.
- 11. Darwin, Map 27.
- 12. Palus Putredinis & Beer, Map 14.
- 13. Luther, Map 9.
- 14. Sinus Iridum, Map18.
- 15. Aristarchus & Herodotus, Map 21.
- 16. Fracastorius, Map 5.
- 17. Murchison, Map 13.
- 18. Valentine Dome (megadome), Map15.

 Other megadomes are shown in next page.

More details:

http://www.glrgroup.org/news/28.htm, http://digilander.libero.it/glrgroup/ **Megadome** is a near-circular plateau or uplift piece (usually on lunar mare) which has diameter more than 30 km and low elevation of few hundred meters. The plateau surface is textured with protrusions, depressions, ridges, rilles, craterlets etc. The large diameter means it is within the reach of small telescopes. But the trick is that all megadomes are truly low in height and poor in contrast, so they are noticeable only under very oblique sunlight. The nature of megadomes is complicated and not fully understood, though hints suggest that they are volcanic. (Reference: http://www.lpi.usra.edu/meetings/lpsc2005/pdf/1116.pdf)



Lunar Rays

When the Sun illumination angle is high enough (e.g. 30^{0} or more), bright rays begin to emit from certain craters. The table below lists those craters known to have bright rays.

Craters with bright rays									
Anaxagoras	(Map 16)	Copernicus	(Map 19)	Lalande	(Map 19)	Glushko	(Map 23)	Taruntius	(Map 6)
Aristarchus	(Map 21)	Euclides	(Map 20)	Langrenus	(Map 3)	Petavius B	(Map 3)	Thales	(Map 10)
Aristillus	(Map 14)	Furnerius A	(Map 3)	Manilius	(Map 9)	Proclus	(Map 2)	Theophilus	(Map 5)
Autolycus	(Map 14)	Geminus C	(Map 2)	Menelaus	(Map 9)	Sirsalis	(Map 27)	Timocharis	(Map 19)
Bessel	(Map 9)	Godin	(Map 13)	Messala B	(Map 2)	Snellius	(Map 3)	Tycho	(Map 11)
Birt	(Map 12)	Hind	(Map 12)	Messier A	(Map 6)	Stevinus A	(Map 3)		
Byrgius A	(Map 27)	Kepler	(Map 20)	Olbers	(Map 23)				

Lunar rays are bright due to two separate causes, or a mix of both.

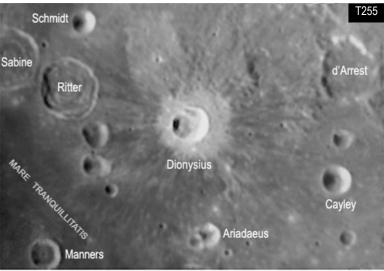
- Some rays are composed of materials ejected from an impact site on the highlands. The highlands are predominately light-color anorthosite (illustrated in Map 1). These rays become bright simply because anorthosite is deposited on the darker maria.
- The ray may also contain fine pulverized rock powder created by the energy of the impact. This powder reflects sunlight effectively making the ray (ejecta) bright under illumination. However, the brightness of such powdery ray is weathered away by micrometeoroids, cosmic rays, and solar winds more rapidly than the ejecta that is rich in anorthosite.

In theory all fresh impact craters have rays. As time goes by, both the anorthositic and powdery rays will vanish. This suggests that rayed craters are generally younger than non-rayed craters.

Lunar rays are unique in the following characteristics:

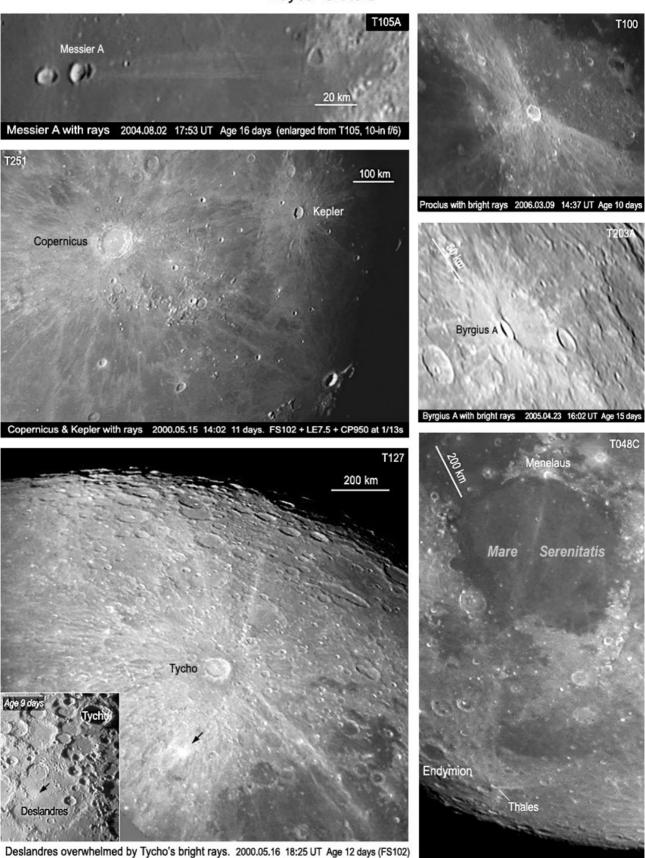
- They do not have fixed pattern. For example in next page, the rays from Tycho are long in multi directions but those from Copernicus and Kepler are wispy. The difference of pattern probably depends on the impact intensity and the viscosity (fluidity) of the ejecta melt.
- The rays may not point exactly back to the crater from which they supposedly originated.
- The rays may shift slightly in position during a lunation.

While bright rays are common, there is a rare type of dark rays. In T255, Dionysius (diameter 18 km, Map 13) seems to appear with a bright halo only. Close inspection, however, shows an additional pattern of dark rays beneath the bright halo. The dark rays were first noted by Clementine spacecraft in 1994. They are actually ejecta composed of dark material excavated from the mare basalts. The bright halo is deposits of light-colored anorthosite excavated from deeper layer of the impact site.



Dionysius with dark rays beneath a white halo 2006.03.09 13:48UT Age 10 days. 10-in f/6+5X+ToUcam

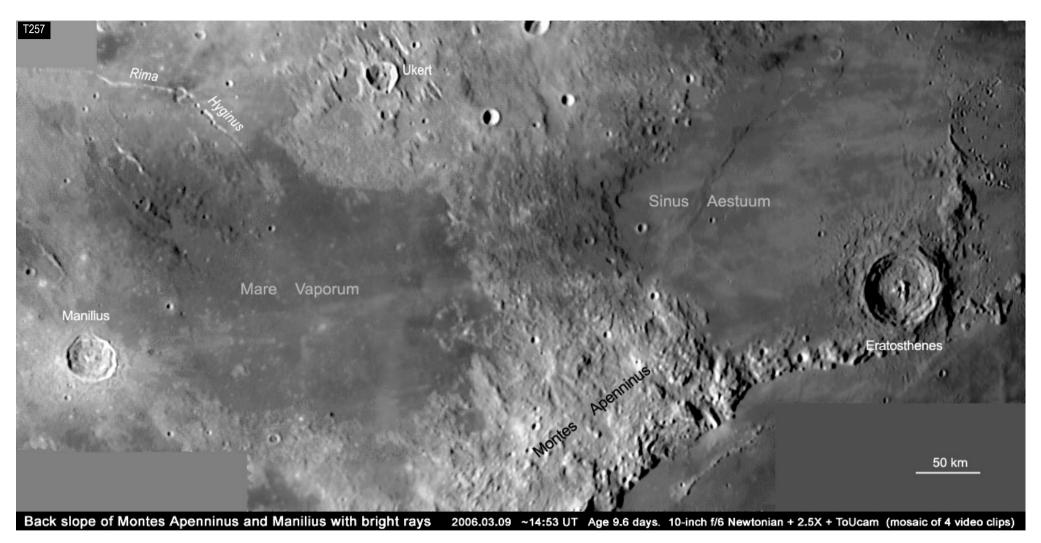
Rayed Craters



The arrow points to a bright patch on the floor of Deslandres. This patch was first noted by

the 17th century astronomer Cassini, hence nicknamed "Cassini's Bright Spot".

Rays of Menelaus crossing Mare Serenitatis 2003.09.11 16:11 UT Age 15 days. FS128 + PL15 + CP995

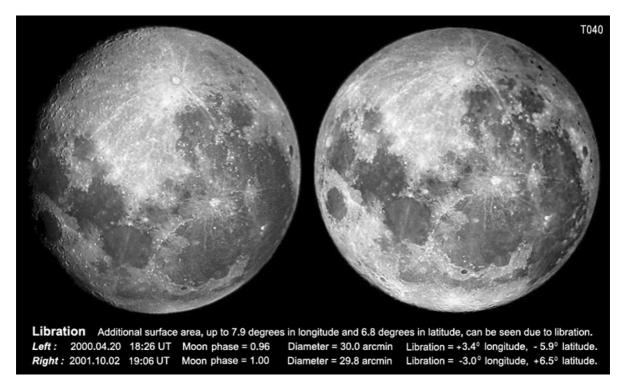


One arm of Manilius rays stretches across Mare Vaporum and the back slope of Montes Apenninus. The ray is as long as 450 km, almost penetrating into Sinus Aestuum. It is lengthy because (1) the impact energy to create Manilius is truly huge; (2) the Moon's surface gravity is only 1/6 that of Earth and (3) the Moon has no air to retard the ejected materials during the crater-forming impact. In more massive impacts such as Tycho, the bright rays stretch even longer, up to 1800 km!

Note also the regions of DMD (dark mantle deposit, Map 9) in the immediate north of Rima Hyginus and in the eastern edge of Sinus Aestuum.

MAP 33

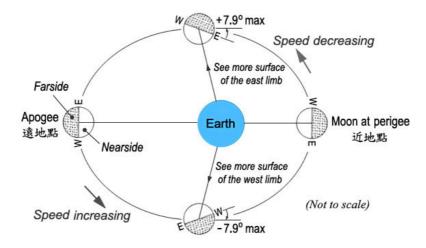
Libration



Libration (天平動) allows the nearside of the Moon to be seen from slightly different angles at different time, producing an overall view of the lunar surface that adds up, over time, to 59% of the total. It was first noted by the Polish astronomer Johannes Hevelius (1611-1687).

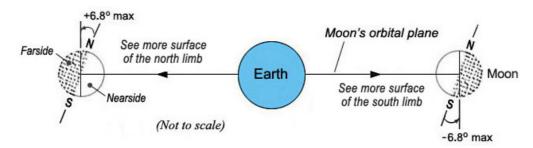
There are three types of optical librations.**

• *Libration In Longitude* (經天平動) is due to the fact that the Moon moves faster when it is near perigee and slower when near apogee, but its rotation remains constant. This means that the Moon's rotation is not yet in perfect synchronization with its orbital motion. As a result, the Moon appears to wobble back and forth around its rotation axis. The additional longitudinal surface that can be seen with this libration is ±7.9°.

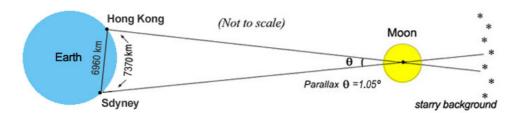


** Due to irregularities of gravitational pull by the Earth and the Sun, the Moon does librate very slightly by itself; this is known as physical libration. See Appendix – Moon Data.

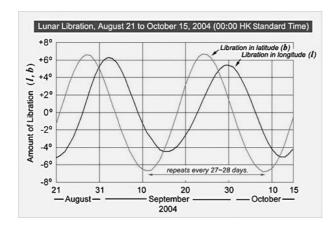
• *Libration In Latitude* (緯天平動) is due to the tilt angle of the Moon's equator (or rotation axis) from its orbital plane. As a result, the Moon appears to nod its polar regions towards and away from the Earth as it goes around its orbit. The additional latitudinal surface that can be seen with this libration is $\pm 6.8^{\circ}$.

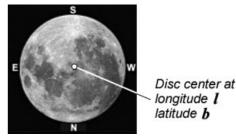


Diurnal Libration (周日天平動) gives an extra 1^0 of visible surface round the east or west limb of the Moon, because the Earth's rotation brings a terrestrial observer at slightly different view angles between moonrise and moonset. Simultaneous observations of the Moon disc from two cities on Earth also produces a parallax, such as θ shown below.

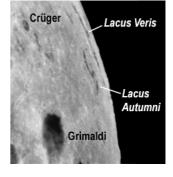


Libration in longitude and libration in latitude occur concurrently and repeat every $27 \sim 28$ days (approximately one sidereal month). They are quantified by parameters \boldsymbol{l} and \boldsymbol{b} , i.e. the shift of zero coordinates (0^0 longitude and 0^0 latitude) from the Moon disc's exact center at that moment. They also mean that the disc center is now at longitude \boldsymbol{l} and latitude \boldsymbol{b} . A positive value of \boldsymbol{l} or \boldsymbol{b} gives more surface of the east or north limb exposed to Earth. A negative value of \boldsymbol{l} or \boldsymbol{b} gives more exposed surface of the west or south limb.

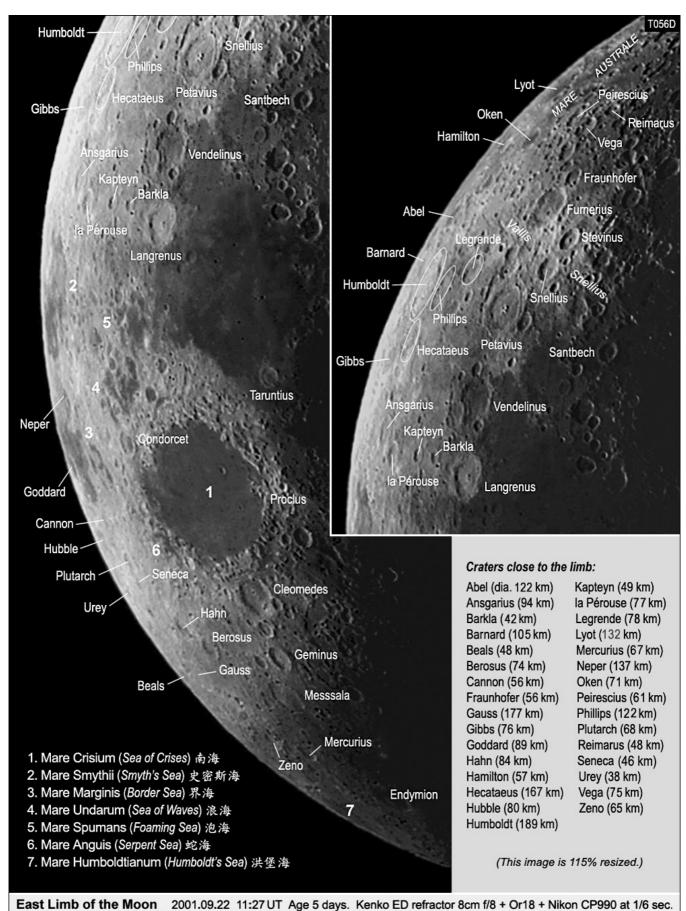




Lunar libration causes surface features near the limb distort noticeably in angular dimensions, and features very close to the limb may be temporarily out of sight. For instance, Lacus Autumni (Autumn Lake) and Lacus Veris (Spring Lake) appear on the west limb only at very favorable libration. The visibility of the maria on the east limb (T056D, next page) are also libration dependent.



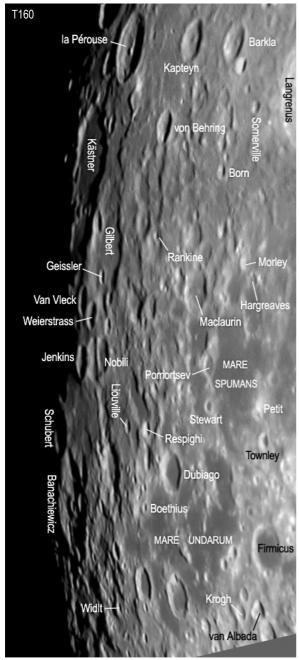
The east limb during favorable libration



This day is almost autumnal equinox. It also happened that lunar libration was maximum in longitude (I = +7.8°). DSCN9724

176

The east limb near equator during favorable libration

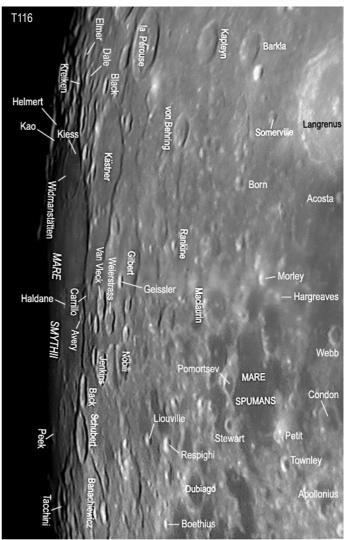


Mare Spumans & Mare Undarum 2004.09.29 ~15:32 UT Age 15 days Libration $I = 5.4^{\circ}$ $b = 1.4^{\circ}$ Terminator at 82° E

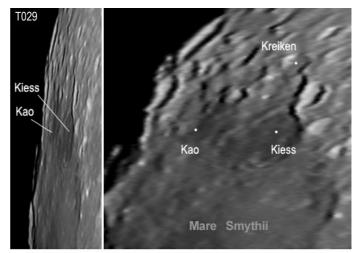
Crater Diameters:

Back (35 km)
Banachiewicz (92 km)
Barkla (42 km)
Born (14 km)
Condon (34 km)
Dubiago (51 km)
Firmicus (56 km)
Gilbert (112 km)
Jenkins (38 km)
Kao 高平子 (34 km)
Kapteyn (49 km)
Kästner (108 km)
Kiess (63 km)
Krogh (19 km)
la Pérouse (77 km)

Liouville (16 km)
Maclaurin (50 km)
Nobili (42 km)
Pomortsev (23 km)
Rankine (8 km)
Respighi (18 km)
Schubert (54 km)
Somerville (15 km)
Stewart (13 km)
Townley (18 km)
van Albada (21 km)
Van Vleck (31 km)
von Behring (38 km)
Weierstrass (33 km)
Widmanstätten (46 km)

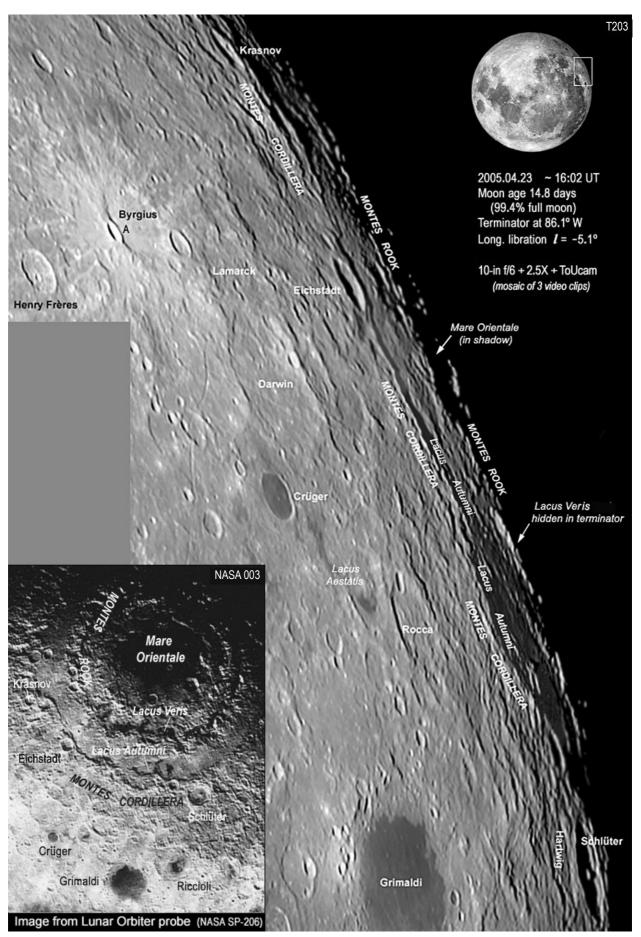


Mare Smythii & Mare Spumans at fairly favorable libration (l = 4.5° b = -1.0°) 2004.10.28 ~14:09 UT Age 15 days. Terminator at 89°E. 10-in f/6 Newtonian + 2.5X +ToUcam

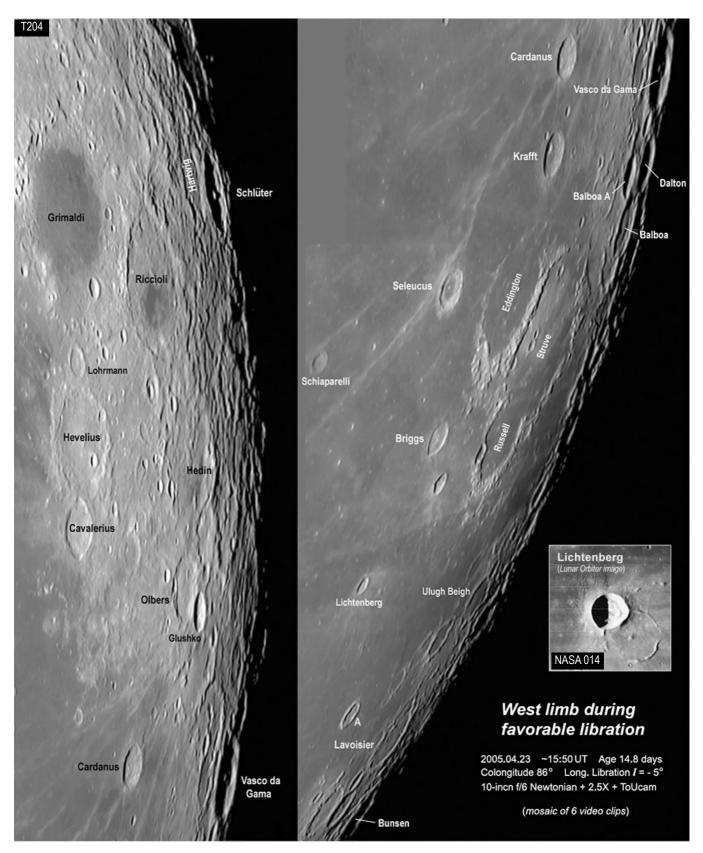


Crater Kao *Left:* original image *Right:* 5X enlargement in horizontal scale 2005.10.17 15:20 UT Age 15 days (Terminator at 93° E Libration $I = 4.6^{\circ}$). 10-inch f/6 Newtonian + 2.5X + ToUcam

The west limb during favorable libration (from 31°S to 4°S)

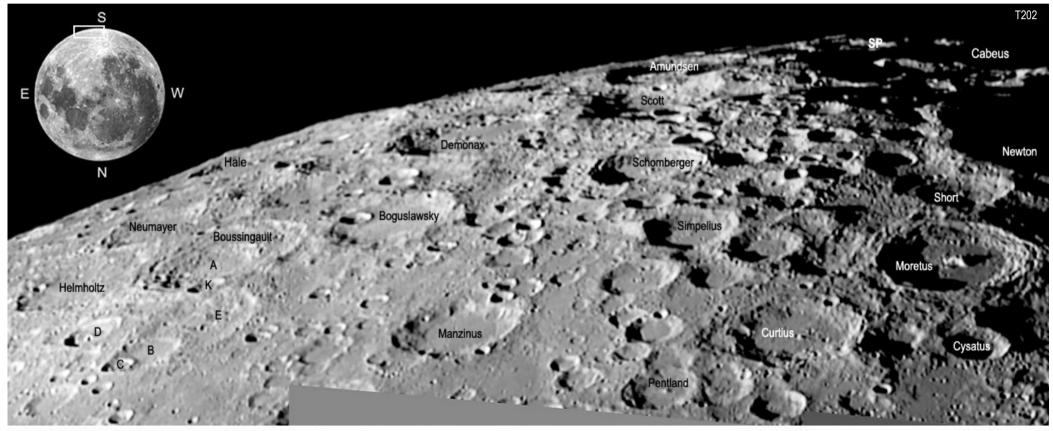


The west limb during favorable libration (from 12°S to 42°N)



South pole and its eastern region during favorable libration

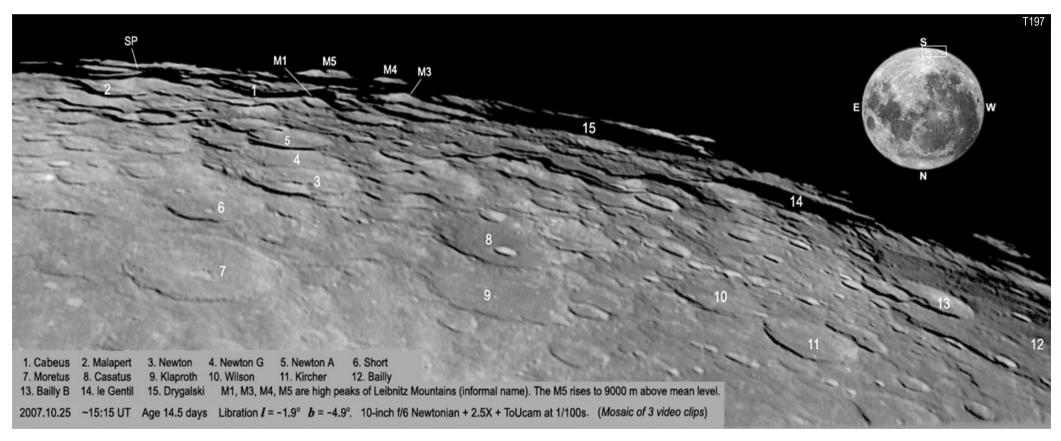
The south pole is marked SP. Crater Cabeus (diameter 98 km) and Newton (78 km) are hidden in the dark side of the terminator. Amundsen (85.6°E 84.3°S, 101 km) is not visible usually but it is recognizable in this image. See also the Farside map for non-oblique views of these craters.



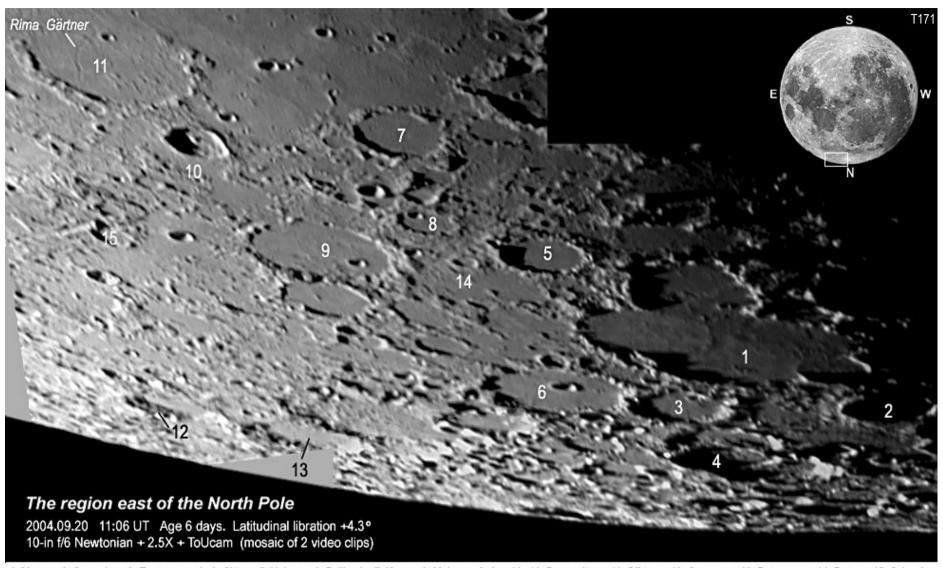
South pole and its eastern region during favorable libration 2005.04.18 14:44 ~ 14:47 UT Age 10 days. Libration $l = -2.3^{\circ}$ $b = -6.0^{\circ}$. 10-in f/6 Newtonian + 2.5X + ToUcam

South pole and its western region during favorable libration

The south pole SP, crater le Gentil and Drygalski (Nos. 14, 15) are heavily shadowed. Newton (No. 3, diameter 78 km) is shown together with satellite craters A and G. M1, M3, M4 and M5 are the high peaks of **Leibnitz Mountains** (informal name). They are actually the peaks on the outer rim of SPA (South-Pole Aitken basin); see also the Global Maps in the Moon Data pages. The M5 rises to 9,000 m above mean level; it is the highest surface feature on the entire Moon.



The region east of the North Pole during favorable libration

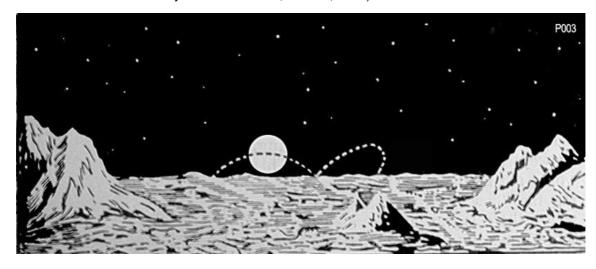


1. Meton 2. Scoresby 3. Euctemon 4. de Sitter 5. Neison 6. Baillaud 7. Kane 8. Moigno 9. Arnold 10. Democritus 11. Gärtner 12. Cusanus 13. Petermann 14. Peters 15. Schwabe



Artist's impression of libration

To an observer at a given place on the nearside of the Moon, the Earth would seem to be almost fixed in the sky. Lunar libration, however, produces an additional peculiar motion of the Earth. Whenever on the Moon the Earth is seen above horizon, it will seem to set and then rise again, as indicated by the broken curves. This peculiar rising or setting of the Earth at the horizon follows the period of libration, which repeats approximately every 27~28 days. (Sketch from Perelman's Astronomy For Entertainment, Moscow, 1958.)



A partially illuminated Earth rises above the lunar horizon

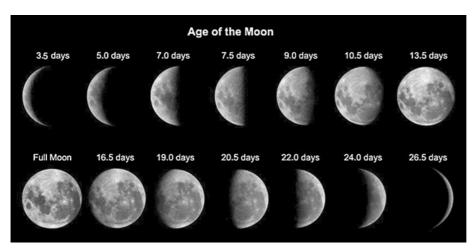
Taken by Apollo 11 crew flying over Mare Smythii, 1969 July 20 (NASA Image AS11-44-6550). Mare Smythii Is on the east limb of the Moon's nearside. If the crew landed on Smythii and stayed there long, they would find the Earth wandering very slowly above the horizon, similar to the above sketch.



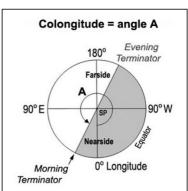
Watch these videos of Earth-rise and Earth-set from the Japanese "Selene" lunar probe. http://www.jaxa.jp/press/2007/11/20071113 kaguya e.html

Terminator

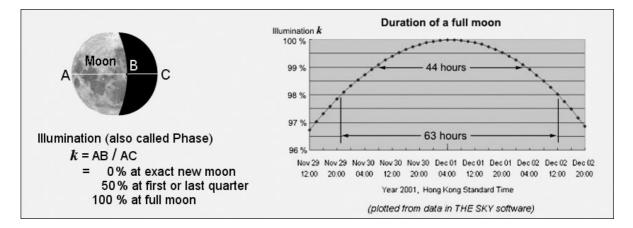
The terminator is the border line between the illuminated and dark portions of the Moon. It is the line of sunrise or sunset. At the morning terminator, the Sun is rising over that part of the Moon; at the evening terminator, the Sun is setting. Precisely the terminator position is specified by the Sun's *colongitude*, which is same as the selenographic longitude of the morning terminator, measured westwards from the 0^0 longitude of the Moon globe. Thus the terminator position is approximately colongitude 0^0 at first quarter, 90^0 at full moon, 180^0 at last quarter and 270^0 (= 90^0 E) at new moon. In some lunar ephemerides, it is often measured in relation to the mean center of the lunar disc not accounting for any effect of libration. This may cause the observer to notice a deviation between the actual terminator position and the position quoted by the ephemeris. To avoid such ambiguity, this book marks the terminator position simply in terms of the "Age of the Moon" or the fractional "Illumination k" although both parameters are not exact indication of the sunlight angle. See the following illustrations.



Mosaic from various images, south is up and west is right. The top row (before full moon) gives the morning terminator; the bottom row (after full moon) gives the evening terminator. Note that Moon age less than 2 days or greater than 27 days is very difficult to trace due to close proximity to the Sun. Practically the Moon crescent is not visible if it is less than 7° from the Sun.



The terminator always moves westwards on the nearside of the Moon, hence it rotates anticlockwise if viewed from top of the lunar south pole. However the terminator rotation is not uniform. It may vary from about 29.27 to 29.83 calendar days for one revolution. The average is 29.53 days, generally known as the Synodic Month.

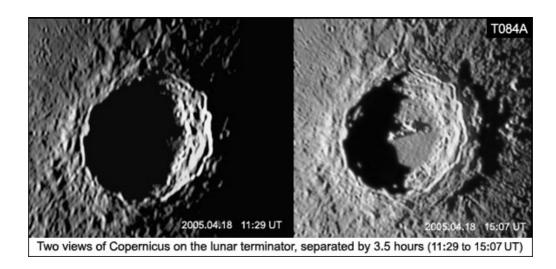


The terminator moves slowly at days close to full moon. This is illustrated by astronomy software in the above diagram, which shows no terminator at exact full moon (k = 100 %), and that the Moon remains "pretty full" (k > 98 %) in 63 hours. The daily shift of terminator along the Moon's equator is marked approximately by the scale in Index Map, cover page of this book.

The movement of terminator is detectable in telescopes. One observation through a 4-inch refractor at low power indicates that the movement is barely distinguishable in interval as short as 10 minutes (Image T040B). When the terminator is crossing Copernicus, its movement can even be detected in a couple of minutes under high power (T084A).



The lunar terminator has moved very slightly in duration as short as 10 min. FS102+K25+CP950 at 1/322s



The lunar terminator produces many intriguing but momentary views. Some examples are

Map 5 The tortoise-shaped shadow on the floor of Cyrillus F, Moon age ~ 19 days.

Map 9 The snaky Serpentine Ridge intersected by Rimae Plinius, Moon age ~20 days.

Map 15 Valentine Dome with surface sculpture.

Map 18 The edge of Sinus Iridum (Montes Jura) that brightens up like a "golden handle" of a teapot.

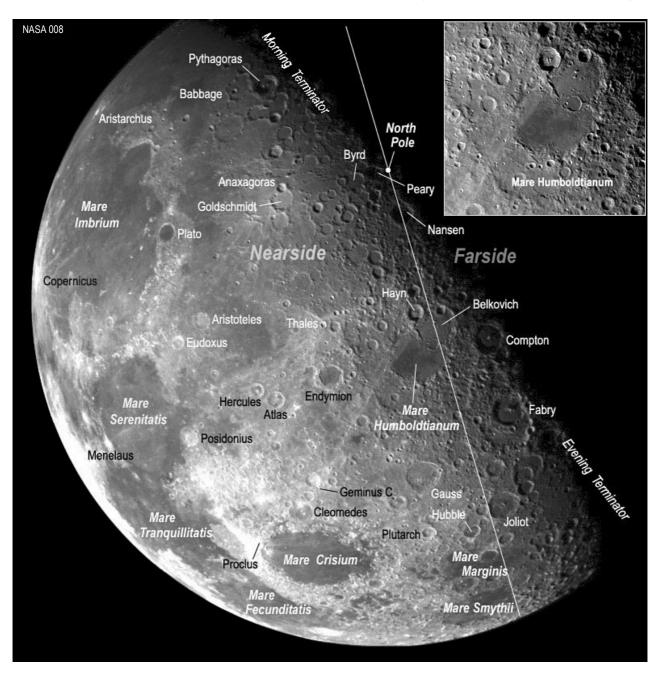
Map 20 The Maestin region that resembles an "ET" (Extraterrestrial) face.

Map 27 The triangular shadow cast by Sirsalis Z.

Terminator seen by Galileo spacecraft as it flew by the Moon

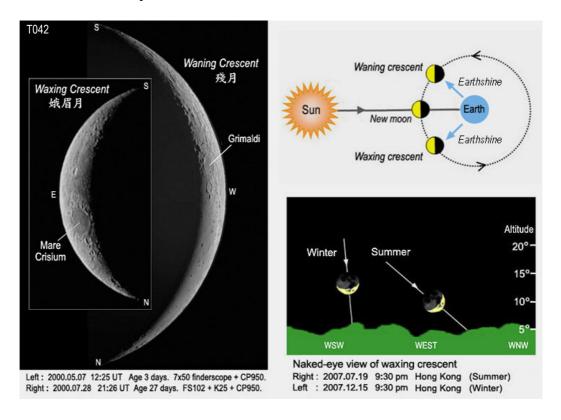
Below is a mosaic of 18 images from the spacecraft's camera through a green filter on 1992 December 7, when the Moon was 94% full and with the illuminated portion approximately facing the Earth. The lunar north pole is on the outer rim of crater **Peary**. This crater is 73 km in diameter and lies just inside the shadow zone next to **Byrd**. To a terrestrial observer, **Mare Humboldtianum** is a difficult object on the northeast limb of the Moon but here it is seen clearly with two concentric mountain rings. Note the bright ray from **Geminus C** striking on the edge of Mare Humboldtianum. The shapes of Mare Tranquillitatis, Mare Fecunditatis and Mare Crisium also change dramatically from their usual impressions.

The straight line through the north pole separates the nearside from the farside of the Moon. The morning terminator rotates clockwise in time. It indicates the Sun is rising over that part of region. At the evening terminator, the Sun is setting. Because the Moon has no atmosphere, there is no Earth-like twilight. The day and night transition over a lunar place occurs quite instantly. During daytime (which lasts about 2 weeks by Earth calendar), the surface temperature at the equatorial zone can reach 130°C maximum. During nighttime (which also lasts about 2 weeks), it falls to -180°C or even lower at the polar regions. The temperature at depth of 1 m under surface, however, is relatively constant, around -35°C. This suggests that lunar "soil" (regolith) is a good thermal insulator. (Reprocessed from NASA image JPL-PIA00130)

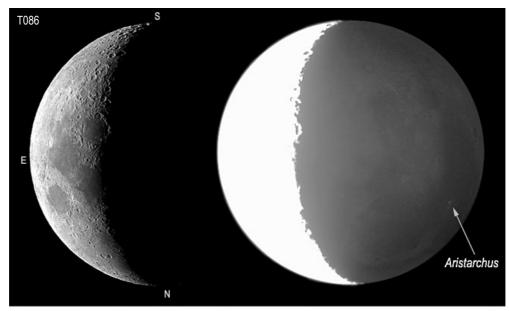


Crescent

When the Moon is a crescent, its sky position is not far away from the Sun. The *Waxing Crescent* (Image T042) indicates the Moon phase is increasing; it always sinks low in the western sky after sunset. The *Waning Crescent* indicates the Moon phase is decreasing; typically it rises few hours before daybreak.



Thin crescents often appear with *Earthshine*, as shown in T086 and T095. Earthshine refers to a faint illumination of the dark portion of the crescent, caused by sunlight reflected from the Earth. Surface features in a photograph of thin crescent (e.g. T094) are likely lack of contrast, because the light reflection of Earth shines on the crescent as well.

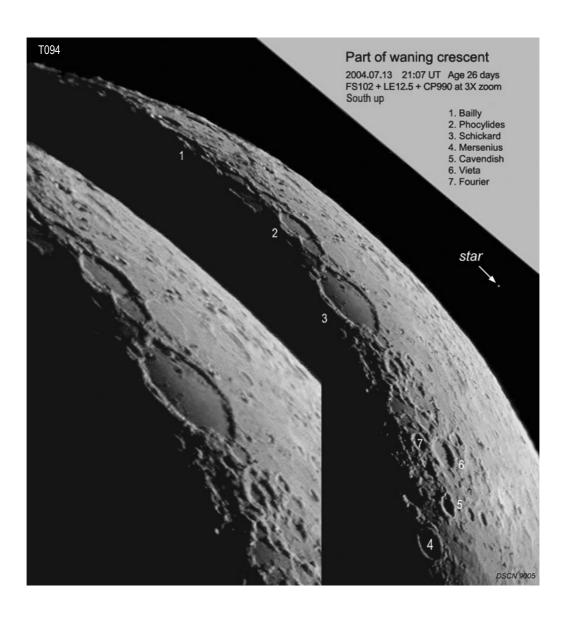


Waxing crescent with earthshine 2002.08.13 ~12:00 UT Age 4 days. FS102 + Or 25 + CP990. The right image is deliberately overexposed to show the earthshine. Aristarchus, a high albedo crater, is visible even in earthshine.



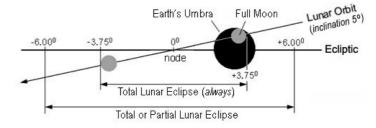
Waning Crescent with Earthshine

(Taken on 2004 July 13 when it was 27 degrees above horizon)



Eclipse and Occultation

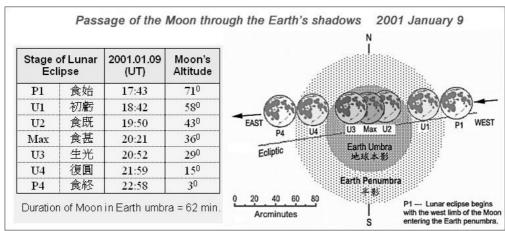
The condition for total lunar eclipse is shown at right. Whenever the full moon comes within 3.75° on either side of the node of orbits, it must be completely shadowed by the Earth's umbra. A total lunar eclipse will be seen on Earth.



Lunar and solar eclipses are also related to the **Saros**, a period of 223 lunations (6585.32 days or 18.03 years) which was known in ancient Babylonian times. After one Saros, the Sun, Earth, Moon and nodes of the orbits return to almost the same alignment; hence a lunar or solar eclipse with passage (duration and obscured portion) resembling its predecessor will recur. This link predicts the worldwide eclipses: http://sunearth.gsfc.nasa.gov/eclipse.html

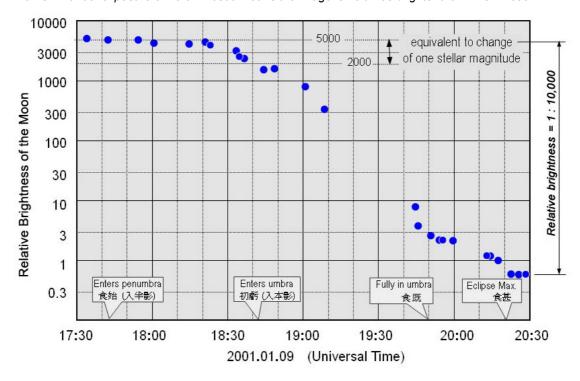
The total lunar eclipse on 2001 January 9 is shown in T044. It represents the view in binoculars at different time. The color and brightness of the Moon did not change much in the Earth's penumbra (18:34 UT). As the Moon entered the Earth's umbra, its color changed gradually and dimmed to dull red at eclipse maximum (20:21 UT). The brightness drop during total eclipse was about 1:10000, as plotted in next page. It also happened that Delta Geminorum, a 3.5-magnitude star, was almost occulted by the Moon in this event. See T045.

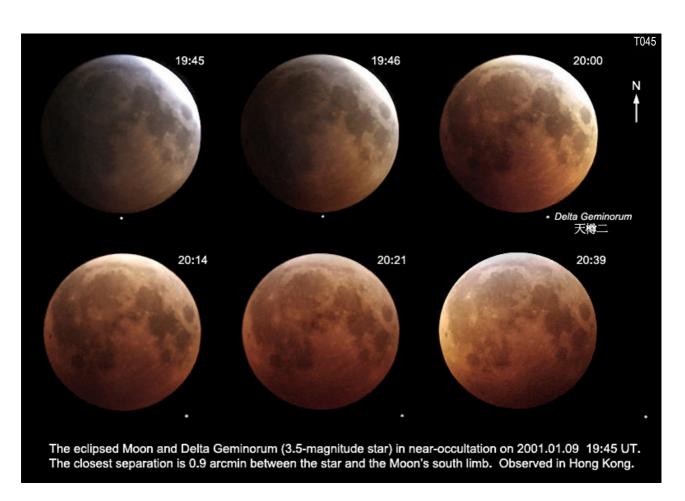




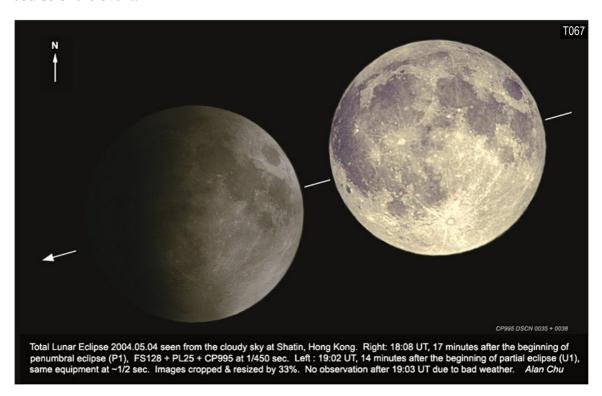
Brightness of the eclipsed Moon, 2001 January 9

The relative brightness is deduced by comparing the exposure readings of different images captured by Casio QV2300 digital camera during the eclipse. For example, at fixed magnification and ISO sensitivity, a non-manual exposure of f/5.6 1/20sec means the image is 40 times brighter than f/2.8 1/2sec.





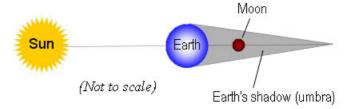
T067 was taken is another Total Lunar Eclipse, occurred on 2004 May 4 and observed in Hong Kong. When the eclipse began, the sky was overcast for rain. Only this picture is available in the full course of the event.



Lunar and solar eclipses at the same time



Credit: David A. Hardly http://www.astroart.org

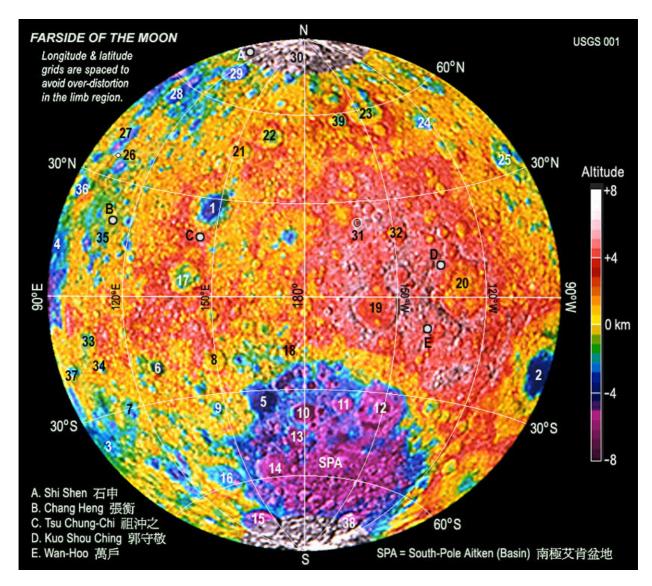


Above: While watchers on the Earth see a lunar eclipse, watchers on the Moon could experience a solar eclipse as well. As the Moon passes through the umbra (darkest portion) of the Earth's shadow, the total solar eclipse seen from the Moon can last up to 1.7 hours, much longer than the duration of any solar eclipse seen from the Earth.

Right: A space painting which depicts an eclipse of the Sun by Earth as seen from the Moon. From here the Earth looks four times larger than the solar disc; hence the corona (extremely hot ionized gas surrounding the Sun) would not be seen. The Earth's atmosphere forms a "ring of fire" as sunlight is refracted by it, giving a typical coppery tint. The bright red glow at the ring bottom is caused by "sunset" effect. The Moon also turns red by the illumination of the Earth's atmosphere.

(This explains why the eclipsed Moon in T045 looks red.)

3. Farside of the Moon



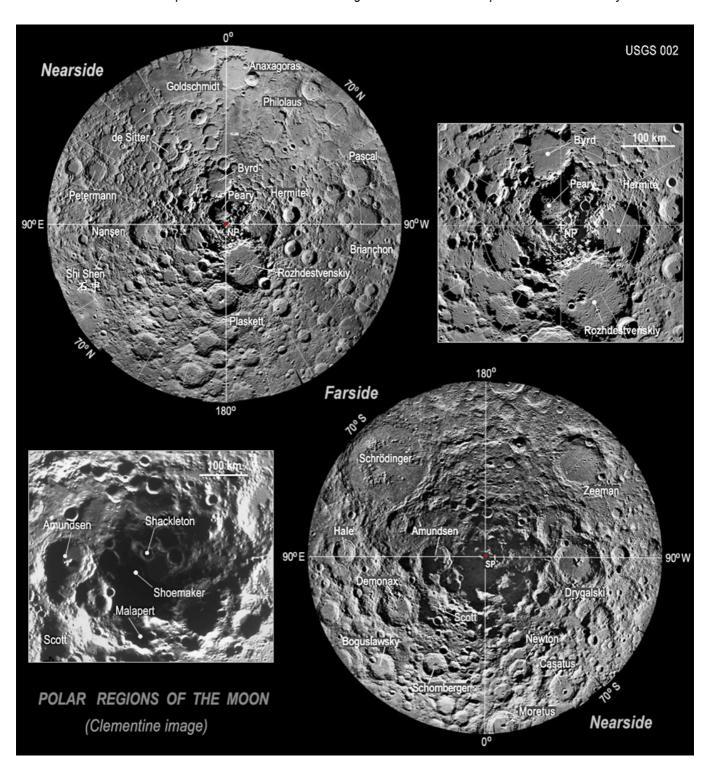
	Feature Name	Long.	Lat. (deg.)	Dia. (km)		Feature Name	Long.	Lat. (deg.)	Dia. (km)
1	Mare Moscoviense (Moscow Sea) 莫斯科海	148 E	27 N	277	Crat	er Hertzsprung 赫茨普隆	129 W	3 N	591 *
2	Mare Orientale (Eastern Sea) 東海	93 W	19 S	327	21	Campbell 坎貝爾	151 E	45 N	219
3	Mare Australe (Southern Sea) 南海	93 E	39 S	603	22	D'Alembert 阿蘭伯特	164 E	51 N	248
4	Mare Marginis (Border Sea) 界海	86 E	13 N	420	23	Birkhoff 伯克霍夫	146 W	59 N	345
5	Mare Ingenii (Sea of Ingenuity) 智海	163 E	34 S	318	24	Landau 蘭道	118 W	42 N	214
Crat	er				25	Lorentz 勞蘭斯 (勞倫斯)	95 W	33 N	312
6	Tsiolkovsky 齊奧爾科夫斯基	129 E	21 S	185	26	Giordano Bruno 左丹奴布魯諾	103 E	36 N	22#
7	Milne 米爾恩	112 E	31 S	272	27	Fabry 法布里	101 E	43 N	184
8	Gagarin 加加林	149 E	20 S	265	28	Compton 康普頓	104 E	55 N	162
9	Jules Verne 朱爾斯·維恩	147 E	35 S	143	29	Schwarzschild 史瓦西	121 E	70 N	212
10	Leibnitz 萊布尼茲	179 E	38 S	245	30	Plaskett 普拉斯基特	174 E	82 N	109
11	Oppenheimer 奧本海默	166 W	35 S	208	31	Jackson 杰克遜	163 W	22 N	71#
12	Apollo 阿波羅	152 W	36 S	537	32	Mach 馬赫	149 W	18 N	180
13	Von Kármán 卡曼	176 E	45 S	180	33	Pasteur 巴士德	105 E	12 S	224
14	Poincaré 龐加萊	164 E	57 S	319	34	Hilbert 希爾伯特	108 E	18 S	151
15	Schrödinger 施羅丁格爾	132 E	75 S	312	35	Fleming 費萊明	110 E	15 N	106
16	Planck 普朗克	137 E	58 S	314	36	Joliot 約里奧	93 E	26 N	164
17	Mendeleev 門捷列夫	141 E	6 N	313	37	Curie 居里	91 E	23 S	151
18	Aitken 艾肯	173 E	17 S	135	38	Zeeman 塞曼	134 W	75 S	190
19	Korolev 科羅列夫	157 W	4 S	437	39	Rowland 勞蘭德	162 W	57 N	171
	* Hertzsprung is the largest crater	-like featur	e on the	entire Mo	on, for	med in Pre-Nectarian period.	# Crater v	vith brigh	t rays



The farside ranges from 90°E to 90°W with the mean center of the disc at 180° longitude and 0° latitude. Compared to the nearside, the farside is more heavily cratered, contains only few small maria and mascons (mass concentrations).

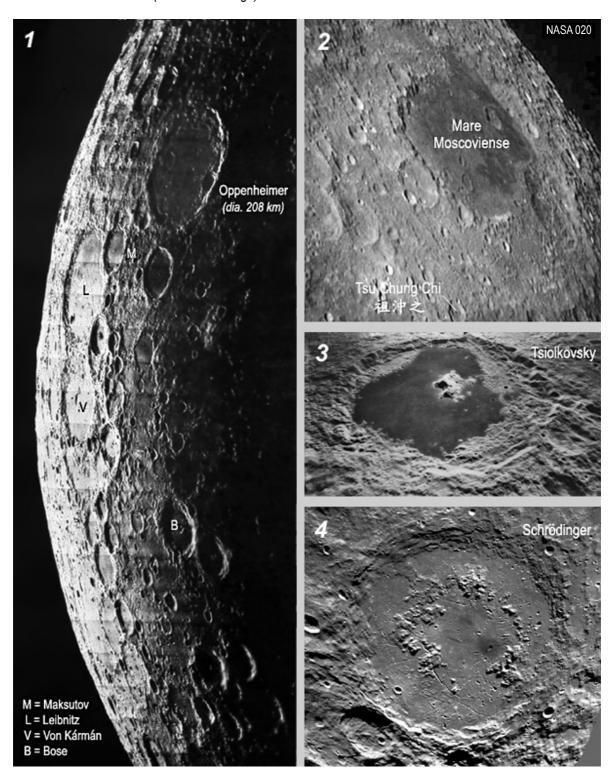
The north pole lies on the outer rim of crater **Peary**, details in <u>Map 16</u>. The south pole is inside **Shackleton**, a crater on a depression which is roughly 100 km across and is so deep that sunlight probably never reaches there. The south pole is therefore a speculative cold area where water ice could exist. On 1999 July 31, the **Lunar Prospector** probe ended its mission with a controlled impact on a permanently shadowed crater near the south pole. This crater is **Shoemaker**, diameter 51 km and named after the American astrogeologist Eugene M. Shoemaker (1928-1997). Shoemaker, his wife Carolyn and his amateur colleague David H. Levy discovered the fragmented comet SL-9 which collided on Jupiter during 1994 July 16 - 22.

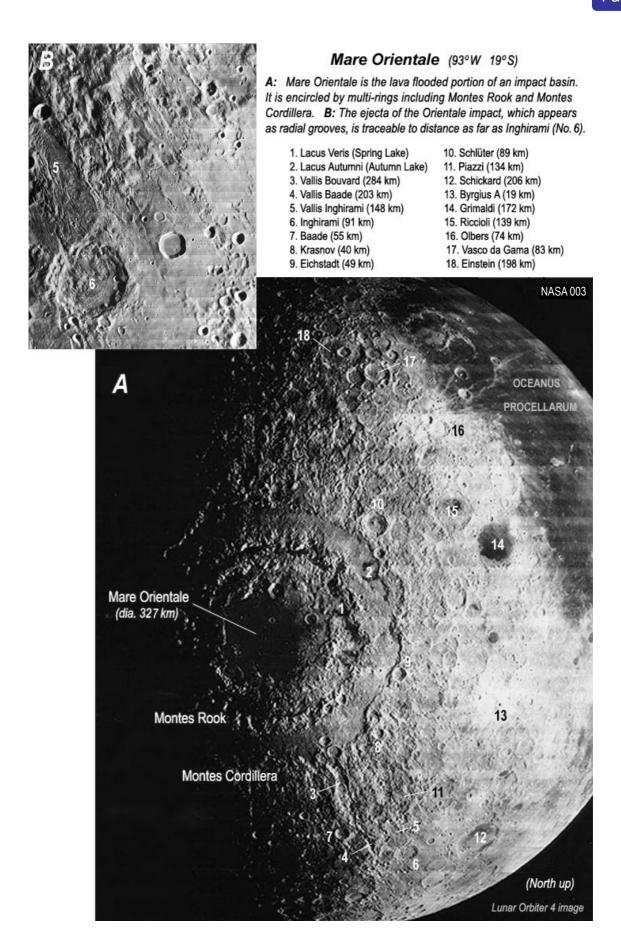
The **South Pole - Aitken** is an impact basin about 2300 km in diameter and 12 km deep, so named for its location between the lunar south pole and crater Aitken. It is the largest and oldest known impact basin in the solar system.



Features on the Farside of the Moon

All images in this page are north up. **1. Sunrise over Oppenheimer:** Oppenheimer is a farside crater at 166⁰ W 35⁰S, 208 km in diameter. It has a narrow rim and a relatively flat floor. Label L is Leibnitz, 245 km; V is Von Kármán, 180 km. All these features are actually circular but appear oval due to limb foreshortening. (Lunar Orbiter 5 image). **2. Mare Moscoviense** (Moscow Sea): It is the most prominent feature on the farside, 277 km in diameter. A large part of the mare floor is darker than the rest. Tsu Chung-Chi is a crater named after a Chinese mathematician in the 5th century, 28 km in diameter. (Apollo 13 image) **3. Tsiolkovsky:** A feature that appears partially crater and partially mare, size 185 km. The crater itself is fairly circular, but its dark mare-like floor is distinctly not circular. The central peaks, terraced walls and slump blocks on the inner rim of the crater are typical of many large impact craters. (Apollo 15 image) **4. Schrödinger:** An impact crater-basin feature, 312 km in diameter. At this size, it may develop an internal ring instead of central peak due to fluidized waves during the impact. The floor of Schrödinger is fractured with a distinctive dark-halo crater. (Clementine image)

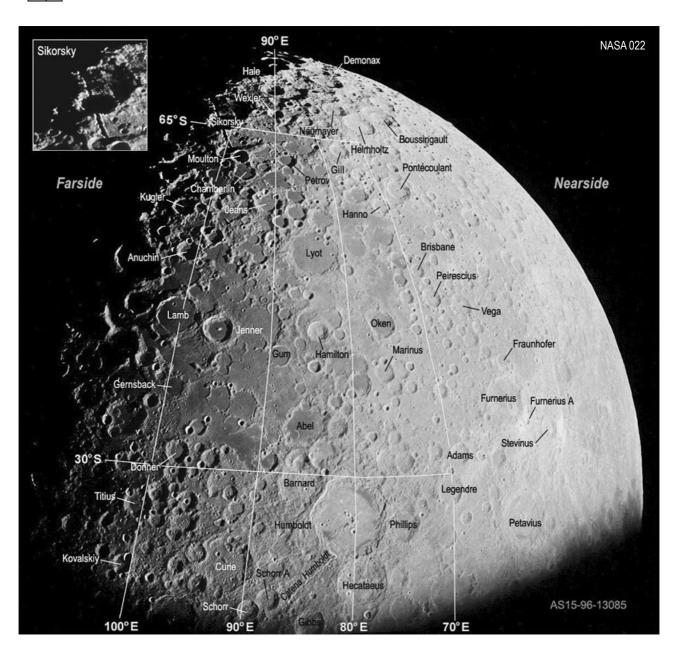






Mare Australe as seen by Apollo-15 in orbit

The lunar south pole is at the frame top. Mare Australe (Southern Sea) is the dark area ranging from longitude $70^{\circ} \sim 110^{\circ}$ E and latitude $30^{\circ} \sim 65^{\circ}$ S, size about 600 km. The mare floor is stuck with many craters of various sizes, **Lyot** (diameter 132 km) being the largest and visible in telescope under favorable libration. **Jenner** and **Lamb** are prominent crater pair, but they are on the farside and hence invisible from Earth. A long narrow valley cuts through the farside crater **Sikorsky**. **Humboldt** is a large walled plain on the nearside close to Mare Australe, diameter 189 km. **Catena Humboldt** is a chain of craterlets running between Humboldt and **Schorr A**, length 165 km. See also T188 in Map 4.



Lunar Features named after Chinese

There are 10 lunar features named after Chinese, 5 on the nearside and 5 on the farside. See the full list below.

Feature Name	Year Adopted	Long. (deg.)	Lat. (deg.)	Dia.* (km)	Origin	Where
Crater					-	
Chang Heng 張衡	1970	112.2 E	19.0 N	43	Astronomer, 78 - 139	Label B, Farside map.
Chang-Ngo 嫦娥	1976	2.1 W	12.7 S	3	Female in Chinese myth	Inside Crater Alphonsus, Map 12.
Ching-Te 正德#	1976	30.0 E	20.0 N	4	Male name	Southwest of Crater Littrow, Map 9.
Kao (Ping-Tse) 高平子	1982	87.6 E	6.7 S	34	Astronomer, 1888 - 1970	On the southern edge of Mare Smythii, Event 1.
Kuo Shou Ching 郭守敬	1970	133.7 W	8.4 N	34	Astronomer, 1231 - 1316	Label D, Farside map.
Shi Shen 石申	1970	104.1 E	76.0 N	43	Astronomer, ~ 300 B.C.	Label A, Farside map.
Tsu Chung-Chi 祖沖之	1970	145.1 E	17.3 N	28	Mathematician, 429 - 500	Label C, South of Mare Moscoviense, Farside map.
Wan-Hoo 萬戶	1970	138.8 W	9.8 S	52	Inventor, ~ 1500	Label E, Farside map.
Rima						
Rima Sung-Mei 宋梅月溪 #	1985	11.3 E	24.6 N	4	Female name	Near western edge of Mare Serenitatis, Map 9.
Rima Wan-Yu 萬玉月溪 #	1976	31.5 W	20.0 N	12	Female name	Almost at the west rim of crater Natasha, Map 19.
*Names in native language are not yet ascertained.				* Dia	ameter or long-side dimensior	1

Shi Shen 石申 ~ 300 B.C.

石申(石申夫)是戰國時代魏國人。他和楚國人<u>甘德</u>各自編過一本星表。兩者都是世界上最早的星表,後人將石申編的資料歸納成《石氏星經》,此書已失,但唐朝《開元占經》輯錄了大量片斷內容。《石氏星經》主要記錄了二十八宿距星和121顆恒星的赤道座標位置,可以說是中國古代天體測量工作的基礎。



Chang Heng 張衡 78 - 139

東漢西鄂人(今河南省南陽市北),字平子。少年時代醉心於文學,曾花十年時間,寫成《二京賦》,藉以諷諫當時的奢侈。三十歲後開始從事天文科學技術的研究工作。三十八歲由郎中遷任太史令,晚年任尚書。他利用滴漏原理設計的「渾天儀」(公元117年),是世界上第一台用水力推動的大型星象演示儀器;他的「候風地動儀」(公元132年),是世界上第一架測定地震及方位的儀器。他還制造出巧妙的指南車、自動記里鼓車和飛行數里的木鳥。主要學術著作有《靈憲》、《渾天儀注》、《算罔論》等。張衡亦是東漢六大畫家之一。



Tsu Chung-Chi 祖沖之 429-500

南北朝时代南朝人。他把圓周率精確地推算到數值在 3.1415926 和 3.1415927 之間,比歐洲人的演算早一千一百多年。他的數學專著《綴術》到唐朝時被定爲學校的課本。他根據自己長期觀測天象的结果,于 33 歲時創制了《大明曆》,採用的一個回歸年的天數,跟現代值只多出 54 秒;採用的一個交點月的天數,跟現代值相差不到 1 秒。在《大明曆》中,祖冲之首次引入了歲差,每隔 391 年設 144 個閏月。這些做法,都是對前代曆法的重大改革。在制曆過程中,他發明了用 圭表測量冬至前後正午時日影長度以定冬至時刻的方法,這個方法爲後世長期採用。



Kuo Shou Ching 郭守敬 1231 - 1316

元代河北邢台人,字若思,他在全國各地設立 27 個觀測站進行大規模的天文和地理測量,最北遠至西伯利亞,最南的在西沙群島,並且首次運用海拔概念,比歐洲的同樣概念早五百年;他的「招差術」,比牛頓的內插法早四百年;他主持編成的《授時曆》,一年的周期 (365.2425 天) 與現代公曆相同,比天文回歸年只多出 25 秒。另外,他創造和改進了十餘種天文儀器,包括著名的「簡儀」「量天尺」(巨型圭表)、「景符」及「窺幾」等等,他又建造「登封觀星台」並主持多項國家工程,集防洪、灌溉、航運爲一體。天文數學著作有十四種共 105 卷,可惜已遺失。

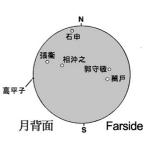
Wan-Hoo 萬戶~1500

據傳原是木匠,後在明朝軍營擔任兵器技藝的開發。他的姓名不詳,萬戶可能是一軍階的名謂,也可能不是軍階。他曾把47枚火箭捆綁在自己的座椅上,並且手持風箏試圖飛天(見下圖),可惜點火後火箭爆炸喪命。外國稱他是「最早乘搭火箭的人」。

Wan-Hoo's attempt to fly on chair powered by 47 rockets.







Kao (Ping-Tse) 高平子 1888 - 1970

原叫高均,江蘇人,對張衡十分敬仰,故又名平子。他沒有接受正規的天文教育,震旦學院畢業後入徐家匯天文台及佘山天文台,隨法國神父從事太陽黑子、小行星及雙星的觀測,工餘自修天文。1924年他代表中國接管由日本人佔用的青島觀象台,1926年參加國際經緯度的測定工作,他也曾主持編算天文年曆及協建南京紫金山天文台。抗日時期避居上海租界研究中國古天文,1948年遷居台灣。其後發起創立台灣「中國天文學會」,連任幾屆理事長,著作有《史日長編》、《圭表測影論》等。1987年台灣的中央研究院數學研究所出版了《高平子天文曆學論著選》。

Shi-Shen 石申 ~300 B.C.

Shi-Shen was an astronomer and astrologist. He catalogued the equatorial positions of 121 stars in 28 Su (ancient Chinese constellations). His catalogue, together with similar works of another Chinese observer Gan-Te, are supposed to be the earliest star catalogue in the world. The original star catalogue by Shi-Shen was lost, but much of his works were frequently quoted and preserved in $Kaiyuan\ Zhanjing$ (Treatise on Astrology of the Kaiyuan Reign Period) compiled in the 8^{th} century.

Chang Heng 張衡 78-139

Chang was interested in literature at youth and produced several works that brought him recognition as a writer. In his early 30s, he decided to turn to astronomy. He was soon recognized as a scientist and entered government service at the age of 38. Eventually he became chief astronomer and minister under the emperor. In year 123 Chang introduced a calendar reform, which aligned the months again with the seasons. Chang's best known invention is a seismograph, or more accurately a "seismoscope", since it did not produce a graph of the earthquake but indicated in which direction it occurred. He also invented a chariot that indicated direction automatically and a wooden bird that could fly hundreds of meters. He had several papers in science, philosophy and literature. Chang also excelled in picture painting.

Tsu Chung-Chi 祖沖之 429-500

A mathematician and an astronomer. He determined Pi (π) between 3.1415926 and 3.1415927, a thousand years ahead of the European precision. At age 33, he proposed an improved calendar with one tropical year only 54 seconds longer than today's value, and a nodical month accurate to within 1 second. He also introduced the concept of "precession of the equinoxes" in his calendar and suggested 144 extra-months (leap months) per 391 years for the season alignment scheme. During calendar development, Tsu invented a method to time the accurate moment of winter solstice by measuring the Sun's shadow at noon on days near the solstice. This method remains to be a standard reference for many later years. However, his calendar was not accepted by court until 10 years after his death.

Kuo Shou Ching 郭守敬 1231-1316

An astronomer and a senior government officer. He once conducted a large-scale land survey, north up to Siberia and south up to the islands in southern China. His survey conveyed the concept of "the elevation above sea level" and the mathematical method of "interpolation", both being 400~500 years earlier than the European did. He developed a calendar with one year = 365.2425 days, same as today's calendar year or 25 seconds more than the tropical year. He invented or improved over 10 astronomical instruments including a torquetum, sight tubes and a huge gnomon with a pin-hole device to read the sun's shadow length accurately. He also built an observatory and held credits in national projects of flood prevention, agriculture and navigation. He authored a variety of scientific books in 105 volumes but they were lost.

Wan-Hoo 萬戶 ~1500

Wan-Hoo is supposed a carpenter who later joined the army of the Ming Dynasty as a weapon builder and inventor. Wan-Hoo may not be his real name but probably a term in the military rank. He attempted to fly by binding himself on a 47-rocket powered chair together with large kites. Unfortunately the rockets, being gun-powder fueled, exploded during ignition. Wan-Hoo died in his attempt. He is credited to be "the first man to fly in rockets".

Kao (Kao Ping-Tse) 高平子 1888-1970

Kao is one of the pioneer astronomers in the 20th century China. He did not have a formal education in astronomy. He picked up everything by himself. In his earlier career, Kao worked under two French observatories in Shanghai, major in the observations of sunspots, asteroids and binary stars. In 1924, he represented the Chinese government to resume the supervision of Qingdau Observatory from the Japanese. In 1926, He participated in the international project of longitude-latitude survey. He had been an editor of astronomical almanac and also one of the planners to establish the Purple Mountain Observatory in Nanjing of China. During World War II when no observations were feasible, he resided in Shanghai to study the history of Chinese astronomy. In 1948 he moved to Taiwan. There he founded the Taiwan-China Astronomical Society and was its president for some years. His papers in astronomical measurements and calendar studies were published collectively in Taiwan in 1987.)

Moon Watch in old China

The first Chinese who watched the Moon in telescope was probably court minister **Xu Guang Qi** (徐光啓) in the late Ming dynasty, when the Jesuit **Schall von Bell** (湯若望 1592-1666) brought the Galilean telescopes to China. The most early documented watch of the Moon by Chinese is a sketch by **Jie Xuan** (揭暄) through his telescope. The sketch was presented in his *New Words About Celestial Bodies* 《寫天新語》,後稱《璇璣遺述》,published around 1675 during the Ching dynasty.



Moon Sketch by Jie Xuan 揭暄 (1610-1702)

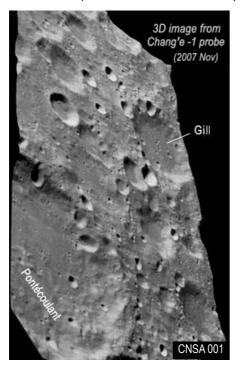
4. Lunar Spacecraft

From 1959 to 2007, over 30 unmanned spacecraft were launched successfully to the Moon. They returned volumes of information about the Moon surface.

List of the major unmanned spacecraft	List of the	major	unmanned	spacecraft
---------------------------------------	-------------	-------	----------	------------

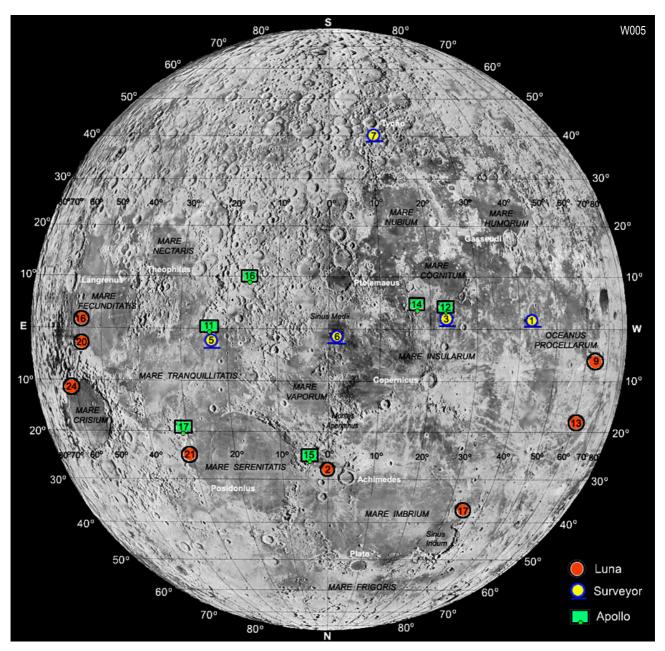
Unmanned Spacecraft	Date of Launch (UT)	Missions / Results
Luna 2, 3, 9 to 14, 16, 17, 19 to 24 (former USSR) 「月球號」	1959 September ~ 1976 August	 Crashed or soft-landed on the Moon surface, or entered lunar orbits. First succeeded to photograph Moon's farside (Luna 3, 1959). Returned a total of 300g soil samples to Earth. http://www.lpi.usra.edu/expmoon/luna/luna.html
Ranger 7, 8, 9 (USA) 「徘徊者」	1964 July ~ 1965 March	 Returned closeup images before the spacecraft crashed on the moon. http://www.lpi.usra.edu/expmoon/ranger/ranger.html
Surveyor 1, 3, 5, 6, 7 (USA) 「探測者」	1966 June ~ 1968 January	 Tested or analyzed lunar soils directly on landing sites. Transmitted to Earth about 86,000 lunar photographs. http://www.lpi.usra.edu/expmoon/surveyor.html
Lunar Orbiter 1, 2, 3, 4, 5 (USA) 「月球軌道飛行器」	1966 August ~ 1967 August	 Photographed the entire moon surface from orbit. Discovered the existence of mascons. http://www.lpi.usra.edu/resources/lunar_orbiter/
Clementine (USA) 「克萊門泰」	1994.01.25	 Mapped the entire Moon at multi-wavelengths from which scientists deduced the abundance of elements on the lunar surface without coming into direct contact with it (the so-called remote sensing technique). http://www.cmf.nrl.navy.mil/clementine/
Lunar Prospector (USA) 「月球勘探者」	1998.01.07 (Controlled crash on the Moon on 1999.07.31.)	 Went into polar orbit around the Moon to survey the composition of lunar crust; searched water-ice at the poles. Mapped the Moon's gravity and magnetic fields. Monitored volcanic emission. http://lunar.arc.nasa.gov/
Smart-1 (Europe) 「智能一號」	2003.09.27 (Controlled crash on the Moon on 2006.09.03.)	 Testing and proving of an ion drive engine and miniaturized instruments, along with investigations of lunar geochemistry and a search for water-ice at the lunar south pole. http://sci.esa.int/science-e/www/area/index.cfm?fareaid=10
Selene "Kaguya" (Japan) 「月亮女神」	2007.09.14	 To investigate the Moon's elemental and mineralogical composition for further study of its origin and evolution. http://www.jaxa.jp/pr/brochure/pdf/04/sat16.pdf
Chang'e-1 (China) 「嫦娥一號」	2007.10.24	 To obtain the Moon's 3D images and elemental distribution; to investigate lunar regolith (its Helium-3 contents) and the space weather (solar wind) en route to the Moon. http://210.82.31.82/

This link compares the instruments on lunar spacecraft: http://www.spudislunarresources.com/Papers/orbital missions all.pdf



The first manned landing began with the Apollo 11 mission when two American astronauts Neil Armstrong and Edwin Aldrin set foot on the Moon in Mare Tranquillitatis (Sea of Tranquility) on 1969 July 20. Meanwhile Michael Collins orbited in the command module. Apollo is a program to land humans on the Moon. A total of six Apollo landing modules including 12 astronauts succeeded in landing between 1969 and 1972, see Landing Map in next page. Since then no human landed on the Moon but surveys by unmanned spacecraft continued. The best rewards from the Apollo are the human experience on the low-gravity lunar surface, the collection of 380 kg of Moon rocks and the on-site experiments about solar wind, cosmic ray, lunar atmosphere, heat flow, magnetic field, seismometry and laser ranging. The Moon rocks played the key role to reveal the lunar evolution. By analyzing the rocks with the technique of radiometric dating, scientists determined the Moon was created 4.5 billions years ago, almost same age as that of Earth.

Moon Landing Map

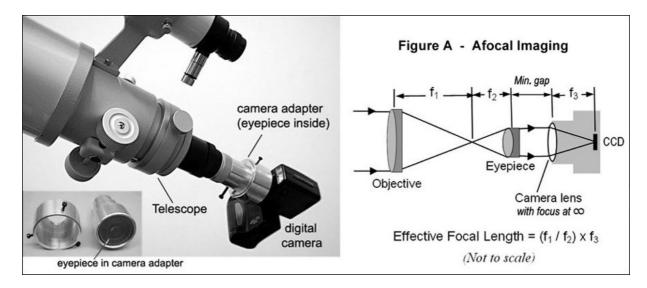


Spacecraft	Date of Landing	Results	Spacecraft	Date of Landing	Results
Luna Probes	(former USS	R)	Apollo Missions (USA)		
Luna 2 Luna 9	1959.09.13 1966.02.03	Hit moon in Palus Putredinis. Soft-landed in Oceanus Procellarum.	Apollo 11	1969.07.20	First manned landing on 23.5° E 0.7° N, Map 8. Collected 22 kg rock/soil samples.
Luna 13 Luna 16	1966.12.24 1970.09.20	Soft-landed in Oceanus Procellarum. Returned 100g soil from M. Fecunditatis.	Apollo 12	1969.11.19	Landed on 23.4°W 3.0°S, Map 20. Collected 34 kg rock/soil samples.
Luna 17 Luna 20	1970.11.17 1972.02.21	Landed one rover in Mare Imbrium. Returned 30g soil from Crisium highlands.	Apollo 14	1971.02.05	Landed on 17.5°W 3.6°S, Map12. Collected 43 kg rock/soil samples.
Luna 21 Luna 24	1973.01.15 1976.08.18	Landed one rover in Mare Serenitatis. Returned 170g soil from Mare Crisium.	Apollo 15	1971.07.30	Landed on 3.6° E 26.1° N, Map 14. Collected 77 kg rock/soil samples.
Surveyor Pro	obes (USA)		Apollo 16	1972.04.21	Landed on 15.5° E 9.0° S, Map 31. Collected 95 kg rock/soil samples.
Surveyor 1 Surveyor 3	1966.06.02 1967.04.20	Soft-landed in Oceanus Procellarum. Tested soil in Mare Insularum, later visited	Apollo 17	1972.12.11	Landed on 30.8° E 20.2° N, Map 9. Collected 110 kg rock/soil samples.
Surveyor 5 Surveyor 6 Surveyor 7	1967.09.11 1967.11.10 1968.01.10	by Apollo 12 astronauts. Tested soil in Mare Tranquillitatis. Tested soil in Sinus Medii. Tested soil near crater Tycho.			

5. Methods of Imaging

The author of this book applied two methods to image the Moon — the "afocal" method and the "video" method.

5.1 Afocal Method



This is implemented by coupling a digital camera to the telescope's eyepiece, Figure A. The camera's focus mechanism is fixed at infinity (hence the term "afocal"). Actual focusing is adjusted on the telescope while watching the camera LCD screen.

The effective focal length of an afocal system is equal to the telescope magnification times the focal length of the camera's front lens.

Example

Telescope focal length, $f_1 = 1040 \text{ mm}$

Eyepiece focal length, $f_2 = 12.5 \text{ mm}$

Telescope magnification = f_1 / f_2 = 1040 / 12.5 = 83

Camera lens focal length, $f_3 = 24 \text{ mm}$

Effective focal length for afocal imaging = $(f_1 / f_2) \times f_3 = 83 \times 24 \approx 2000 \text{ mm}$

The frame FOV (field of view) is equal to the FOV of the camera lens divided by telescope magnification. If the FOV of the camera lens is 15×11 degrees (which can be estimated from its specifications), then following the above example, the frame FOV will be 11×8 arcmin. This covers about $1/3 \sim 1/4$ diameter of the Moon disc.

The afocal method is very flexible while image quality is quite promising. Changing the eyepiece, zooming the camera lens, rotating the camera body, and/or using telescopes of different sizes virtually satisfy all needs of wide-field and close-up images of the Moon. However, there is a limit of telescope magnification. Under average seeing, the author controls the telescope magnification not to exceed 25X per inch aperture (10X per cm). 40X per inch (16X per cm) is used only during very good seeing. The author also avoids using eyepieces longer than 30mm focal length, because they produce excessive darkening (vignette) of the frame corners.

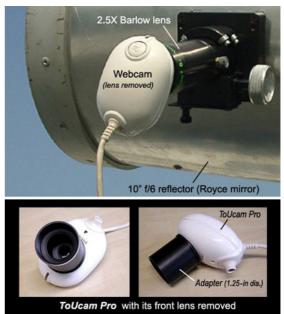
The telescopes used depend on instant availability, see Figure B. The digital cameras are $2\sim3$ megapixels with $3\sim4X$ optical zoom range, including Casio QV2300, Nikon Coolpix-950 and Coolpix-99x. These cameras incorporate CCD of pixel size around 3.5 x 3.5 μ m.

Typically a raw image from any digital camera looks flat. The author enhances it with the editing software "Photoshop".

Figure B - Telescopes Used for Afocal Imaging



Figure C - Video Method



5.2 Video Method

The default setup of this method is illustrated in Figure C. It includes a 10-inch (254 mm) f/6 Newtonian reflector in which the prime mirror was produced by the specialist Robert F. Royce (http://www.rfroyce.com), a 2.5X Barlow lens, a webcam with its original lens removed and a computer that controls the webcam exposure. The webcam is Philips ToUcam Pro. It incorporates a Sony CCD chip (Type ICX098BQ, 3.6 x 2.7 mm, 640 x 480 pixels, each pixel = $5.6 \times 5.6 \mu m$) and allows video frames to be captured at shutter speed $1/25 \sim 1/10,000$ second. The whole setup is quite powerful for high magnification works, for the webcam can be set at highest possible speed to compensate the jittering of images, and the overall resolution can reach 3.3 pixels per arcsecond of the imaged object. Each frame covers a FOV of 3.2×2.4 arcmin or roughly 1/10 of a lunar diameter at 2.5X Barlow. In theory this 10-inch telescope resolves round objects to 0.45 arcsecond or lunar craters as small as 800 m in diameter. Linear objects like clefts can be detected to 400 m or less in width, subject to their contrast and the atmospheric seeing.



CD-version only

← Click here to play a half-minute ToUcam video clip. It produces Image T064 in Figure F.

ToUcam Settings: Video Format = I-420, Frame Size = 640x480 pixels, Frame Rate = 10 frames/sec,
Color = off (B&W only), Audio = off, Gamma = 1/5 full scale, Gain = 1/3 full scale, Shutter = 1/50 sec.
All other settings at default values.

After video capturing, the sharper raw frames are extracted and stacked with the freeware "RegiStax" (http://registax.astronomy.net). Stacking is a technique to reduce image noise inherent in CCD. RegiStax can sort out the sharper frames automatically while the user determines by preference the number of frames stacked. No more than 300 frames are stacked, for over-stacking leads to loss of image details. In general, good seeing allows less stacking (e.g. 50 frames) and bad seeing requires more stacking (e.g. 200 frames). RegiStax also provides a sharpening tool, the so called wavelet filter where image sharpness is adjustable on individual layers. However, the author prefers to enhance the image by "Photoshop" whereas the wavelets serve only as ancillary tool. Note that this method, though superior, may take several minutes to convert a video clip to final image. A high-speed PC is preferred to run RegiStax.

Figure D - The 10-inch f/6 Newtonian



Figure D shows the full view of the 10-inch f/6 Newtonian, equipped with a Barlow lens and a motorized Crayford focuser. When seeing is good, a 4X or even a 5X Barlow lens is used instead of the 2.5X. The 4X is supposed an optimal choice according to Nyquist sampling theory. At 4X, the effective focal length of the 10-inch Newtonian is 6100 mm. A lunar feature of angular size equals to the telescope's resolution (i.e. 0.45 arcsecond) thus projects an image length = $6100 \sin (0.45 / 3600) = 13 \mu m$ at the focal plane. This covers approximately two pixels on each side of the CCD chip in ToUcam --- a fitted Nyquist sampling. However the 4X is not always useable due to unfavorable seeing.

The choice of afocal or video method is a matter of FOV and seeing consideration. For instance in Figure E, a wide field like T019 is obtained with the afocal method. High magnification like T118 in Figure F is obtained with the video method. The image is rotated "south-up" like an eyepiece view in Newtonian telescope placed in the northern hemisphere.

This Moon book adopts magnified images more than wide-fields. Therefore much of the imaging works were done with the video method (10-inch f/6 Newtonian + Barlow lens + ToUcam). Sometimes, frames from different video clips were combined to make a mosaic. Those who wish to capture the Moon at large format may refer to cameras with larger CCD chips or more pixels. It is also possible to replace the Barlow lens with a projection eyepiece (e.g. 9 mm focal length) for imaging.

Figure E - Moon imaging by afocal method



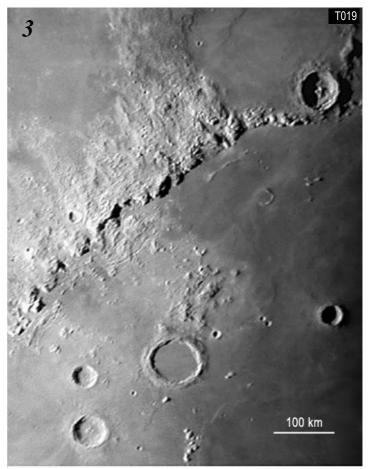
Vixen 7x50 finderscope + CP995 at 4X zoom, 1/85 sec.



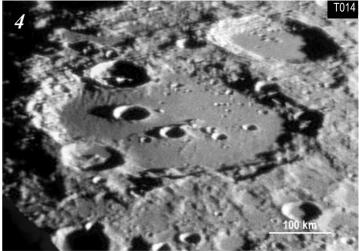
Total Lunar Eclipse 2001.01.09 FS104 + Or25 + QV2300

Digital camera coupled to:

- 1. 7x50 mm finderscope with cross-hair removed.
- 2. 4-inch (102 mm) f/8 refractor + 25 mm eyepiece.
- 3. 5-inch (128 mm) f/8 refractor + 12.5 mm eyepiece.
- **4.** 9.25-inch (235 mm) f/10 Schmidt-Cassegrain + 7.5 mm eyepiece. (All images are south up.)



Montes Apenninus 2000.11.05 13:58 UT Age 9 days. FS128+LE12.5+QV2300

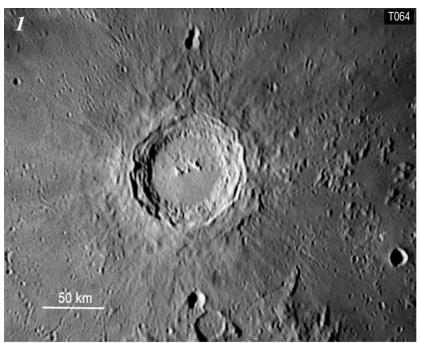


Clavius (Blancanus at corner) 2001.08.11 20:42 UT Age 22 days. C9+CP990

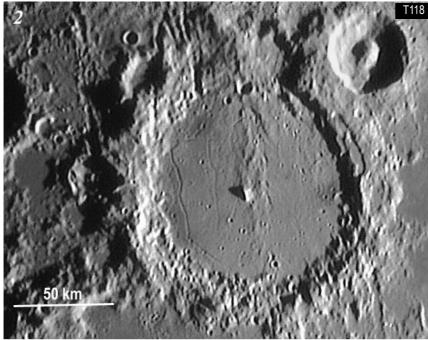
Figure F - Moon imaging by video method

Webcam coupled to:

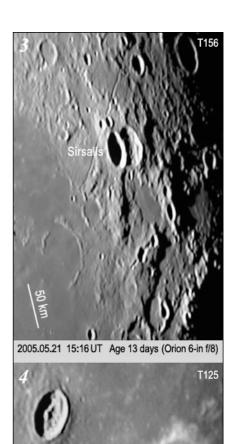
- 1: Royce 10-inch (254 mm) f / 6 Newtonian + 2.5X Barlow lens, effective f / 15.
- 2: Royce 10-inch (254 mm) f / 6 Newtonian + 2.5X + 1.6X Barlow lenses in cascade, effective f / 24.
- 3: Orion 6-inch (150 mm) f/8 Newtonian + 2.5X Barlow lens, effective f/20.
- **4:** Orion 6-inch (150 mm) f /8 Newtonian + 2.5X + 1.6X Barlow lenses in cascade, effective f / 32. (All images are south up.)



Copernicus 2004.05.29 15:20 UT Age 10 days. 10-in f/6 Newtonian + 2.5X + ToUcam



Alphonsus 2004.08.07 21:31 UT Age 22 days. 10-in f/6 Newtonian + 2.5X + 1.6X + ToUcam, 14 frames stacked.





2005.05.21 16:09 UT Age 13 days (Orion 6-in f/8)

Reiner Gamma

5.3 Other Considerations

It should be noted that the brightness of the Moon changes significantly with its age in a lunation. This implies that when shooting the Moon, a wide range of camera shutter speed is required. Typically the shutter speed is a fraction of a second at crescent to about 1/500 second for a full moon. If the frame includes both very bright and very dark features, the exposure is compromised by trials. Today's technology makes exposure rather easy, because the trials can be judged from the digital camera or PC screen any time.

A second consideration is precise focusing. In close-up images taken by the video method (the setup in Figure D), a motorized focuser has been found extremely useful. It also avoids telescope vibration as focusing is made.

Object tracking is important to create image mosaic from a multiple of video clips, otherwise the post-work of stacking and mosaicking are complicated by any excessive drift of the object in field. The author tracks the Moon's R.A. and Declination with the *Vixen New Atlux* mount; it virtually "locks" the object in field during the entire video session.

For high magnification works, it is essential to ensure proper collimation of the optics and allow them to reach thermal equilibrium.

5.4 Environment and Image Archives

All lunar images in this book and taken by the author are traceable from the Image Data in next pages. The images were taken mostly in City One Shatin of Hong Kong where the author's observing site is located. The night sky above the site is heavily light-polluted, and there are hundreds of air conditioners in the windows of the neighbor buildings. The site is also blocked in the east direction, hence much of the imaging were done in phases before the last quarter.

In the list of Image Data, the **Moon Age** is expressed in rounded number, e.g. 15 means the age of the Moon is about 15 days. The **Equipment Used** are abbreviated, e.g. FS102 + K25 + QV2300 = Takahashi FS102 refractor with Kellner 25mm eyepiece and Casio QV2300 digital camera. All digital cameras are set to ~ISO100 and full resolution for maximum available pixels. When the ToUcam was used, not all video clips were archived; only the stack of raw frames were saved.

Figure G - The Night Sky

A light-polluted sky like this is disappointing to explore deep sky objects but still manageable for lunar (and planetary) observations.



The following data apply to lunar images taken by the author in Hong Kong; each image is identified by a Tcode at the frame corner.

Image Code	Date / Time (UT)	Moon Age	Equipment Used	Exposure (sec)	Raw Image
	2000.09.13 14:39	15 days	FS102 + K25 + QV2300	1/265	QV2300-20000913-0072
	2000.04.20 17:52 2000.09.15 15:25	15 16	FS102 + LE5 + CP950 MK67 (6-in f/12) + PL16 + CP950	1/3 1/11	CP950-DSCN 1589 CP950-DSCN 4013
	2006.11.08 20:06	18	ETX90 Maksutov + LE24 + CP990		CP990-DSCN 9738 (2)
	2000.06.15 16:28	13	FS102 + LE7.5 + CP950	1/21	CP950-DSCN 2989
	2000.09.15 15:52 2000.04.20 17:58	17 15	MK67 (6-in f/12) + K25 + CP950 FS102 + LE5 + CP950	1/42 1/4	CP950-DSCN 3997 CP950-DSCN 1591
T008, A	2000.11.02 12:14	6	FS128 + LE12.5 + QV2300	1/6	QV2300-20001102-0044
	2001.05.12 18:20 2004.06.26 14:54	19 9	C9 + LE12.5 + CP990 10-in f/6 + ToUcam at prime focus	? 1/100	CP990-DSCN 9080 38 frames stacked
	2001.01.09 20:39		FS102 + Or25 + QV2300	4 sec	QV2300-20010110-0021
T012	2002.12.15 ?	11			ToUcam single frame ?
	2003.03.17 16:49 2001.08.11 20:42	14 22	10-in f/6 Royce + 2.5X + ToUcam C9 + LE7.5 + CP990	1/500 ?	60 frames stacked CP990-DSCN 9642
T015	2000.11.05 13:35	9	FS128 + LE12.5 + QV2300	1/10	QV2300-20001105-0018
	2000.11.05 13:38	9 8	FS128 + LE12.5 + QV2300	1/8	QV2300-20001105-0020
	2001.09.25 12:49 2001.01.06 15:17	o 11	C9 + LE12.5 + CP990 FS102 + LE7.5 + QV2300	1/2 1/8	CP990-DSCN 9797 QV2300-20010106-0041
	2000.11.05 13:58	9	FS128 + LE12.5 + QV2300	1/8	QV2300-20001105-0029
	2001.09.25 12:57	8 21	C9 + LE12.5 + CP990 10-in f/6 + 2.5X + 1.6X + ToUcam	1/4 1/25	CP990-DSCN 9804
	2004.09.05 ~21:31 2004.12.19 13:15	7	10-in f/6 Royce + 2.5X + ToUcam	1/50	Stacked from 2 video clips 200 frames stacked
	2004.09.25 14:10 2002.08.21 14:40	11 12	10 in f/6 Royce + 2.5X + ToUcam	1/50 1/28	16 frames stacked
	2002.08.21 14:40 2002.12.14 16:40	10	FS128 + LE12.5 + CP990 C9 + Or25 + CP990	1/20	CP990-DSCN 5490 CP990-DSCN 5832
T026	2002.12.16 14:02	12	10-in f/6 Royce + 2.5X + ToUcam		2 frames stacked
	2002.11.14 14:58 2000.09.12 15:34	9 14	C9 + LE12.5 + CP990 MK67 (6-in f/12) + PL16 + QV2300	1/7 0 1/10	CP990-DSCN 5818 ?
T029	2005.10.17 15:20	15	10-in f/6 Royce + 2.5X + ToUcam	1/100	75 frames stacked
	2006.09.04 ~14:30	12	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
	2004.08.07 20:27 2002.06.21 13:30	22 10	10-in f/6 Royce + 2.5X + ToUcam C9 + LE12.5 + CP990	1/25 1/3	27 frames stacked CP990-DSCN 4483 (lost)
T033	2002.12.16 15:12	12	10-in f/6 Royce + 2.5X + ToUcam	1/33	7 frames stacked
	2000.06.15 14:36 2005.05.22 15:26	13 14	ETX90 Maksutov + PL16 + CP950 10-in f/6 Royce + 5X + ToUcam) 1/15 1/25	CP950-DSCN 2964 82 frames stacked
	2006.05.09 14:40	12	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	120 frames stacked
T037	2006.05.10 ~14:52	13	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 3 video clips
	2002.12.16 15:17 2005.01.22 ~15:17	12 12	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	2 frames stacked Mosaic of 2 video clips
	2000.04.20 18:26	15 15	FS102 + K25 + CP950	1/322	CP950-DSCN 1596
	2001.10.02 19:06 2004.08.07 20:10	22	Kenko 8cm f/8 + Or18 + CP990 10-in f/6 Royce + 2.5X + ToUcam	1/140 1/33	CP990-DSCN 9823 11 frames stacked
T042	2000.05.07 12:25	3	7x50 finderscope + CP950 at 3X	1/4	CP950-DSCN 1958
	2000.07.28 21:26 2001.04.03 10:08	27 9	FS102 + K25 + CP950 FS128 + LE12.5 + CP990	1/7 ?	CP950-DSCN 3399 CP990-DSCN 8764
T044	2001.01.09 Total lu	ınar eclipse	FS102 + Or25 + QV2300	•	Mosaic from a batch of images
		ınar eclipse	FS102 + Or25 + QV2300		Mosaic from a batch of images
	2000.12.07 14:16 2000.05.15 14:15	11 11	? FS102 + LE12.5 + CP950	1/8 1/40	QV2300-20001207-0002 CP950-DSCN 2350
	2003.09.11 16:11	15	FS128 + PL25 + CP995	1/416	CP995-DSCN 9883
	2004.10.21 ~14:26 2005.05.21 16:21	8 13	10-in f/6 + ToUcam at prime focus Orion 6-in f/8 + 4X + ToUcam	1/100 1/25	Mosaic of 2 video clips 68 frames stacked
	2004.08.31 19:07	15	10-in f/6 + ToUcam + IR Blocker	1/500	12 frames stacked
	2004.06.26 14:09 2000.11.05 13:50	9 9	10-in f/6 Royce + 2.5X + ToUcam FS128 + LE12.5 + QV2300	1/50 1/8	11 frames stacked QV2300-20001105-0024
T054	2001.08.11 20:21	22	C9 + LE12.5 + CP990	?	CP990-DSCN 9622
	2005.04.22 16:34	14	10-in f/6 + 2.5X + 1.6X + ToUcam	1/33	69 frames stacked
	2001.09.22 11:27 2005.04.21 14:17	5 13	Kenko 8cm f/8 + Or18 + CP990 10-in f/6 + 2.5X + 1.6X + ToUcam	1/8 1/25	CP990-DSCN 9724 64 frames stacked
T058	2005.01.22 ~15:38	12	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
	2005.01.22 15:10 2004.01.06 15:03	12 14	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/25 1/50	68 frames stacked 48 frames stacked
T061	2005.04.22 ~16:41	14	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
	2004.04.30 14:05 2004.12.17 ~10:19	11 5	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/33 1/50	19 frames, cropped, 2X resized. Mosaic of 3 video clips
T064	2004.05.29 15:20	10	10-in f/6 Royce + 2.5X + ToUcam	1/50	2 frames stacked
	2005.04.19 ~13:14	11	10-in f/6 Royce + 2.5X + ToUcam	1/33	Mosaic of 3 video clips
	2004.05.31 12:37 2004.05.04 Total lu	12 ınar eclipse	7x50 finderscope + CP995 at 4X FS128 + PL25 + CP995	1/85	CP995-DSCN 0120 CP995-DSCN 0035 + 0038
T068	2004.04.30 13:06	11	10-in f/6 Royce + 2.5X + ToUcam	1/33	55 frames stacked
	2005.04.22 16:00 2005.11.09 ~11:43	14 7	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/25 1/50	88 frames stacked Mosaic of 4 video clips
			,		

Image Code	Date / Time (UT)	Moon Age	Equipment Used	Exposure (sec)	Raw Image
T071 T072 T073 T074 T075	2004.06.25 12:47 2004.06.26 13:32 2004.06.26 13:59 2004.06.26 13:47 2005.04.18 ~12:48	9 9 9 10	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50 1/50 1/50 1/50 1/50	6 frames stacked 10 frames stacked 14 frames stacked 5 frames stacked Mosaic of 5 video clips
T076 T077 T078 T079 T080	2004.06.26 13:53 2005.05.17 11:43 2000.11.05 13:22 2004.06.26 14:15 2004.08.07 19:48	9 9 9 9 22	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam FS128 + Or25 + QV2300 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50 1/25 1/74 1/50 1/33	12 frames stacked 85 frames stacked QV2300-20001105-0016 35 frames stacked 9 frames stacked
T081 T082 T083 T084, A T085	2005.11.11 ~12:43 2004.06.26 15:03 2005.11.11 12:06 2005.04.18 11:29 2005.04.18 ~14:53	9 10	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + ToUcam at prime focus 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam	1/25 1/100 1/50 1/33 1/25	Mosaic of 2 video clips 16 frames stacked 97 frames stacked 33 frames stacked Mosaic of 2 video clips
T086 T087 T088 T089 T090	2002.08.13 ~12:00 2004.06.27 13:47 2005.04.18 14:56 2004.06.27 13:30 2006.05.09 15:03	10 10	FS102 + Or25 + CP990 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam	1/33 1/33 1/50 1/25	CP990-DSCN 4967 + 5021 11 frames stacked 52 frames stacked 18 frames stacked 130 frames stacked
T091 T092 T093 T094 T095	2005.05.17 ~12:30 2004.06.27 14:25 2004.09.05 ~20:12 2004.07.13 21:07 2004.07.13 ~20:42	10 21 26	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 5X + ToUcam FS102 + LE12.5 + CP990, 3X zoon FS102 + PL25 + CP990, 2X zoom	1/50 1/50 1/25 m 1/8 1 sec	Mosaic of 2 video clips 3 frames stacked Stacked from 3 video clips CP990-DSCN 9005 (2) CP990-DSCN 8992+9000(2)
T096 T097 T098 T099 T100	2004.09.20 ~11:13 2005.11.08 ~11:30 2001.08.11 21:01 2004.07.25 12:16 2006.03.09 14:37	6 6 22 8 10	10-in f/6 Royce + 2.5X + ToUcam 10 in f/6 + 2.5X + 1.6X + ToUcam C9 + LE7.5 + CP990 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50 1/25 ? 1/50 1/50	Mosaic of 2 video clips Mosaic of 2 video clips CP990-DSCN 9648 9 frames stacked 200 frames stacked
T101 T102 T103 T104 T105, A	2004.09.05 ~21:49 2004.08.01 14:22 2004.08.01 16:50 2004.08.01 17:12 2004.08.02 17:53	15 15	10-in f/6 + 2.5X + 1.6X + ToUcam FS128 + LE12.5 + CP990 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/25 1/38 1/100 1/100 1/50	Two adjacent images CP990-DSCN 9081(2) 9 frames stacked 4 frames stacked 16 frames stacked
T106 T107 T108 T109 T110	2004.09.05 21:34 2004.08.31 17:14 2004.08.31 17:04 2004.08.31 17:27 2004.08.31 17:16		10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/25 1/100 1/100 1/100 1/100	88 frames stacked 16 frames stacked 16 frames stacked 16 frames stacked 16 frames stacked
T111 T112 T113 T114 T115	2004.08.31 16:53 2004.08.31 18:38 2004.08.31 18:54 2004.08.02 17:24 2004.08.02 17:28	15 15 15 16 16	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/100 1/100 1/100 1/100 1/50	16 frames stacked 9 frames stacked 25 frames stacked 12 frames stacked 9 frames stacked
T116, A T117 T118 T119 T120	2004.10.28 ~14:09 2004.08.07 19:04 2004.08.07 21:31 2004.08.07 ~20:36 2005.11.09 ~12:00	22 22	10 in f/6 Royce + 2.5X + ToUcam FS128 + LE24 + CP990 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/100 1/30 1/33 1/25 1/50	Mosaic of 2 video clips CP990-DSCN 9131 (2) 14 frames stacked 50 frames (from 5 video clips) Mosaic of 2 video clips
T121 T122 T123 T124 T125	2005.11.11 ~13:08 2005.05.22 15:44 2006.09.04 14:18 2004.08.02 ~17:53 2005.05.21 ~16:09	12 16	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam Orion 6-in f/8 + 4X + ToUcam	1/25 1/25 1/33 1/50 1/25	Mosaic of 2 video clips 81 frames stacked 130 frames stacked Mosaic of 2 video clips Mosaic of 2 frames
T126 T127 T128 T129 T130	2004.08.31 17:38 2000.05.16 18:25 2004.09.05 21:18 2004.09.05 21:16 004.09.05 ~20:53	21	10-in f/6 Royce + 2.5X + ToUcam FS102 + LE12.5 + CP950 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam	1/100 1/41 1/25 1/25 1/25	16 frames stacked CP950-DSCN 2465 47 frames stacked 64 frames stacked Mosaic of 6 video clips
T131 T132 T133 T134 T135	2004.09.05 ~21:15 2004.09.05 21:23 2004.09.05 21:46 2004.09.05 21:30 2004.09.05 20:46	21 21	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 0-in f/6 + 5X + ToUcam	1/25 1/25 1/25 1/25 1/25	Mosaic of 2 video clips 47 frames stacked 41 frames stacked 68 frames stacked 90 frames stacked
T136 T137 T138 T139 T140	2004.09.05 21:40 2004.09.05 21:26 2004.09.04 ~18:18 2005.01.22 ~15:34 2004.12.17 ~10:04	21 20 12	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam 12.5-in f/6 Royce + 4X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam 10 in f/6 Royce + 2.5X + ToUcam	1/25 1/25 1/25 1/50 1/50	69 frames stacked 87 frames stacked Mosaic of 5 video clips Mosaic of 2 video clips Mosaic of 3 video clips

Image Code	Date / Time (UT)	Moon Age	Equipment Used	Exposure (sec)	Raw Image
T141	2004.09.20 ~12:00	6 days	10 in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 4 video clips
T142	2004.09.20 ~11:17	6	10 in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T143 T144	2004.12.19 ~12:18	7 18	10 in f/6 Royce + 2.5X + ToUcam	1/50 1/25	Mosaic of 4 video clips
T145	2006.08.12 21:43 2004.09.04 ~17:28	20	10-in f/6 + 2.5X + 1.6X + ToUcam 12.5 in f/6 +2.5X + 1.6X + ToUcam		180 frames stacked Mosaic of 4 video clips
T146					•
T146 T147	2004.06.27 14:23 2004.09.25 14:12	10 11	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/33 1/50	2 frames stacked 22 frames stacked
T148	2004.09.25 ~14:44	11	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T149	2005.01.22 ~15:45	12	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 4 video clips
T150	2006.05.09 14:14	12	10-in f/6 Royce + 5X + ToUcam	1/25	190 frames stacked
T151, A	2006.05.10 14:09	13	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	200 frames stacked
T152	2006.05.10 ~15:06	13	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 3 video clips
T153	2004.09.26 14:22	12	10-in f/6 Royce + 2.5X + ToUcam	1/50	34 frames stacked
T154 T155	2005.04.19 13:33 2004.09.26 ~15:36	11 12	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam	1/50 1/33	Mosaic of 3 video clips Mosaic of 2 video clips
					•
T156 T157	2005.05.21 15:16 2004.09.26 ~16:50	13 12	Orion 6-in f/8 + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/33 1/50	68 frames stacked Mosaic of 3 video clips
T158	2006.05.09 13:56	12	10-in f/6 Royce + 5X + ToUcam	1/25	176 frames stacked
T159	2005.04.21 ~14:09	13	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 3 video clips
T160	2004.09.29 ~15:32	15	10-in f/6 Royce + 2.5X + ToUcam	1/100	Mosaic of 3 video clips
T161	2006.05.09 13:50	12	10-in f/6 Royce + 5X + ToUcam	1/25	108 frames stacked
T162	2005.11.11 13:04	9	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	98 frames stacked
T163	2005.11.11 13:12	9	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	99 frames stacked
T164	2004.12.19 ~12:29	7	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T165	2004.10.03 ~21:49	19	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 3 video clips
T166	2004.10.03 21:15	19	10-in f/6 Royce + 2.5X + ToUcam	1/50	10 frames stacked
T167 T168	2005.11.09 ~11:45 2004.10.03 ~21:28	7 19	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50 1/50	Mosaic of 2 video clips Mosaic of 2 video clips
T169	2004.10.03 ~21.26	19	10-in f/6 Royce + 2.5X + ToUcam	1/50	48 frames stacked
T170	2007.10.20 12:57	9	10-in f/6 Royce + 2X + ToUcam	1/25	270 frames stacked
T171	2004.09.20 ~11:06	6	10-in f/6 Royce + 2.5X + ToUcam	1/33	Mosaic of 2 video clips
T172	2004.09.19 11:00	5	10-in f/6 Royce + 2.5X + ToUcam	1/33	60 frames stacked
T173	2004.09.05 20:27	2	10-in f/6 Royce + 5X + ToUcam	1/25	67 frames stacked
T174 T175	2004.05.29 15:19 2006.01.07 ~13:30	10 7	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/33 1/33	18 frames stacked Mosaic of 2 video clips
			•		•
T176 T177	2005.04.23 16:15 2005.11.11 11:49	15 9	10-in f/6 Royce + 2.5X + ToUcam	1/100 1/50	68 frames stacked
T178	2006.02.07 ~11:56	9	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50	68 frames stacked Mosaic of 2 video clips
T179	2005.04.18 ~13:49	10	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T180	2004.12.15 19:13	3	10-in f/6 Royce + 2.5X + ToUcam	1/50	68 frames stacked .
T181, A	2004.11.25 ~16:42	13	10-in f/6 Royce + 2.5X + ToUcam	1/100	Mosaic of 3 video clips
T182	2005.04.22 ~16:09	14	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 3 video clips
T183	2004.11.25 14:52	13	10-in f/6 Royce + 2.5X + ToUcam	1/100	67 frames stacked
T184 T185	2004.11.25 14:50 2004.08.31 19:59	13 15	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/100 1/50	64 frames stacked 25 frames stacked
			-		
T186 T187	2004.12.17 ~10:54 2004.12.17 ~10:43	5 5	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50 1/50	Stack of 4 video clips Mosaic of 3 video clips
T188	2006.03.09 ~14:11	10	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T189	2004.12.19 ~12:13	7	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T190	2004.12.19 ~13:09	7	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 4 video clips
T191	2004.09.04 ~19:08	20	12.5-in f/6 Royce + 4X + ToUcam	1/25	Mosaic of 2 video clips
T192	2004.12.19 ~12:41	7	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 3 video clips
T193	2004.12.17 ~10:14	5	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 3 video clips
T194 T195	2005.01.19 12:18 2005.01.22 ~15:05	9 12	10-in f/6 Royce + 5X + ToUcam 10-in f/6 + 2.5X + 1.6X + ToUcam	1/25 1/25	88 frames stacked Mosaic of a batch of video clips
T196	2004.09.26 16:35	12		1/50	·
T197	2004.09.26 16.35	14	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/100	50 frames stacked Mosaic of 3 video clips
T198	2006.05.09 14:10		10-in f/6 Royce + 5X + ToUcam	1/25	171 frames stacked
T400	2005 04 40 42-20	44	40 in #6 Davis + 0 5V + Tallage	4/50	70 france a stanley d
T199 T200	2005.04.19 13:36 2005.01.22 ~14:06	11 12	10-in f/6 Royce + 2.5X + ToUcam 10-in f/6 Royce + 2.5X + ToUcam	1/50 1/50	78 frames stacked Mosaic of 3 video clips
T201	2005.04.18 ~11:58	10	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
T201	2005.04.18 ~14:44	10	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 3 video clips
T203, A	2005.04.23 ~16:02	15	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 4 video clips
T204, A	2005.04.23 ~15:50	15	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 6 video clips
T205	2005.04.19 ~12:39	11	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 3 video clips
T206, A	2005.04.19 ~12:35	11	10-in f/6 Royce + 5X + ToUcam	1/25	Mosaic of 3 video clips
T207	2005.04.19 13:40	11	10-in f/6 Royce + 2.5X + ToUcam	1/33	78 frames stacked
T208	2005.04.23 ~15:38	15	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 2 video clips
T209 T210	2005.04.22 ~16:25 2005.04.19 12:58	14 11	10-in f/6 + 2.5X + 1.6X + ToUcam 10-in f/6 Royce + 5X + ToUcam	1/25 1/25	Mosaic of 2 video clips 54 frames stacked
·=·*	.2.00	•			

Image Code	Date / Time (UT)	Moon Age	Equipment Used	Exposure (sec)	Raw Image
T211	2006.05.09 13:31	12 days	10-in f/6 Royce + 5X + ToUcam	1/25	198 frames stacked
T212	2005.04.21 14:29	13	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	88 frames stacked
T213	2005.04.22 ~16:32	14	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
T214	2005.04.23 16:08	15	10-in f/6 Royce + 2.5X + ToUcam	1/50	57 frames stacked
T215	2005.05.22 17:17	14	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	88 frames stacked
T216	2005.04.19 ~13:43	11	10-in f/6 Royce + 2.5X + ToUcam	1/33	Mosaic of 3 video clips
T217	2005.04.18 ~13:35		10-in f/6 Royce + 2.5X + ToUcam		Mosaic of 2 video clips
T218	2005.05.22 15:42		10-in f/6 Royce + 5X + ToUcam	1/25	75 frames stacked
T219	2005.04.18 11:53	10	10-in f/6 + 2.5X + 1.6X + ToUcam		67 frames stacked
T220	2005.04.21 13:56		10-in f/6 + 2.5X + 1.6X + ToUcam		65 frames stacked
T221	2005.05.22 15:02	14	10-in f/6 Royce + 5X + ToUcam	1/33	68 frames stacked
T222	2005.05.22 15:42		10-in f/6 Royce + 5X + ToUcam	1/33	75 frames stacked
T223	2007.05.25 ~11:43		10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 2 video clips
T224	2005.05.22 ~14:31		10-in f/6 Rovce + 5X + ToUcam	1/25	Mosaic of 2 video clips
T225	2005.05.22 15:11	14	10-in f/6 Royce + 5X + ToUcam	1/25	85 frames stacked
T226	2005.05.23 14:52	15	10-in f/6 Royce + 2.5X + ToUcam	1/100	68 frames stacked
T227	2005.05.22 15:38		10-in f/6 Royce + 5X + ToUcam	1/25	88 frames stacked
T228	2005.08.22 ~18:56		10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 3 video clips
T229	2005.08.22 19:07		10-in f/6 + 2.5X + 1.6X + ToUcam		93 frames stacked
T230	2005.08.22 19:34		10-in f/6 + 2.5X + 1.6X + ToUcam		88 frames stacked
T231	2005.10.14 14:14		10-in f/6 Royce + 2.5X + ToUcam		97 frames stacked
T232	2006.05.09 14:28		10-in f/6 + 2.5X + 1.6X + ToUcam		180 frames stacked
T232	2006.05.09 14.26			1/25	
			10-in f/6 Royce + 5X + ToUcam		Mosaic of 3 video clips
T234	2004.10.03 21:36		10-in f/6 Royce + 2.5X + ToUcam		68 frames stacked
T235	2005.10.19 16:08		10 in f/6 Royce + 2.5X + ToUcam		92 frames stacked
T236	2004.08.02 18:15		10 in f/6 Royce + 2.5X + ToUcam		10 frames stacked
T237	2004.08.02 18:10		10 in f/6 Royce + 2.5X + ToUcam		11 frames stacked
T238	2005.10.19 ~16:27		10 in f/6 Royce + 2.5X + ToUcam		Mosaic of 2 video clips
T239	2005.10.20 ~17.16		10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 2 video clips
T240	2007.05.29 14:41	13	10-in f/6 + 2.5X + 1.6X + ToUcam	1/50	250 frames stacked
T241	2006.08.12 ~20:49	18	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
T242	2005.10.21 15:37	18	10-in f/6 Royce + 2.5X + ToUcam	1/50	92 frames stacked
T243	2005.11.09 12:35	7	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	400 frames stacked (testing)
T244	2005.11.08 ~12:03	6	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 3 video clips
T245	2005.11.08 ~11:50	6	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
T246	2005.11.09 12:41	7	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	150 frames stacked
T247	2004.10.03 21:00	19	10-in f/6 Royce + 2.5X + ToUcam	1/50	48 frames stacked
T248	2005.11.11 ~12:19	9	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
T249	2005.11.09 11:04	7	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	72 frames stacked
T250	2006.01.07 ~13:08	7	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Mosaic of 2 video clips
T251	2000.05.15 14:02	11	FS102 + LE7.5 + CP950	1/13	CP950-DSCN 2354
T252	2006.02.07 ~12:00	9	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 4 video clips
T253	2006.05.09 ~13:37	12	10-in f/6 Royce + 5X + ToUcam	1/25	Mosaic of 2 video clips
T254	2006.03.09 13:26	10	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	100 frames stacked
T255	2006.03.09 13:48	10	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Stack of 2 video clips
T256	2006.03.09 13:56	10	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	190 frames stacked
T257	2006.03.09 ~14:53	10	10-in f/6 Royce + 2.5X + ToUcam	1/50	Mosaic of 3 video clips
T258	2006.03.09 ~15:30	10	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	Stack of 3 video clips
T259	2006.03.09 14:08	10	10-in f/6 Royce + 2.5X + ToUcam	1/50	200 frames stacked
T260	2006.04.04 ~11:46		10-in f/6 Royce + 2.5X + ToUcam		Mosaic of 2 video clips
T261	2006.05.09 14:02	12	10-in f/6 Royce + 5X + ToUcam	1/25	169 frames stacked
T262	2006.07.02 ~12:40		10-in f/6 Royce + 2.5X + ToUcam		Mosaic of 2 video clips
T263	2006.07.31 ~12:18		10-in f/6 Royce + 2.5X + ToUcam		Mosaic of 2 video clips
T264	2006.08.12 ~20:36	18	10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 6 video clips
T265	2006.08.12 ~21:22		10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 2 video clips
T266	2006.08.12 21:23	18	10-in f/6 + 2.5X + 1.6X + ToUcam	1/25	200 frames stacked
T267	2006.08.12 20:42		10-in f/6 + 2.5X + 1.6X + ToUcam		170 frames stacked
T268	2006.08.12 20:27		10-in f/6 + 2.5X + 1.6X + ToUcam		200 frames stacked
T269	2006.08.12 ~21:30		10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 4 video clips
T270	2006.08.12 ~21:11	18	10-in f/6 + 2.5X + 1.6X + ToUcam		Mosaic of 2 video clips
					•

Data of the Moon

Equatorial diameter 赤道直徑 Polar diameter 極直徑 Angular diameter 角直徑 Axial rotation period 自轉周期

Mass 質量

Mean density 平均密度 Surface gravity 表面引力

Surface Escape velocity 表面脫離速度

Albedo 平均反照率

Apparent magnitude 目視星等

Atmosphere 大氣層

Average thickness of crust 平均地殼厚度 Surface height variation 地形起伏範圍 Surface magnetic field 表面磁場 Surface temperature 表面溫度

Average heat flow through Moon's surface平均表面熱流

Mean distance from Earth 月地平均距 Increase of distance from Earth 月地距離增加率 Distance of Moon at apogee 遠地點距離 Distance of Moon at perigee 近地點距離 Period of revolution of perigee 近地點移行周期

Orbital eccentricity 軌道偏心率 Mean orbital velocity 平均軌道速度 Mean sidereal motion 平均月移行

Inclination of orbit to ecliptic 白道與黃道交角

Inclination of lunar equator to ecliptic 月球赤道與黃道交角 Inclination of lunar equator to orbit 月球赤道與白道交角

Lunar Months (Epoch J2000)

Sidereal month (orbital period) 恒星月 Synodic month (new moon to new moon) 朔望月 Anomalistic month (perigee to perigee) 近點月 Tropical month (equinox to equinox) 分至月 Draconic month (node to node) 交點月 Regression of nodes 交點退行

Earth-Moon System

Earth: Moment of inertia about rotation axis 地球慣性矩 Moon: Moment of inertia about rotation axis 月球慣性矩 Lagrangian points拉格朗日點 Total angular momentum 總角動量

3476 km (0.2725 of Earth's diameter)

2 km less than equatorial

29.4 - 33.5 arcmin (geocentric); 29.8 - 34.1 arcmin (topocentric 地面計) same as sidereal month (1:1 spin-orbit coupling)

7.348 x 10^{22} kg (Earth-Moon mass ratio = 81.30)

3.34 g / cm³ (0.6 of Earth's density)

1.62 m / sec² (1/6 of Earth's gravity), Map B.

2.38 km / sec

maria 0.06 highlands 0.17 mean 0.12

-12.7 at full moon

none, except particles from solar wind and radioactive decay.

approx. 60 km nearside, 90 km farside.

up to about 16 km, Map A.

very weak except few localized anomaly, Map C. approx. 130° C at day to -180° C at night

29 mW / m²

384 401 km (30 times Earth's diameter)

3.8 cm / year

406 700 km (406 712 km on 1984 March 2) 356 400 km (356 375 km on 1912 January 4)

8.849 years (3232 days)

0.0549 (variable 0.026 to 0.077), Note 1.

1.023 km / sec

13.18° / day (moving eastward, variable 12° to 15° / day)

5.14° (oscillating between 4.96° to 5.31° every 173 days), *Note 2*.

1.54⁰

6.68°

27.321662 days

29.530589 days (variable 29.27 to 29.83 days), Note 3.

27.554550 days 27.321582 days 27.212221 days

 19.34° / year (period = 18.61 years), *Note 4*.

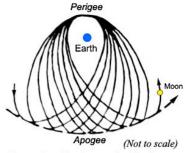
 $0.331 \text{ M}_{e} \text{R}_{e}^{2}$ where M_{e} = Earth's mass & R_{e} = its radius.

0.394 $M_m R_m^2$ where M_m = Moon's mass & R_m = its radius, **Note 5**. Note 6.

3.48 x 10³⁴ kg • m² / sec, *Note 7*.

Libration of the Moon 月球天平動

	Longitudinal 經天平動	Latitudinal 緯天平動
Optical libration 光學天平動	1,25 0 1 250	115 01 23
Displacement (selenocentric) 從月心位移	$\pm 7.88^{0}$	\pm 6.85 $^{\circ}$
Period	approximately on	e sidereal month
Physical libration 物理天平動		
Displacement (selenocentric) 從月心位移	± 66"	± 105"
Period	1 year	6 years
Surface area of Moon visible from Earth	59 % m	naximum



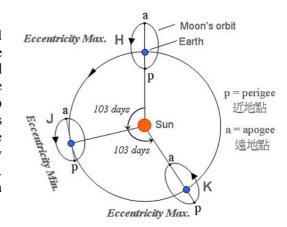
The perigee (and apogee) of the lunar orbit revolves in a period 0f 8.849 years.

Lunar Geologic Timescale 月球地質紀年

Time (10 ⁹ years ago)	Name of Period	Marking events
4.55 - 4.5		impact debris accretion & melting, global magma ocean
4.5 - 3.9	Pre-Nectarian 前酒海紀	cooling & primary differentiation, crust formation
3.9 - 3.85	Nectarian 酒海紀	intense bombardment, impact basins & highland formation
3.85 - 3.2	Imbrian 雨海紀	volcanism, mare basalt formation
3.2 - 1.1	Eratosthenian 愛拉托遜紀	continuing but less intense bombardment
1.1 - present	Copernican 哥白尼紀	continuing crater formation, regolith

Note 1:

According to Jean Meeus (the author of Mathematical Astronomy Morsels), the instantaneous eccentricity of the Moon's orbit can vary between the extremes 0.026 and 0.077. Eccentricity maximum occurs at position **H** of the attached diagram, where the apogee and perigee line up towards the Sun. Eccentricity minimum occurs 103 days later at position **J**, where the apogee-perigee line are perpendicular to the Sun-Earth line. A new eccentricity maximum is reached again after 103 days at position **K**. Overall the apogee and perigee lines up towards the Sun every 206 days or 7 synodic months.



Note 2:

Because the ecliptic inclines at 23.44^{0} to the celestial equator, the declination of the Moon shall vary up to $23.44^{0} + 5.31^{0} = 28.75^{0}$ north or south of the celestial equator, e.g. the Moon's declination exceeded 28^{0} N on 2007 March 25; 28^{0} S on April 8; 28^{0} N again on April 21.

Note 3:

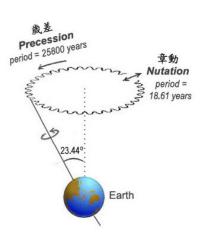
The mean value of synodic month is calculated from

1 / synodic month = 1 / sidereal month - 1 / sidereal year

i.e. 1/29.530589 days = 1/27.321662 days -1/365.256363 days

Note 4:

The positions of the Moon and Sun relative to the Earth are continuously changing. They cause an irregular tidal pull on the Earth's equatorial bulge, and hence a slight periodic oscillation of the Earth's pole superimposed on the precession circle. This slight oscillation, called *Nutation*, has a main amplitude of \pm 9 arcseconds and a period equal to the regression of the Moon's nodes (18.61 years).



Note 5:

The Moon's moment of inertia is slightly below the theoretical value (0.4 MR²) of a homogeneous sphere. It implies that the Moon's interior is not uniform and might contain a small core of denser material.

Note 6:

The Lagrangian points refer to 5 points L₁ L₂ L₃ L₄ and L₅ on the orbital plane of the Earth-Moon System. L₁ L₂ and L₃ are points of quasi-equilibrium. That is, a small perturbation will cause an object in these points to drift away. The L₄ and L₅ are points of stable equilibrium.

O = center of mass in Earth-Moon system

= 4,700 km from center of Earth (1/82 of Earth-Moon distance)

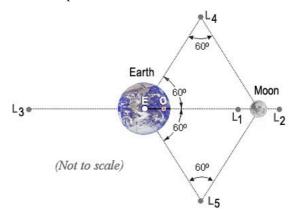
 $L_1 = 61,500 \text{ km}$ from center of Moon

 $L_2 = 61,500 \text{ km}$ from center of Moon (16% of Earth-Moon distance)

 $L_3 = 384,400$ km from center of Earth

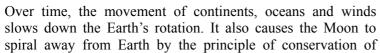
 $L_4 = 384,400$ km from center of Earth

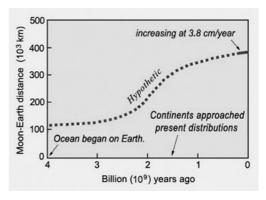
 $L_5 = 384,400$ km from center of Earth (same as Earth-Moon distance)



Note 7:

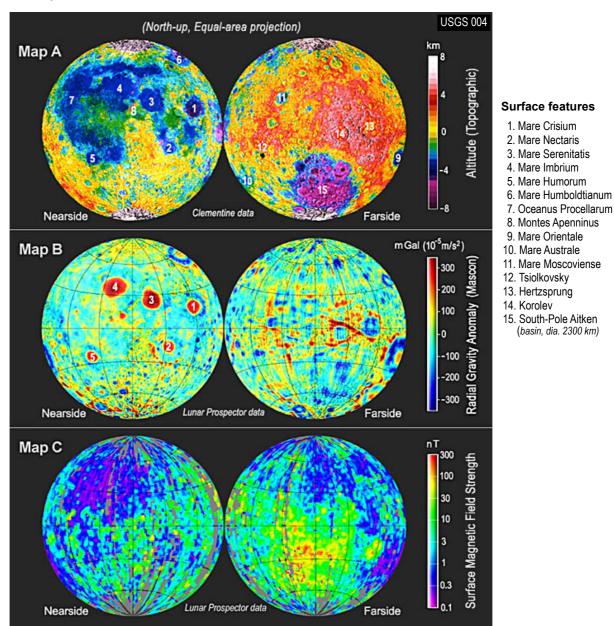
The total angular momentum is virtually equal to the sum of the angular momentum of the Moon in its orbit around Earth (2.89 x 10^{34} kg • m²/s) and the angular momentum of the Earth about its own rotation axis (0.59 x 10^{34} kg • m²/s). This value is anomalously high compared with that of Mars, Venus or the Earth alone, but is plausible by referring to the giant impact theory of the Moon's origin.





angular momentum. The curve at right hypothesizes the change of lunar distance in the past. It is hypothetic because the past distribution of land and sea is not ascertained. Today the Moon is receding from Earth at average rate of 3.8 cm/year, a result obtained by laser ranging since the Apollo missions.

Global Maps:



Glossary

Abundance of Elements 元素豐度 The relative amount of each element in a given object such as a star, planet or satellite.

Accretion 吸積 The increase of mass of a body by the accumulation of smaller objects that collide and stick to it.

Age of the Moon 月齡 The period that has elapsed since the last new moon. It starts at "zero" day (exact new moon).

Albedo 反照率 Fraction of sunlight reflected from a planetary surface. The albedo of lunar maria are 5-10 %; highlands are 12-18 %.

Angular Momentum 角動量 A property of any rotating or revolving body. Its value depends on the distribution of the body's mass and velocity about the axis of rotation or revolution. The total angular momentum is constant in a closed system.

Anorthosite 斜長岩 Light-colored rock from lunar highlands or beneath mare basalts, rich in silicon, calcium and aluminum.

Apogee 遠地點 The farthest point on the Moon's orbit from the Earth.

Apollo Missions 阿波羅登月任務 The American NASA (National Aeronautics and Space Administration) program to land humans on the Moon. The first manned landing is Apollo 11 (1969 July 20), and the last is Apollo 17 (1972 December 11). Apollo 13 (1970 April) aborted in the third day of the mission. A total of 12 Apollo astronauts landed on the Moon.

Basalt 玄武岩 Dark-colored rock formed from solidified lava. See also Mare Basalt.

Breccia 角礫岩 On the Moon, it refers to the rock of 2 or more types cemented together by heat or pressure (e.g. meteorite impacts).

Caldera 火山口 A type of volcanic crater formed primarily by a sinking of its floor rather than by the ejection of lava.

Catena 環形山串 Latin for chain of relatively small craters (plural: catenae).

Center of Mass 質心 The point in a system of bodies (e.g. Earth-Moon) which acts as if all the mass were concentrated there.

Colongitude 餘經度 A measure of the Sun's relative position. On the Moon, it is same as the selenographic longitude of the morning terminator, measured westwards from the prime meridian. Thus its value is 0^0 at first quarter, 90^0 at full moon, 180^0 at last quarter & 270^0 at new moon.

Crater 環形山 A generic term for circular depression on surface, typically a ring mountain or a walled plain which has relatively large and flat floor. Craters are of either impact or volcanic origin.

Crescent 娥眉月 The phase of the Moon when it is less than half illuminated as seen from the Earth.

Crust 地殼 The outermost solid layer of a planet or satellite.

Dark Mantle Deposit 黑地幔澱積物 Remarkably dark deposit on the Moon's surface. It contains a mixture of small black and orange glass debris, possibly formed from quickly cooled droplets during fountain-like volcanic eruption.

Differentiation 分化作用 The formation of variety of rock types and layers (crust, mantle etc.) from an initial single parental magma. Diurnal 周日的 Happening daily.

Dome 拱形小山 / 拱丘 Low rounded elevation formed by volcanism, typically 5 to 20 km in diameter and slope under 50.

Dorsum 皺脊 (plural: dorsa) Latin for wrinkle ridge. Long narrow rising feature on the mare floor, resulted from surface shrinkage following the cease of volcanism, or buckling of the lunar crust due to the weight of accumulated lava in the impact site.

Earthshine 地照 / 地球照 The faint illumination on the dark side of a crescent, caused by sunlight reflected from the Earth.

Ejecta 噴出物 Material thrown out from an explosive event, such as a crater-forming impact or volcanic eruption.

Ejecta Blanket 噴出覆蓋物 The area immediately outside the rim of an impact crater where the ejecta has completely covered the underlying terrain.

Farside of the Moon 月背面 The side of the Moon facing away from the Earth.

Fault 斷層 A fracture of surface along which there has been slippage, either vertical or horizontal.

First Quarter 上弦 The phase of the Moon that occurs midway between new and full moon, when half of the Moon is illuminated. At first quarter, the Moon has moved 1/4 of its orbit around the Earth and lies 90° east of the Sun.

Full Moon 滿月 / 望 The phase of the Moon when it is fully illuminated and 1800 away from the Sun, as seen from the Earth.

Ghost Crater 假環形山 The bare hint of a crater formation that has been destroyed or heavily modified by some later action.

Giant Impact Theory 大碰撞論 A popular theory (hypothesis) for the origin of the Moon from impact debris when a Mars-sized proto-planet collided with the proto-Earth in about 4.5 billion years ago, developed after the Apollo missions.

Graben 地塹 Sunken area between faults.

Harvest Moon 穫月 The full moon closest to the autumnal equinox when it rises at minimum delay time in successive days.

Highlands 高地 Raised areas on the Moon, light-colored, heavily cratered and chemically distinct from the maria.

IAU 國際天文聯合會 International Astronomical Union, an assembly to govern the world of astronomy, founded in 1919.

Igneous 火成的 Referring to processes that involve the formation and solidification of hot, molten magma or lava.

Illumination 照度 A measure of moon phase, equal to the ratio of illuminated area to the total area of the Moon disc. New moon gives illumination = 0 %, full moon gives 100 %.

Impact Basin 隕擊盆地 A vast depressed surface (size larger than about 300 km) caused by colossal impactors. Quite often it is encircled by multiple mountain rings. A typical example is the farside basin that holds Mare Orientale.

Isotopes 同位素 Atoms of the same element having same number of protons but different numbers of neutrons in their nuclei.

KREEP 克里普岩 A special type of rock concentrated in Oceanus Procellarum and Mare Imbrium. It is relatively rich in potassium (symbol K), rare-earth elements (REE), phosphorus (P) as well as other radioactive elements such as thorium and uranium.

Lacus 湖 Latin for lake. A "small version" of lunar mare.

Laser Ranging 激光測距 Establishment of precise Earth-Moon distances by aiming and reflecting laser beams between them.

Last Quarter 下弦 The phase of the Moon that occurs midway between full and new moon, when half of the Moon is illuminated. At last quarter, the Moon has moved 3/4 of its orbit around the Earth and lies 90^0 west of the Sun.

Late Heavy Bombardment 後期猛烈碰撞 The event that postulates the Moon was heavily bombarded around 3.9 billion years ago. **Lava** 溶岩 Molten rock that reaches the surface during a volcanic eruption. See also **Magma**.

Libration 天平動 The apparent vertical or horizontal rocking motions of the Moon as it orbits around the Earth. The amount of libration is measured by the shift of longitude and latitude at the center of the Moon disc.

LTP 月面暫變現象 Abbreviation for "Lunar Transient Phenomena" or "Transient Lunar Phenomena". A controversial observed phenomena of weird happenings or changes on the Moon's surface. It only lasts for a short while.

Lunation (**Synodic Month**) 朔望月 The period of time taken for the Moon to go through a complete cycle of phases.

Magma 岩漿 Subsurface molten rock. When it reaches the surface during a volcanic eruption, it is called lava 溶岩.

Mantle 幔 / 地幔 The thicker layer in the interior of a planet or satellite, underneath the crust but overlying the core, and differing in composition from both.

Mare 海 / 月海 Latin for sea (plural: maria). The broad dark plain formed from ancient lava outflow from the Moon's interior.

Mare Basalt 月海玄武岩 Dark rock on lunar maria, enriched by heavy metals like iron and titanium. Few samples of mare basalt from the Apollo missions are vesicular; they suggest that trapped gases escaped from the rocks during mare formation.

Mascon 質量瘤 / 重力異常區 Abbreviated from the term "mass concentration". An area on the Moon composed of relatively denser material, as evidenced by an increased gravitational pull on orbiting spacecraft.

Meteoroid 流星體 Small low-mass interplanetary debris. A meteoroid that hits the Earth's or lunar surface is called Meteorite 隕石.

Mineral 礦物 Inorganic solid with a definite composition and crystal structure formed through geologic processes. Chemically it is a bonding of silicates (silicon + oxygen) with composites of calcium, aluminum and/or magnesium etc. Minerals are classified according to their chemical compositions. They are the basic components of rock.

Moment of Inertia 慣性矩 A measure of a body's ability to resist changes in its angular velocity about a given axis. The Moon's moment of inertia is slightly less than that of a homogeneous sphere, so the Moon might have a small dense core.

Mons 山 Latin for mountain. A group of isolated mountains or mountain ranges are Latinized as Montes 山脈.

Moonquake 月震 Sudden trembling of the Moon caused by the abrupt release of internal energy, meteorite impacts or landslides.

Nearside of the Moon 月正面 The side of the Moon facing the Earth.

New Moon 新月 / 朔 The phase of the Moon when it is directly between the Earth and the Sun.

Occultation 掩 The movement of one celestial object (e.g. a star) behind another (e.g. the Moon).

Oceanus 洋 Latin for ocean. The "large version" of lunar mare. Oceanus Procellarum is the only feature so named.

Palus 沼 Latin for marsh or swamp. A "small version" of lunar mare.

Penumbra 半影 The less dark outer region of the shadow of the Earth.

Perigee 近地點 The nearest point on the Moon's orbit from the Earth.

Phase 月相 Illuminated portion of the Moon disc. There are four specific phases: new moon, first quarter, full moon and last quarter.

Promontorium 岬 / 海角 Latin for promontory or cape.

Radiometric Dating 放射性同位素計年 Age-determination of rocks by comparing the decay of radioactive elements such as the isotopes of potassium (40 K), rubidium (87 Rb) and uranium (235 U) embedded in the samples.

Rays, Lunar 月面輻射紋 Streaks (normally bright) radiating from certain impact craters of the Moon.

Regolith 浮土 / 表層層 From the Greek for "blanket of stone". A layer of loose and broken rock and dust on the crust of a planet or satellite. The lunar regolith 月壤 contains a small amount of tiny, black glass beads produced by micrometeoroid impacts.

Remote Sensing 遙感 Gathering of information without actual physical contact with what is being observed.

Rima 溪 / 月溪 / 溝紋 Latin for rille (plural: rimae). A narrow and relatively long cleft, slumped channel or valley on the surface of the Moon, caused by ancient running lava or slight pulling of ground to either side.

Ritcher Scale 黎克特地震等級 A scale to determine the magnitude of earthquake (and moonquake). Each whole number increase in scale magnitude represents 31.6 times more energy release than the preceding magnitude. Thus magnitude 8.0 releases 1000 times more energy than magnitude 6.0. Magnitudes below about 2.0 are generally not noticed by human.

Roche Limit 洛希極限 The minimum distance from a planet's center at which a satellite will not be disrupted by the planet's tidal force. Its theoretical value is 2.46 times the radius of the planet (16,000 km from the center of Earth).

Rock 岩 A solid mass on the crust of a planet or satellite, largely composed of silicates (composites of silicon and oxygen) while the rest may be one or more types of other minerals.

Rupes 懸崖 / 峭壁 / 斷層 Latin for scarp, cliff or fault.

Saros 沙羅周期 A cycle of nearly identical lunar or solar eclipses that recur every 223 lunations (6585.32 days or 18.03 years).

Secondary Craters 次級環形山 / 次級隕擊坑 Impact craters produced by the ejecta of a large impact-crater.

Seeing 視寧度 A measure of the steadiness of air through which a celestial object is observed.

Seismometry 地震測量 Measurement of seismic waves, such as those produced by earthquakes or moonquakes.

Selenographic 月面的 Belonging or relating to the surface of the Moon. "Selene" is the Greek goddess of the Moon.

Shield Volcano 盾形火山 Volcano that appears in gently sloping cone, constructed of solidified lava flows.

Shock Wave 激波 An abrupt ripple of compression across a medium, due to a fast object hitting on or moving through the medium.

Sinus 🍍 Latin for bay. A "small version" of lunar mare, usually in the appearance of a bay but can be irregular in shape.

Tectonics 地殼構造作用 Large-scale movements of the crust of a planet or satellite, such as land rising to form a mountain.

Terminator 明暗界線 The boundary on the Moon between day and night, or between light and shadow. At the morning terminator, the Sun is rising over that part of the Moon; at the evening terminator, the Sun is setting.

Terraced Wall 台地牆 The inner wall (of a lunar crater) that appears in terrace structure.

Terrain 地體 / 地勢 A generic term referring to any surface area with a distinctive geological character.

Tidal Force 引潮力/起潮力 The ability of a celestial body A to raise tides on another body B. It is quantified by the difference of gravitational forces experienced by B between its surface and center, and is inversely proportional to the cube of the distance between the two bodies. The lunar tidal force acting on Earth is 2.2 times greater than the Sun's tidal force.

Umbra 本影 The darker core of the shadow of the Earth, typically cone shaped, and surrounded by a lighter penumbra shadow. Within the umbra, the Moon is completely obscured from direct sunlight; a **total lunar eclipse** will be seen on Earth.

UT 世界時 Abbreviation for "Universal Time". For time conversion, UT = Hong Kong Standard Time - 8 hours.

Volatile 揮發的 Easy to vaporize. Volatile substances have low boiling points, e.g. water, hydrogen, nitrogen, methane, ammonia, CO2.

Vallis 谷 / 月谷 / 槽 Latin for lunar valley that appears as a broad trough of volcanic origin or a chain of overlapping craters.

Viscosity 粘度 Resistance to flow. The lunar lava is believed less viscous than the terrestrial and hence can flow in long distance.

Volcanism 火山作用 Any process to transfer molten material and gases in the interior of a planet or satellite to its surface.

Wrinkle Ridge 皺脊 Sometimes called mare ridges because they are found usually in mare floors. See also Dorsum.

References

Atlas & Maps

- 1. Atlas of the Moon, Antonín Rükl, 1996, Kalmbach Books.
- 2. The Hatfield Photographic Lunar Atlas, Jeremy Cook, 1998, Springer.
- 3. Zdeněk Kopal, A New Photographic Atlas of the Moon, 1971, Taplinger Publishing Company.
- 4. Lunar & Planetary Institute Resources
 - Images from Ranger, Lunar Orbiter, Apollo, Consolidated Lunar Atlas http://www.lpi.usra.edu/resources/
- 5. Nomenclature and Topography Maps (Moon) http://planetarynames.wr.usgs.gov/
- 6. Clementine Images http://www.cmf.nrl.navy.mil/clementine/
- 7. Google Moon http://www.google.com/moon/

Observation Guides

- 8. Patrick Moore on the Moon, Patrick Moore, 2001, Cassell & Co.
- 9. Observing the Moon, Gerald North, 2000 edition, Cambridge University Press.
- 10. Exploring the Moon through Binoculars and Small Telescopes, E. H. Cherrington, Jr., 1984, Dover Inc.
- 11. Pictorial Guide to the Moon, Dinsmore Alter, 3rd edition, Thomas Y. Crowell Company.

Software Tools

- 12. WinJupos http://www.grischa-hahn.homepage.t-online.de/astro/winjupos/ (Moon ephemerides)
- 13. Virtual Moon Atlas http://www.astrosurf.com/avl/UK download.html
- 14. The Sky Astronomy Software, Software Bisque. (Moon orbital simulation)

Lunar Science & Geology

- 15. Geologic History of the Moon, Don Wilhelms http://cps.earth.northwestern.edu/GHM/
- 16. Geology of the Moon: A Stratigraphic View, Thomas A. Mutch, 1970, Princeton University Press.
- 17. The Modern Moon: A Personal View, Charles A. Wood, 2003, Sky Publishing Corporation.
- 18. The Once and Future Moon, P. D. Spudis, 1996, Smithsonian Institution Press.
- 19. The Moon (a concise paper by S. R. Taylor), Encyclopedia of the Solar System, second edition.
- 20. Introduction to Lunar Science (Chinese text), China Astronautic Publishing House, ISBN 7-80218-001-5
- 21. Planetary Science Research Discovery http://www.psrd.hawaii.edu/
- 22. USGS Planetary GIS Web Server http://astrogeology.usgs.gov/Projects/webgis/
- 23. Remote Sensing Tutorial http://rst.gsfc.nasa.gov/Front/tofc.html (Section 18 & 19)

General Interest

- 24. The Moon Book, Kim Long, 1998, Johnson Books.
- 25. Astronomy For Entertainment, Y. Perelman, translated by A. Shkarovsky, 1958, Moscow, (Chapter 2)
- 26. Epic Moon, William P. Sheehan & Thomas A. Dobbins, 2001, Willmann-Bell, Inc.
- 27. The New Solar System, 4-th edition, Sky Publishing Corp. and Cambridge University Press. (Chapter 6, 10)
- 28. Lunar Notebook, Charles A. Wood, Sky & Telescope magazine, issues since May 2000.

Handbooks

- 29. The Planetary Scientist's Companion, K. Lodders & Bruce Fegley, Jr., 1998, Oxford University Press.
- 30. Mathematical Astronomy Morsels, Jean Meeus, 2000, Willmann-Bell, Inc. (Chapter 1 6)
- 31. Allen's Astrophysical Quantities, Arthur N. Cox, 4-th edition, AIP Press. (Chapter 12)

Other Web Resources

- 32. Apollo Over the Moon http://www.hq.nasa.gov/office/pao/History/SP-362/contents.htm
- 33. Lunar Science Results http://www.lpi.usra.edu/expmoon/science/science-index.html
- 34. Giant Impact Hypothesis: Strengths & Weaknesses http://en.wikipedia.org/wiki/Giant impact hypothesis
- 35. Moondust http://science.nasa.gov/headlines/y2006/28dec truefake.htm
- 36. Charles Wood's Moon & LPOD http://www.lpod.org/
- 37. An Amateur's Moon, Alexander Vandenbohede http://users.pandora.be/lunarsite/
- 38. Lunar Transient Phenomena (LTP) http://www.ltpresearch.org/nav.htm

Nearside

Crater	Long.	Lat.	Dia	ı. (+Longi	tude =	= East		- Longitude	= West	t	+La	titude = North	-	- Latitu	ıde :	= South	Diamete	rinkm	1)
Abbot	54.8	5.6		Beketov	29.2	16.3	8		15.1	4.0		Eichstadt	-78.3	-22.6	49	Hahn	73.6	31.3	84
Abel	87.3	-34.5		Béla Ballanniah	2.3	24.7	11	Celsius	20.1	-34.1	36 3	Eimmart	64.8	24.0	46	Haidinger	-25.0	-39.2	22
Abenezra Abetti	11.9 27.8	-21.0 20.1	1.5	Bel'kovich Bellot	90.2 48.2	61.1	214 17	Censorinus Cepheus	32.7 45.8	-0.4 40.8	د 39	Einstein Elger	-88.7 -29.8	16.3 -35.3	198 21	Hainzel Haldane	-33.5 84.1	-41.3 -1.7	70 37
Abulfeda	13.9	-13.8	65	1000 CONTRACTOR	60.7	35.0	47	Chacomac	31.7	29.8	51	Elmer	84.1	-10.1	16	Hale	90.8	-74.2	83
Acosta	60.1	-5.6	13		69.9	33.5	74	Challis	9.2	79.5	55	Encke	-36.6	4.6	28	Hall	37.0	33.7	35
Adams Agatharchides	68.2 -30.9	-31.9 -19.8	66 48		50.9 -37.3	36.6 14.9	50 10	Chang-Ngo Charles	-2.1 -26.4	-12.7 29.9	3	Endymion Epigenes	57.0 -4.6	53.9 67.5	123 55	Halley Hamilton	5.7 84.7	-8.0 -42.8	36 57
Agrippa	10.5	4.1	44	100000	17.9	21.8	15	Chevallier	51.2	44.9	52		-30.2	40.9	27	Hanno	71.2	-56.3	56
Airy		-18.1		Bettinus	-44.8	-63.4	71	Ching-Te	30.0	20.0	4	Eratosthenes	-11.3	14.5	58	Hansen	72.5	14.0	39
Akis	-31.8	20.0 -10.9	2	Bianchini	-34.3 51.3	48.7 -54.9	38 76	Chladni	1.1	4.0	13	Esclangon Euclides	42.1 -29.5	21.5 -7.4	15	Hansteen	-52.0 -71.7	-11.5 43.5	44 22
Alan Al-Bakri	-6.1 20.2	14.3	12	Biela Bilharz	56.3	-5.8	43	Cichus Clairaut	-21.1 13.9	-33.3 -47.7	40 75	Euchen	31.3	76.4	11 62	Harding Hargreaves	-/1./ 64.0	-2.2	16
Albategnius		-11.7	114		-50.1	-13.8	45	Clausius	-43.8	-36.9	24	Eudoxus	16.3	44.3	67	Harlan	79.5	-38.5	65
Aldrin	22.1	1.4	3	Biot	51.1	-22.6	12	Clavius	-14.1	-58.8	245	Euler	-29.2	23.3	27	Harold	-6.0	-10.9	2
Alexander Alfraganus	13.5 19.0	40.3 -5.4	81 20		-10.5 -8.5	65.1 -22.4	92 16	Cleomedes Cleostratus	56.0 -77.0	27.7 60.4	125 62	Fabbroni Fabricius	29.2 42.0	18.7 -42.9	10 78	Harpalus Hartwig	-43.4 -80.5	52.6 -6.1	39 79
Alhazen	71.8	15.9	32		80.4	-9.2	18	Clerke	29.8	21.7	6	Fahrenheit	61.7	13.1	6	Hase	62.5	-29.4	83
Aliacensis	5.2	-30.6	79		1.5	1.3	5	Collins	23.7	1.3	_2	Faraday	8.7	42.4	69	Hausen	-88.1	-65.0	167
Almanon Al-Marrakushi	15.2 55.8	-16.8 -10.4	49 8	Contract Con	-21.4 2.5	-63.8 -25.4	117 61	Colombo Condon	45.8 60.4	-15.1 1.9	76 34	Faustini Fauth	77.0 -20.1	-87.3 6.3	39 12	Hayn Hecataeus	85.2 79.4	64.7 -21.8	87 167
Aloha	-53.9	29.8	3		-13.5	53.0	20	Condorcet	69.6	12.1	74	Faye	3.9	-21.4	36	Hédervári	84.0	-81.8	69
Alpetragius	4.5	-16.0	39		15.5	19.6	6	Conon	2.0	21.6	21	Fedorov	-37.0	28.2	6	Hedin	-76.5	2.0	150
Alphonsus		-13.7 3.3	108		-2.4	6.7 5.6	18	Cook	48.9	-17.5	46 93	Felix Fermat	-25.4	25.1 -22.6	1	Heinrich	-15.3	24.8	6
Ameghino Ammonius	57.0 -0.8	-8.5	8	Boethius Boguslawsky	72.3 43.2	-72.9	10 97	Copernicus Courtney	-20.1 -30.8	9.7 25.1	93 1	Fernelius	19.8 4.9	-38.1	38 65	Heinsius Heis	-17.7 -31.9	-39.5 32.4	64 14
Amontons	46.8	-5.3	2	Bohnenberger	40.0	-16.2	33	Cremona	-90.6	67.5	85	Feuillée	-9.4	27.4	9	Helicon	-23.1	40.4	24
Amundsen	85.6	-84.3	101	4814672	-86.6	12.4	71	Crile	46.0	14.2	9	Finsch	21.3	23.6	4	Hell	-7.8	-32.4	33
Anaxa goras Anaximander	-10.1 -51.3	73.4 66.9	50 67	Boltzmann Bombelli	-90.7 56.2	-74.9 5.3	76 10	Crozier Crüger	50.8 -66.8	-13.5 -16.7	22 45	Firmicus Flammarion	63.4 -3.7	7.3 -3.4	56 74	Helmert Helmholtz	87.6 64.1	-7.6 -68.1	26 94
Anaximenes	44.5	72.5	80		-17.4	-8.3	60	Curie	91.0	-22.9	151	Flamsteed	-44.3	4.5	20	Henry	-56.8	-24.0	41
Anděl	12.4	-10.4	35		-87.4	63.7	63	Curtis	56.6	14.6	2	Fontana	-56.6	-16.1	31	Henry Frères	-58.9	-23.5	42
Ango	-32.3	20.5	1	Borda	46.6	-25.1	44	Curtius	4.4	-67.2	95	Fontenelle	-18.9	63.4	38	Heraclitus	6.2	-49.2	90
Angström Ann	-41.6 -0.1	29.9 25.1	9 3	455 F C 175 F	26.4 -33.5	22.3 30.6	1	Cusanus Cuvier	70.8 9.9	72.0 -50.3	63 75	Foucault Fourier	-39.7 -53.0	50.4 -30.3	23 51	Hercules Herigonius	39.1 -33.9	46.7 -13.3	69 15
Annegrit	-25.6	29.4	1	Born	66.8	-6.0	14	Cyrillus		-13.2	98	Fra Mauro	-17.0	-6.1	101	Hermann	-57.0	-0.9	15
Ansganus	79.7	-12.7	94	Boscovich	11.1	9.8	46	Cysatus	-6.1	-66.2	48	Fracastorius	33.2	-21.5	112	Hermite	-89.9	86.0	104
Anville Apianus	49.5 7.9	1.9 -26.9	10 63		89.2 -35.8	45.8 52.3	47 22	da Vinci Dag	45.0 5.3	9.1 18.7	37	Franck Franklin	35.5 47.7	22.6 38.8	12 56	Herodotus Herschel	-49.7 -2.1	23.2 -5.7	34 40
Apollonius	61.1	4.5	53		54.6	-70.2	142	Daguerre Daguerre	33.6	-11.9	46	Franz	40.2	16.6	25	Hesiodus	-16.3	-29.4	42
Arago	21.4	6.2	26		9.1	17.6	8	Dale	82.9	-9.6	22	Fraunhofer	59.1	-39.5	56	Hevelius	-67.6	2.2	115
Aratus	4.5	23.6 29.7	10		23.6 -36.9	17.9 20.9	8	Dalton	-84.3	17.1 5.7	60 17	Fredholm	46.5 -52.3	18.4 25.8	14	Hill Hind	40.8	20.9 -7.9	16 29
Archimedes Archytas	-4.0 5.0	58.7	82 31		18.3	48.2	14 49	Daly Damoiseau	59.6 -61.1	4.8	36	Freud Fumerius	60.6	-36.0	135	Hind Hippalus	7.4 -30.2	-7.9	57
Argelander	5.8	-16.5	34		39.3	-39.0	97	Daniell	31.1	35.3	29	G. Bond	36.2	32.4	20	Hipparchus	5.2	-5.1	138
Ariadaeus	17.3	4.6	11		34.7	23.3	10		-23.5	-14.5	15	Galen Cattanai	5.0	21.9	10	Holden	62.5	-19.1	47
Aristarchus Aristillus	47.4 1.2	23.7 33.9	40 55		-86.2 -69.1	75.0 26.5	134 37	d'Arrest Darwin	14.7 -69.5	2.3 -20.2	30 120	Galila ei Galle	-62.7 22.3	10.5 55.9	15 21	Hommel Hooke	33.8 54.9	-54.7 41.2	126 36
Aristoteles	17.4	50.2	87	Brisbane	68.5	49.1	44	Daubrée	14.7	15.7	14	Galvani	-84.6	49.6	80	Hornsby	12.5	23.8	3
Armstrong	25.0	1.4	4	Brown	-17.9	46.4	34	Davy		-11.8	34	Gambart	-15.2	1.0	25	Horrebow	40.8	58.7	24
Arnold Artemis	35.9 -25.4	66.8 25.0	94 2		0.4 90.9	1.1 -9.9	6 53	Dawes de Gasparis	26.4 -50.7	17.2 -25.9	18 30	Gardner Gärtner	33.8 34.6	17.7 59.1	18	Horrocks Hortensius	5.9 -28.0	-4.0 6.5	30 14
Artsimovich	-36.6	27.6	8	Buch	17.7	-38.8	53	de Gerlache	-87.1	-88.5	32	Gassendi	-40.1	-17.6	101	Houtermans	87.2	-9.4	29
Aryabhata	35.1	6.2	22		-22.2	-20.7	60	de La Rue	52.3	59.1	134	Gaston	-34.0	30.9	2	Hubble	86.9	22.1	80
Arzachel Asada	-1.9 49.9	-18.2 7.3	96 12		-85.3 56.5	41.4 31.1	52 56	de Morgan de Sitter	14.9 39.6	3.3 80.1	10 64	Gaudibert Gauricus	37.8 -12.6	-10.9 -33.8	34 79	Huggins Humason	-1.4 -56.6	-41.1 30.7	65 4
Asclepi	25.4	-55.1	42		28.2	45.0	39	de Vico	-60.2	-19.7	20	Gauss	79.0	35.7	177	Humboldt	80.9	-27.0	189
Aston	-87.7	32.9	43	Burnham	7.3	-13.9	24	Debes	51.7	29.5	30	Gay-Lussac	-20.8	13.9	26	Hume	90.4	-4.7	23
Atlas Atwood	44.4 57.7	46.7 -5.8	87 29	Büsching Byrd	20.0 9.8	-38.0 85.3	52 93	Dechen Delambre	-68.2 17.5	46.1 -1.9	12 51	Geber Geissler	13.9 76.5	-19.4 -2.6	44 16		4.5 6.3	20.2 7.8	4 9
Autolycus	1.5	30.7		Byrgius	-65.3	-24.7	87	Delaunay		-22.2	46	Geminus	56.7	34.5	85	Hyginus Hypatia	22.6	-4.3	40
Auwers	17.2	15.1	20	C. Herschel	-31.2	34.5	13	Delia	-6.1	-10.9	2	Gemma Frisius	13.3	-34.2	87	Ian	-0.4	25.7	1
Auzout	64.1	10.3	32 9	C. Mayer Cabeus	17.3	63.2		Delisle	-34.6	29.9	25	Gerard	-80.0	44.5 -18.4	90 76	Ibn Battuta	50.4	-6.9	11
Avery Azophi	81.4 12.7	-1.4 -22.1	47	Cajal Cajal	-35.5 31.1	-84.9 12.6	90	Delmotte Deluc	60.2 -2.8	27.1 -55.0	32 46	Gibbs Gilbert	76.0	-10.4	112	Ibn-Rushd Ideler	21.7 22.3	-11.7 -49.2	32 38
Baade		-44.8	55	Calippus	10.7	38.9	32	Dembowski	7.2	2.9	26	Gill	75.9	-63.9	66	Ina	5.3	18.6	3
Babbage	-57.1	59.7	143		45.9	6.2		Democritus	35.0	62.3	39	Gioja	2.0	83.3	41	Inghirami	-68.8	-47.5	91
Back Baco	80.7 19.1	1.1 -51.0	35 69	Campanus Cannon	-27.8 81.4	-28.0 19.9		Demonax Desargues	-73.3	-77.9 70.2	128 85	Glaisher Glushko	49.5 -77.6	13.2 8.4	15 43	Isabel Isidorus	-34.1 33.5	28.2 -8.0	1 42
Baillaud	37.5	74.6	89	Capella	35.0	-7.5		Descartes		-11.7	48	Godenius	45.0	-10.0	72	Isis	27.5	18.9	1
Bailly	-69.1	-66.5	287	Capuanus	-26.7	-34.1	59	Deseilligny	20.6	21.1	6	Goddard	89.0	14.8	89	Ivan	43.3	26.9	4
Baily Balboa	30.4 -83.2	49.7 19.1	26 69	Cardanus Carlini	-72.5 -24.1	13.2 33.7		Deslandres Diana	-4.8 35.7	-33.1 14.3	256	Godin Goldschmidt	10.2 -3.8	1.8 73.2	34 113	J. Herschel Jacobi	42.0 11.4	62.0 -56.7	165 68
Ball		-35.9	41	Carlos	2.3	24.9	4	Dionysius	17.3	2.8	18	Golgi	-60.0	27.8	5	Jansen	28.7	13.5	23
Balmer		-20.3	138		40.4	19.6	20	Diophantus	-34.3	27.6	17	Goodacre		-32.7	46	Jansky	89.5	8.5	72
Banachiewicz Bancroft	80.1 -6.4	5.2 28.0	92 13		-50.9 26.7	69.4 10.7	59	Dollond Donati		-10.4 -20.7	11 36	Gould Grace	-17.2 35.9	-19.2 14.2	34	Janssen Jehan	40.3 -31.9	-45.4 20.7	199 5
Banting	16.4	26.6	5	Carrillo	80.9	-2.2		Donna	38.3	7.2	2	Graff	-88.6	42.4	36		78.1	0.3	38
Barkla	67.2	-10.7	42	Carrington	62.1	44.0	30	Doppelmayer	-41.4	-28.5	63	Greaves	52.7	13.2	13	Jenik	27.6	18.5	1
Barnard		-29.5	105		59.3	4.2	15	Dove		46.7	30	Grimaldi	-68.3	-5.5	172	Jomo José	2.4	24.4	7
Barocius Barrow	16.8 7.7	-44.9 71.3	82 92	Casatus Cassini	-29.5 4.6	-72.8 40.2	108 56	Draper Drebbel	-21.7 -49.0		8 30	Grove Gruemberger	32.9 -10.0	40.3 -66.9	28 93	José Joy	-1.6 6.6	-12.7 25.0	2 5 2
Bartels	-89.8	24.5	55		-87.3	45.7	25	Drygalski	-84.9	-79.3	149	Gruithuisen	-39.7	32.9	15	Julienne	3.2	26.0	
Bayer		-51.6	47	Catharina	23.4	-18.1		Dubyago	70.0	4.4	51	Guericke		-11.5	63	Julius Caesar		9.0	90
Beals Beaumont	86.5 28.8	37.3 -18.0	48 53		38.6 -66.8	9.6 5.1	12 57	Dunthorne Eckert	-31.6 58.3	-30.1 17.3	15	Gum Gutenberg	88.6 41.2	-40.4 -8.6	54 74	Kaiser Kane	6.5 26.1	-36.5 63.1	52 54
Beer	-9.1	27.1	9	Cavendish	-53.7	-24.5	56	Eddington	-72.2		118	Gyldén	0.3	-5.3	47	Kant	20.1	-10.6	33
Behaim	79.4	-16.5	55	Caventou	-29.4	29.8	3	Egede	10.6	48.7	37	Hagecius		-59.8	76	Kao	87.6	-6.7	34
				1															

Nearside

Crater	Long.	Lat.	Dia	ı. (+Longi	tude =	East		-Longitude =	West	t	+ Lai	titude = North		Latitu	ide =	South Dia	amete	rinkom)
Kapteyn	70.6	-10.8	49	Mädler	29.8	-11.0	27	Palmieri	-47.7	-28.6	40	Russell	-75.4	26.5	103	Theiler	83.3	13.4	7
Kästner	78.5	-6.8	108	Maestlin	-40.6	4.9	7	Parrot	3.3	-14.5	70	Ruth	-45.1	28.7	3	Theon Junior	15.8	-2.3	17
Kathleen	-0.7	25.4	5	Magelhaens	44.1	-11.9	40		-15.8	-7.9	47	Rutherfurd	-12.1	-60.9	48	Theon Senior	15.4	-0.8	18
Keldysh Vonler	43.6 -38.0	51.2 8.1	33 31	Maginus Main	-6.3 10.1	-50.5 80.8	194	Pascal Patricia	-70.3 0.3	74.6 25.0	115	Sabatier Sabine	79.0 20.1	13.2	10 30	Theophilus	26.4 39.0	-11.4 17.5	110 9
Kepler Kies	-22.5	-26.3	45	Mairan	-43.4	41.6	46 40	Peary	33.0	88.6	73	Sacrobosco	16.7	-23.7	98	Theophrastus Timaeus	-0.5	62.8	32
Kiess	84.0	-6.4	63	Malapert	12.9	-84.9	69	Peek	86.9	2.6	12	Samir	-34.3	28.5	2	Timocharis	-13.1	26.7	33
Kinau	15.1	-60.8	41	Mallet	54.2	45.4	58	Peirce	53.5	18.3	18	Sampson	-16.5	29.7	1	Tisserand	48.2	21.4	36
Kirch	-5.6	39.2	11	Manilius	9.1	14.5	38	Peirescius	67.6	46.5	61	Santbech	44.0	-20.9	64	Tolansky	-16.0	-9.5	13
Kircher	45.3	-67.1	72	Manners	20.0	4.6	15	Pentland	11.5	-64.6	56	Santos-Dumont	4.8	27.7	8	Torricelli	28.5	-4.6	22
Kirchhoff Klaproth	38.8 -26.0	30.3 -69.8	24 119	Manuel Manzinus	11.3 26.8	24.5 -67.7	0.5 98	Petavius Petermann	60.4	-25.1 74.2	188 73	Sarabhai Sasserides	21.0 -9.3	24.7 -39.1	90	Toscanelli Townley	47.5 63.3	27.4 3.4	7 18
Klein		-12.0	44	Maraldi	34.9	19.4	39	Peters	29.5	68.1	15	Saunder	8.8	4.2	44	Tralles	52.8	28.4	43
Knox-Shaw	80.2	5.3	12	Marco Polo	-2.0	15.4	28	Petit	63.5	2.3	5	Saussure	-3.8	43.4	54	Triesnecker	3.6	4.2	26
König		-24.1	23	Marinus	76.5	-39.4	58	Petrov	88.0	-61.4	49	Scheele	-37.8	-9.4	4	Trouvelot	5.8	49.3	9
Kopff	-89.6 -72.6	-17.4	41 51	Marius	-50.8 -62.7	11.9 53.4	41	Pettit	-86.6 75.3	-27.5	35	Scheiner	-27.5 -58.8	-60.5	110	Tucker	88.2 -13.2	-5.6 -1.4	7 11
Krafft Krasnov	-72.0	16.6 -29.9	40	Markov Marth	-02.7	-31.1	40 6	Phillips Philolaus	-32.4	-26.6 72.1	122 70	Schiaparelli Schickard	-55.3	23.4 -44.3	206	Tumer Tycho	-13.2	-43.4	102
Kreiken	84.6	-9.0	23	Mary	27.4	18.9	1		-57.0	-52.7	121	Schiller	-39.0	-51.9	180	Ukert	1.4	7.8	23
Knieger	45.6	29.0	22	Maskelyne	30.1	2.2	23	Piazzi	-67.9	-36.6	134	Schlüter	-83.3	-5.9	89	Ulugh Beigh	-81.9	32.7	54
Krogh	65.7	9.4	19	Mason	30.5	42.6	33	Piazzi Smyth	-3.2	41.9	13	Schmidt	18.8	1.0	11	Urey	87.4	27.9	38
Krusenstern Kuiper	5.9 -22.7	-26.2 -9.8	47 6	Maupertuis Maurolycus	-27.3 14.0	49.6 -42.0	45 114	Picard Piccolomini	54.7 32.2	14.6 -29.7	22 87	Schomberger Schorr	24.9 89.7	-76.7 -19.5	85 53	Väisälä van Albada	47.8 64.3	25.9 9.4	8 21
Kundt		-11.5	10		39.6	37.1	17	Pickering	7.0	-29.7	15	Schröter	-7.0	2.6	35	Van Biesbroeck	45.6	28.7	9
Kunowsky	-32.5	3.2	18	100000000000000000000000000000000000000	-26.4	29.8	1	Pictet	-7.4	43.6	62	Schubert	81.0	2.8	54	Van Vleck	78.3	-1.9	31
la Caille	1.1	-23.8	67	McClure	50.3	-15.3	23	Pilâtre	-86.9	-60.2	50	Schumacher	60.7	42.4	60	Vasco da Gama	-83.9	13.6	83
la Condamine	-28.2	53.4	37	McDonald	-20.9	30.4	7	-	-73.7	-58.7	88	Schwabe	45.6	65.1	25	Vega	63.4	-45.4	75
la Pérouse		-10.7 -37.9	77 37	Mee Menelaus	-35.3 16.0	43.7 16.3	126 26		-13.5 30.9	-29.9	106	Scoresby	14.1 48.5	77.7	55 103	Vendelinus	61.6	-16.4 26.3	131
Lacroix Lade	10.1	-1.3	55	Menzel	36.9	3.4	20 3	Pitiscus Plana	28.2	-50.4 42.2	82 44	Scott Secchi	43.5	-82.1 2.4	22	Vera Verne	-43.7 -25.3	24.9	2 2
Lagalla		-44.6	85	Mercator	-26.1	-29.3	46	Plato	-9.4	51.6	109	Seeliger	3.0	-2.2	8	Very	25.3	25.6	5
Lagrange		-32.3	225	Mercurius	66.2	46.6	67	Playfair	8.4	-23.5	47	Segner	-48.3	-58.9	67	Vieta	-56.3	-29.2	87
Lalande	-8.6	-4.4	24	Mersenius	-49.2	-21.5	84	Plinius	23.7	15.4	43	Seleucus	-66.6	21.0	43	Virchow	83.7	9.8	16
Lallemand	-84.1 -69.8		18 100	Messala Messier	60.5 47.6	39.2 -1.9	125	Plutarch	79.0 10.6	24.1	68 42	Seneca Shoold stop	80.2	26.6	46	Vitello Vitruvius	-37.5 31.3	-30.4	42 29
Lamarck Lambert	-21.0	-22.9 25.8	30	Metius	43.3	40.3	11 87	Poisson Polybius	25.6	-30.4 -22.4	41	Shackleton Shaler	-85.2	-89.9 -32.9	19 48	Victorius	38.8	17.6 -53.3	89
Lamé		-14.7	84	Meton	18.8	73.6	130	Pomortsev	66.9	0.7	23	Shapley	56.9	9.4	23	Vogel	5.9	-15.1	26
Lamèch	13.1	42.7	13	Michael	0.2	25.1	4		-54.1	75.8	69	Sharp	-40.2	45.7	39	Volta	-84.4	53.9	123
Lamont	23.7	4.4	106		-30.2	10.0	12	Pons	21.5	-25.3	41	Sheepshanks	16.9	59.2	25	von B ehring	71.8	-7.8	38
Landsteiner	-14.8	31.3 51.1	6 59	Miller	0.8 20.2	-39.3 49.7	61 30	Pontanus	14.4	-28.4	57 91	Shoemaker	44.9 -7.3	-88.1 -74.6	51 70	von Braun	-78.0	41.1 28.0	60
Langley Langrenus	-86.3 61.1	-8.9	127	Mitchell Moigno	28.9	66.4	36	Pontécoulant Porter	-10.1	-58.7 -56.1	51	Short Shuckburgh	52.8	42.6	38	Voskresenskiy W. Bond	-88.1 4.5	65.4	49 156
Lansberg	-26.6	-0.3	38	Moltke	24.2	-0.6	6	Posidonius	29.9	31.8	95	Silberschlag	12.5	6.2	13	Wallace	-8.7	20.3	26
Lassell	-7.9	-15.5	23	Monge	47.6	-19.2	36	Prinz	-44.1	25.5	46	Simpelius	15.2	-73.0	70	Wallach	32.3	4.9	6
Lavoisier	-81.2	38.2	70	Monira	-1.7	-12.6	2	Priscilla	-6.2	-10.9	1.8	Sinas	31.6	8.8	11	Walter	-33.8	28.0	1
Lawrence Le Gentil	43.2 -75.7	7.4 -74.6	24 128	Montanari Moretus	-20.6 -5.8	-45.8 -70.6	76 111	Proclus Proctor	46.8	16.1 -46.4	28 52	Sirsalis Slocum	-60.4 89.0	-12.5 -3.0	42 13	Walther Wargentin	1.0 -60.2	-33.1 -49.6	128 84
Le Monnier	30.6	26.6	60	Morley	64.6	-2.8	14	Protagoras	7.3	56.0	21	Smithson	53.6	2.4	5	Warner	87.3	-4.0	35
Le Verrier	-20.6	40.3	20	Moseley	-90.1	20.9	90	Ptolemaeus	-1.9	-9.3	164	Snellius	55.7	-29.3	82	Watt	48.6	-49.5	66
Leakey	37.4	-3.2	12	Mösting	-5.9	-0.7	24		-39.0	-27.8	24	Somerville	64.9	-8.3	15	Watts	46.3	8.9	15
Lebesgue	89.0	-5.1	11	Mouchez	-26.6	78.3 -7.6	81		-11.0	23.8	115	Sömmering	-7.5	0.1	28	Webb	60.0	-0.9	21
Lee Legendre	40.7 70.2	-30.7 -28.9	41 78	Müller Murchison	2.1 -0.1	5.1	22 57	Purbach Pythagoras	-2.3 -63.0	-25.5 63.5	115 142	Soraya Sosigenes	-1.6 17.6	-12.9 8.7	17	Weierstrass Weigel	77.2 -38.8	-1.3 -58.2	33 35
Lehmann	-56.0	-40.0	53		30.1	-63.6	77		-20.6	20.5	20	South	-50.8	58.0	104	Weinek	37.0	-27.5	32
Lepaute	-33.6	-33.3	16	Naonobu	57.8	4.6	34	Rabbi Levi	23.6	-34.7	81	Spallanzani	24.7	46.3	32	Weiss	-19.5	-31.8	66
Letronne		-10.8	116	Nasireddin	0.2	41.0	52		-55.1	27.0	10	Spörer	-1.8	4.3	27	Werner	3.3	-28.0	70
Lexell		-35.8	62	25524511512525255	-56.2	-50.5	76			-32.9	24	Spurr	-1.2	27.9	13	Wexler	90.2	-69.1	51
Licetus Lichtenberg	6.7 -67.7	-47.1 31.8	74 20		-31.3 -62.0	20.0 35.4	12 9	Rankine Ravi	71.5	-3.9 -12.5	2.5	Stadius Steinheil	-13.7 46.5	10.5 48.6	69 67	Whewell Wichmann	13.7 -38.1	4.2 -7.5	13 10
Lick	52.7	12.4	31	Neander	39.9	-31.3		Rayleigh	89.6	29.3		Stella	29.8	19.9	í	Widmannstätten	85.5	-6.1	46
Liebig	48.2		37	Nearch	39.1	-58.5		Réaumur	0.7	-2.4	52	Stevinus		-32.5	74	Wildt	75.8	9.0	11
Lilius		-54.5	61	Neison	25.1	68.3		Regiomontanus	-1.0	-28.3	108	Stewart	67.0	2.2	13	Wilhelm	-20.4	-43.4	106
Linda Lindbergh	-33.4 52.9	30.7 -5.4	12	Neper Neumaver	84.6 70.7	8.5 -71.1	137	Regnault Reichenbach	-88.0	54.1 -30.3	46 71	Stiborius Stöfler	6.0	-34.4 -41.1	43 126	Wilkins Williams	19.6 37.2	-29.4 42.0	57 36
Lindenau	24.9			Newcomb	43.8	29.9	41	Reimarus	60.3	47.7	48	Stokes	-88.1	52.5	51	Wilson	42.4	-69.2	69
Lindsay	13.0	-7.0		Newton	-16.9	-76.7	78		-54.9	7.0	29	Strabo	54.3	61.9	55	Winthrop	44.4	-10.7	17
Linné	11.8	27.7	2	Nicholson	-85.1	-26.2			-22.8	3.3	42	Street			57	Wöhler	31.4	-38.2	27
Liouville	73.5	2.6		Nicolai	25.9	42.4			-78.6	51.3	109	Struve	-77.1	22.4	164	Wolf	-16.6	-22.7	25
Lippershey Littrow	-10.3 31.4	21.5	30	Nicollet Nielsen	-12.5 -51.8	-21.9 31.8	15	Respighi Rhaeticus	71.9	2.8 0.0	18 45	Suess Sulpicius Gallus	-47.6	4.4 19.6	12	Wollaston Wright	-46.9 -86.6	30.6 -31.6	10 39
Lockyer		-46.2	34		53.5	-85.2		Rheita		-37.1	70	Susan		-11.0	1	Wrottesley	56.8	-23.9	57
Loewy	-32.8		24		75.9	0.2		Riccioli	-74.6	-3.3	139		89.7	-5.5	23	Wurzelbauer		-33.9	88
Lohrmann	-67.2	-0.5	30		-45.7	48.8		Riccius		-36.9	71	Swift	53.4	19.3	10	Xenophanes	-82.0	57.5	125
Lohse		-13.7	41		3.8	-34.8		Riemann	86.8	38.9		Sylvester	-79.6	82.7	58	Yakovkin	-78.8	-54.5	37
Longomontanus Louise	-21.8 -34.2	-49.6 28.5	157	Norman Oenopides	-30.4 -64.1	-11.8 57.0	67	Ritchey Ritter	19.2	-11.1 2.0	24 29	T. Mayer Tacchini	-29.1 85.8	15.6 4.9	33 40	Yangel' Yerkes	4.7 51.7	17.0 14.6	8 36
Louville	46.0	44.0	36		47.2	43.1	42	Robert	27.4	19.0	1	Tacitus		-16.2	39	Yoshi	11.0	24.6	1
Lubbock	41.8	-3.9	13	Oken	75.9	43.7	71	Robinson	-45.9	59.0	24	Tacquet	19.2	16.6	7	Young	50.9	-41.5	71
Lubiniezky	-23.8		43	3.00 m 19.00 m	-75.9	7.4	74			-12.7	89	Taizo	2.2	24.7	6	Zach	5.3	-60.9	70
Lucian	36.7	14.3	7	Opelt	-17.5	-16.3			-45.0	28.9	4	Talbot	85.3	-2.5	11	Zagut	22.1	-32.0	84
Luther Lyapunov	24.1 89.3	33.2 26.3	66	Oppolzer Orontius	-0.5 -4.6	-1.5 -40.6		Römer Rosa	36.4 -32.3	25.4 20.3	39 1	Tannerus Taruntius	22.0 46.5	-56.4 5.6	28 56	Zähringer Zeno	40.2 72.9	5.6 45.2	11 65
Lyapunov Lyali	40.6	13.6	32		5.2	18.6	0.5	Rosenberger		-55.4	95	Taylor	16.7	-5.3	42	Zinner	-58.8	26.6	4
Lyot	84.5	-49.8	132	Osiris	27.6	18.6	1	Ross	21.7	11.7	24	Tebbutt	53.6	9.6	31	Zöllner	18.9	-8.0	47
Madaurin	68.0	-1.9	50		-6.2	-11.0	2	Rosse		-17.9	11	Tempel	11.9	3.9	45	Zucchius	-50.3	-61.4	64
Maclear MacMillan	20.1 -7.8	10.5 24.2	20 7	Palisa Palitzsch	-7.2 64.5	-9.4 -28.0	33 41	Rost Rothmann		-56.4 -30.8	48 42	Thales Theaetetus	50.3	61.8 37.0	31 24	Zupus	-52.3	-17.2	38
Macrobius	46.0	21.3		Palitzsch Pallas	-1.6	5.5		Runge		-2.5	38	Theaetetus		-22.0	56				
			1			2.13	,,,			2.3					- 0				

Farside

Crater Name	Long.	Lat.	Dia.	(+ Longitude = E	ant I	ongitud	o - 18/o	st + Latitude = North	Lat	itude = 9	Courth	Diameter in km)	• •	0	
Abbe	175.2	-57.3	66	Champollion	175.2	37.4	e – vve 58	Fairouz	102.9	-26.1	3	Icarus	-173.2	-5.3	96
Abul Wáfa	116.6	1.0	55	Chandler	171.5	43.8	85	Fechner	124.9	-59.0	63	Idel'son	110.9	-81.5	60
Aitken	173.4	-16.8	135	Chang Heng	112.2	19.0	43	Fényi	-105.1	44.9	38	llin	-97.5	-17.8	13
Al-Biruni	92.5	17.9	77	Chant	-109.2	40.0	33	Feoktistov	140.7	30.9	23	Ingalis	-153.1	26.4	37
Alden Alder	110.8 -177.4	-23.6 -48.6	104 77	Chaplygin Chapman	150.3 -100.7	-6.2 50.4	137 71	Fermi Fersman	122.6 -126.0	-19.3 18.7	183 151	Innes Ioffe	119.2 -129.2	27.8 -14.4	42 86
Alekhin	-131.3	-68.2	70	Chappe	-91.5	-61.2	59	Fesenkov	135.1	-23.2	35	Isaev	147.5	-17.5	90
Al-Khwarizmi	106.4	7.1	65	Chappell	-177.0	54.7	80	Finsen	-177.9	42.0	72	Izsak	117.1	-23.3	30
Alter	-107.5	18.7	64	Charlier	-131.5	36.6	99	Firsov	112.2	4.5	51	Jackson	-163.1	22.4	71
Amici Anders	-172.1 -142.9	-9.9 -41.3	54 40	Chaucer Chauvenet	-140.0 137.0	3.7 -11.5	45 81	Fischer Fitzgerald	142.4 -171.7	8.0 27.5	30 110	Jarvis Jeans	-148.9 91.4	-34.9 -55.8	38 79
Anderson	171.1	15.8	109	Chawla	-147.5	42.8	15	Fizeau	-133.9	-58.6	111	Jenner	95.9	-42.1	71
Andersson	-95.3	-49.7	13	Chebyshev	-133.1	-33.7	178	Fleming	109.6	15.0	106	Joliot	93.1	25.8	164
Andronov Antoniadi	146.1 -172.0	-22.7 -69.7	16 143	Chernyshev Chrétien	174.2 162.9	47.3 45.9	58 88	Florensky Focas	131.5 -93.8	25.3 -33.7	71 22	Joule Jules Verne	-144.2 147.0	27.3 -35.0	96 143
Anuchin	101.3	-49.0	57	Clark	118.9	-38.4	49	Foster	-141.5	23.7	33	Kamerlingh Onnes	-115.8	15.0	66
Apollo	-151.8	-36.1	537	Coblentz	126.1	-37.9	33	Fowler	-145.0	42.3	146	Karima	103.0	-25.9	3
Appleton	158.3	37.2	63	Cockcroft	-162.6	31.3	93	Fox	98.2	0.5	24	Karpinskiy	166.3	73.3	92
Armiński Arrhenius	154.2 -91.3	-16.4 -55.6	26 40	Compton Comrie	103.8 -112.7	55.3 23.3	162 59	Freundlich Fridman (Friedmann)	171.0 -126.0	25.0 -12.6	85 102	Karrer Kasper	-141.8 122.1	-52.1 8.3	51 12
Artamonov	103.5	25.5	60	Comstock	-121.5	21.8	72	Froelich	-109.7	80.3	58	Katchalsky	116.1	5.9	32
Artem'ev	-144.4	10.8	67	Congreve	-167.3	-0.2	57	Frost	-118.4	37.7	75	Kearons	-112.6	-11.4	23
Ashbrook	-112.5	-81.4	156	Cooper	175.6	52.9	36	Fryxell	-101.4	-21.3	18	Keeler	161.9	-10.2	160
Avicenna Avogađro	-97.2 164.9	39.7 63.1	74 139	Cori Coriolis	-151.9 171.8	-50.6 0.1	65 78	Gadomski Gagarin	-147.3 149.2	36.4 -20.2	65 265	Kekulé Kepínski	-138.1 126.6	16.4 28.8	94 31
Babakin	123.3	-20.8	20	Conder	-92.4	-4.8	21	Galois	-151.9	-14.2	222	Khvol'son	111.4	-13.8	54
Babcock	93.9	4.2	99	Coulomb	-114.6	54.7	89	Gamow	145.3	65.3	129	Kibal'chich	-146.5	3.0	92
Backlund	103.0	-16.0	75	Cremona	-90.6	67.5	85	Ganskiy (Hansky)	97.0	-9.7	43	Kidinnu	122.9	35.9	56
Balandin Baldet	152.6 -151.1	-18.9 -53.3	12 55	Crocco Crommelin	150.2 -146.9	-47.5 -68.1	75 94	Ganswindt Garavito	110.3 156.7	-79.6 -47.5	74 74	Kimura King	118.4 120.5	-57.1 5.0	28 76
Barbier	157.9	-23.8	66	Crookes	-164.5	-10.3	49	Gavrilov	130.7	17.4	60	Kira	132.8	-17.6	3
Barringer	-149.7	-28.0	68	Ctesibius	118.7	0.8	36	Geiger	158.5	-14.6	34	Kirkwood	-156.1	68.8	67
Bawa	102.6	-25.3	1	Curie	91.0	-22.9	151	Gerasimovich	-122.6	-22.9	86	Kleymenov	-140.2	-32.4	55
Becquerel Bečvář	129.7 125.2	40.7 -1.9	65 67	Cyrano D. Brown	157.7 -147.2	-20.5 -42.0	80 15	Gernsback Ginzel	99.7 97.4	-36.5 14.3	48 55	Klute Koch	-141.3 150.1	37.2 -42.8	75 95
Beijerinck	151.8	-13.5	70	Daedalus	179.4	-5.9	93	Giordano Bruno	102.8	35.9	22	Kohlschütter	154.0	14.4	53
Bel'kovich	90.2	61.1	214	D'Alembert	163.9	50.8	248	Glauber	142.6	11.5	15	Kolhörster	-114.6	11.2	97
Be11	-96.4	21.8	86	Danjon	124.0	-11.4	71	Glazenap	137.6	-1.6	43	Komarov	152.5	24.7	78
Bellinsgauzen Belopol'skiy	-164.6 -128.1	-60.6 -17.2	63 59	Dante d'Arsonval	180.0 124.6	25.5 -10.3	54 28	Golitsyn Golovin	-105.0 161.1	-25.1 39.9	36 37	Kondratyuk Konoplev	115.5 -125.5	-14.9 -28.5	108 25
Belyaev	143.5	23.3	54	Das	-136.8	-26.6	38	Grachev	-108.2	-3.7	35	Konstantinov	158.4	19.8	66
Benedict	141.5	4.4	14	Davisson	-174.6	-37.5	87	Grave	150.3	-17.1	40	Korolev	-157.4	-4.0	437
Bergman	137.5	7.0	21	Dawson	-134.7	-67.4	45	Green	132.9	4.1	65	Kosberg	149.6	-20.2	15
Bergstrand Berkner	176.3 -105.2	-18.8 25.2	43 86	de Forest de Moraes	-162.1 143.2	-77.3 49.5	57 53	Gregory Grigg	127.2 -129.4	2.2 12.9	67 36	Kostinskiy Kovalevskaya	118.8 -129.6	14.7 30.8	75 115
Berlage	-162.8	-63.2	92	de Roy	-99.1	-55.3	43	Grissom	-147.4	47.0	58	Koval'skiy	101.0	-21.9	49
Bhabha	-164.5	-55.1	64	de Vries	-176.7	-19.9	59	Grotnian	128.3	-66.5	37	Kozyrev	129.3	-46.8	65
Bingham	115.1	8.1	33	Debus	99.6	-10.5	20	Guillaume	-173.4	45.4	57	Kramarov	-98.8	-2.3	20
Birkeland Birkhoff	173.9 -146.1	-30.2 58.7	82 345	Debye Dellinger	-176.2 140.6	49.6 -6.8	142 81	Gullstrand Guthnick	-129.3 -93.9	45.2 -47.7	43 36	Kramers Krasovskiy	-127.6 -175.5	53.6 3.9	61 59
Bjerknes	113.0	-38.4	48	Delporte	121.6	-16.0	45	Guyot	117.5	11.4	92	Krylov	-165.8	35.6	49
Blackett	-116.1	-37.5	141	Denning	142.6	-16.4	44	H. G. Wells	122.8	40.7	114	Kugler	103.7	-53.8	65
Blanchard Blazhko	-94.4 -148.0	-58.5 31.6	40 54	Deutsch Dewar	110.5 165.5	24.1 -2.7	66 50	Hagen Hale	135.1 90.8	-48.3 -74.2	55 83	Kulik Kuo Shou Ching	-154.5 -133.7	42.4 8.4	58 34
Bobone	-131.8	26.9	31	Diderot	121.5	-20.4	20	Harden	143.5	5.5	15	Kurchatov	142.1	38.3	106
Bok	-171.6	-20.2	45	Dirichlet	-151.4	11.1	47	Haret	-176.5	-59.0	29	L. Clark	-147.7	-43.7	16
Boltzmann	-90.7	-74.9	76	Dobrovol'skiy	129.7	-12.8	38	Harkhebi	98.3	39.6	237	Lacchini	-107.5	41.7	58
Bolyai Bondarenko	125.9 136.3	-33.6 -17.8	135 30	Doerfel Donner	-107.9 98.0	-69.1 -31.4	68 58	Harriot Hartmann	114.3 135.3	33.1 3.2	56 61	Lamb Lampland	100.1 131.0		106 65
Borman	-147.7	-38.8	50	Doppler	-159.6	-12.6	110	Harvey	-146.5	19.5	60	Landau	-118.1	41.6	214
Bose	-170.0	-53.5	91	Douglass	-122.4	35.9	49	Hatanaka	-121.5	29.7	26	Lander	131.8	-15.3	40
Bowditch	103.1	-25.0	40	Dreyer	96.9	10.0	61	Hayford	-176.4	12.7	27	Lane	132.0	-9.5	55
Boyle Bragg	178.1 -102.9	-53.1 42.5	57 84	Drude Dryden	-91.8 -155.2	-38.5 -33.0	24 51	Healy Heaviside	-110.5 167.1	32.8 -10.4	38 165	Langemak Langevin	118.7 162.7	-10.3 44.3	97 58
Brashear	-170.7	-73.8	55	Dufay	169.5	5.5	39	Helberg	-102.2	22.5	62	Langmuir	-128.4	-35.7	91
Bredikhin	-158.2	17.3	59	Dugan	103.3	64.2	50	Henderson	152.1	4.8	47	Larmor	-179.7	32.1	97
Bridgman	137.1	43.5	80	Dunér	179.5	44.8	62	Hendrix	-159.2	46.6	18	Laue	-96.7	28.0	87
Bronk Brouwer	-134.5 -126.0	26.1 -36.2	64 158	Dyson Dziewulski	-121.2 98.9	61.3 21.2	63 63	Henyey Heron (Hero)	-151.6 119.8	13.5 0.7	63 24	Lauritsen Leavitt	-139.3	-27.6 -44.8	52 66
Brunner	90.9	-9.9	53	Edison	99.1	25.0	62	Hertz	104.5	13.4	90	Lebedev	107.8		102
Buffon	-133.4	-40.4	106	Edith	102.3	-25.8	8	Hertzsprung	-129.2	2.6	591	Lebedinskiy	-164.3	8.3	62
Buisson	112.5	-1.4	56	Ehrlich	-172.4	40.9	30	Hess	174.6	-54.3	88	Leeuwenhoek	-178.7		125
Butlerov Buvs-Ballot	-108.7 174.5	12.5 20.8	40 55	Eijkman Einthoven	-141.5 109.6	-63.1 -4.9	54 69	Heymans Heyrovsky	-144.1 -95.3	75.3 -39.6	50 16	Leibnitz Lemaître	179.2 -149.6		245 91
Cabannes	-169.6	-60.9	80	Ellerman	-120.1	-25.3	47	Hilbert	108.2	-17.9	151	Lents (Lenz)	-102.1	2.8	21
Cailleux	153.3	-60.8	50	Ellison	-107.5	55.1	36	Hippocrates	-145.9	70.7	60	Leonov	148.2	19.0	33
Cajori	168.8	-47.4	70	Elvey	-100.5	8.8	74	Hirayama	93.5	-6.1	132	Leucippus	-116.0	29.1	56
Campbell Cannizzaro	151.4 -99.6	45.3 55.6	219 56	Emden Engel'gardt	-177.3 -159.0	63.3 5.7	111 43	Hoffmeister Hogg	136.9 121.9	15.2 33.6	45 38	Leuschner Levi-Civita	-108.8 143.4	1.8 -23.7	49 121
Cantor	118.6	38.2	81	Eötvös	133.8	-35.5	99	Hohmann	-94.1	-17.9	16	Lewis		-18.5	42
Camot	-143.5	52.3	126	Erro	98.5	5.7	61	Holetschek	150.9	-27.6	38	Ley	154.9	42.2	79
Carol	122.3	8.5	8	Esnault-Pelterie	-141.4	47.7	79	Hopmann	160.3	-50.8	88	Lindblad	-98.8	70.4	66
Carver Cassegrain	126.9 113.5	-43.0 -52.4	59 55	Espin Evans	109.1 -133.5	28.1 -9.5	75 67	Houzeau Hume	-123.5 90.4	-17.1 -4.7	71 23	Lippmann Lipskiy	-114.9 -179.5	-56.0 -2.2	160 80
Chadwick	-101.3	-52.7	30	Evdokimov	-153.0	34.8	50	Husband	-147.9	40.8	29	Litke (Lütke)	123.1		39
Chaffee	-153.9	-38.8	49	Evershed	-159.5	35.7	66	Hutton	168.7	37.3	50	Lobachevskiy	112.6	9.9	84
Chalonge Chambadin	-117.3	-21.2	30	Ewen	121.4	7.7	194	Ibn Firmas	122.3	6.8	89	Lodygin		-17.7	62
Chamberlin	95.7	-58.9	58	Fabry	100.7	42.9	184	Ibn Yunus	91.1	14.1	58	Lomonosov	98.0	27.3	92

Farside

-	12000000000			(. l				-4	1 -4:	4I- C	41.	Di			
Crater Name	Long. -95.3	Lat. 32.6	Dia. 312	(+ Longitude = Ea	ast - L -149.9	ongitude 50.4	= We		- Lati	tude = S 24.3	outh 21	Diameter in km) von der Pahlen	-132.7	24.0	56
Lorentz Love	129.0	-6.3	84	Paraskevopoulos Parenago	-149.9	25.9	93	Shatalov Shayn	172.5	32.6	93	von Kármán	175.9	-24.8	56 180
Lovelace	-106.4	82.3	54	Parkhurst	103.6	-33.4	96	Sherrington	118.0	-11.1	18	von Neumann	153.2	40.4	78
Lovell Lowell	-141.9 -103.1	-36.8 -12.9	34	Parsons Paschen	-171.2 -139.8	37.3 -13.5	40	Shi Shen Shirakatsi	104.1 128.6	76.0 -12.1	43 51	von Zeipel Walker	-141.6	42.6 -26.0	83 32
Lucretius	-103.1	-8.2	66 63	Pasteur	104.6	-11.9	124 224	Shtemberg (Sternberg)	-116.3	19.5	70	Wan-Hoo	-162.2 -138.8	-9.8	52
Ludwig	97.4	-7.7	23	Patsaev	133.4	-16.7	55	Shuleykin	-92.5	-27.1	15	Waterman	128.0	-25.9	76
Lundmark	152.5	-39.7	106	Pauli	137.5	44.5	84	Siedentopf	135.5	22.0	61	Watson	-124.5	-62.6	62
Lyman M. Anderson	163.6 -149.0	-64.8 -41.6	84 17	Pavlov Pawsey	142.5 145.0	-28.8 44.5	148 60	Sierpinski Sikorsky	154.5 103.2	-27.2 -66.1	69 98	Weber Wegener	-123.4 -113.3	50.4 45.2	42 88
Mach	-149.3	18.5	180	Pease	-106.1	12.5	38	Sisakyan	109.0	41.2	34	Wexler	90.2	-69.1	51
Maksutov	-168.7	-40.5	83	Perel'man	106.0	-24.0	46	Sita	120.8	4.6	. 2	Weyl	-120.2	17.5	108
Malyy Mandel'shtam	105.3 162.4	21.9 5.4	41 197	Perepelkin Perkin	129.0 -175.9	-10.0 47.2	97 62	Sklodowska Slipher	95.5 160.1	-18.2 49.5	127 69	White Wiechert	-158.3 165.0	-44.6 -84.5	39 41
Marci	-167.0	22.6	25	Perrine	-127.8	42.5	86	Smith	-150.2	-31.6	34	Wiener	146.6	40.8	120
Marconi	145.1	-9.6	73	Petrie	108.4	45.3	33	Smoluchowski	-96.8	60.3	83	Wilsing	-155.2	-21.5	73
Mariotte Maunder	-139.1 -93.8	-28.5 -14.6	65 55	Petropavlovskiy Petzval	-114.8 -110.4	37.2 -62.7	63 90	Sniadecki Soddy	-168.9 121.8	-22.5 0.4	43 42	Winkler Winlock	-179.0 -105.6	42.2 35.6	22 64
Maxwell	98.9	30.2	107	Pikel'ner	123.3	47.9	47	Sommerfeld	-162.4	65.2	169	Woltjer	-159.6	45.2	46
McAdie	92.1	2.1	45	Pirquet	139.6	-20.3	65	Spencer Jones	165.6	13.3	85	Wood	-120.8	43.0	78
McAuliffe McCool	-148.9 -146.3	-33.0 -41.7	19 21	Pizzetti Planck	118.8 136.8	-34.9 -57.9	44 314	St. John Stark	150.2 134.6	10.2 -25.5	68 49	Wróblewski Wyld	152.8 98.1	-24.0 -1.4	21 93
McKellar	-170.8	-15.7	51	Planté	163.3	-10.2	37	Steams	162.6	34.8	36	Xenophon	122.1	-22.8	25
McLaughlin	-92.9	47.1	79	Plaskett	174.3	82.1	109	Stebbins	-141.8	64.8	131	Yablochkov	128.3	60.9	99
McMath McNair	-165.6 -147.3	17.3 -35.7	86 29	Plummer Poczobutt	-155.0 -98.8	-25.0 57.1	73 195	Stefan Stein	-108.3 179.0	46.0 7.2	125 33	Yamamoto Zanstra	160.9 124.7	58.1 2.9	76 42
McNally	-127.2	22.6	47	Pogson	110.5	42.2	50	Steklov	-104.9	-36.7	36	Zansua Zasyadko	94.2	3.9	11
Mechnikov	-149.0	-11.0	60	Poincaré	163.6	-56.7	319	Steno	161.8	32.8	31	Zeeman	-133.6	-75.2	190
Mees	-96.1	13.6	50	Poinsot	-145.7	79.5	68	Sternfeld Stetson	-141.2	-19.6	100	Zelinskiy	166.8	-28.9	53
Meggers Meitner	123.0 112.7	24.3 -10.5	52 87	Polzunov Popov	114.6 99.7	25.3 17.2	67 65	Stoletov	-118.3 -155.2	-39.6 45.1	64 42	Zernike Zhiritskiy	168.2 120.3	18.4 -24.8	48 35
Melissa	121.8	8.1	18	Poynting	-133.4	18.1	128	Stoney	-156.1	-55.3	45	Zhukovskiy	-167.0	7.8	81
Mendel	-109.4	-48.8	138	Prager	130.5	-3.9	60	Störmer	146.3	57.3	69	Zsigmondy	-104.7	59.7	65
Mendeleev Merrill	140.9 -116.3	5.7 75.2	313 57	Prandtl Priestley	141.8 108.4	-60.1 -57.3	91 52	Stratton Strömgren	164.6 -132.4	-5.8 -21.7	70 61	Zwicky	168.1	-15.4	150
Meshcherskiy	125.5	12.2	65	Purkyně	94.9	-1.6	48	Subbotin	135.3	-29.2	67				
Mezentsev	-128.7	72.1	89	Quételet	-134.9	43.1	55	Sumner	108.7	37.5	50				
Michelson Milankovič	-120.7 168.8	7.2 77.2	123 101	Racah Raimond	-179.8 -159.3	-13.8 14.6	63 70	Sundman Sverdrup	-91.6 -152.0	10.8 -88.5	40 35				
Millikan	121.5	46.8	98	Ramon	-148.1	41.6	17	Swann	112.7	52.0	42				
Mills	156.0	8.6	32	Ramsay	144.5	40.2	81	Szilard	105.7	34.0	122				
Milne Mineur	112.2 -161.3	-31.4 25.0	272 73	Raspletin Rayet	151.8 114.5	-22.5 44.7	48 27	Tamm Teisserenc	146.4 -135.9	4.4 32.2	38 62				
Minkowski	-146.0	-56.5	113	Razumov	-114.3	39.1	70	Ten Bruggencate	134.4	-9.5	59				
Minnaert	179.6	-67.8	125	Recht	124.0	9.8	20	Tereshkova	144.3	28.4	31				
Mitra Möbius	-154.7 101.2	18.0 15.8	92 50	Resnik Ricco	-150.1 176.3	-33.8 75.6	20 65	Tesla Thiel	124.7 -134.5	38.5 40.7	43 32				
Mohorovičić	-165.0	-19.0	51	Richards	140.1	7.7	16	Thiessen	-169.0	75.4	66				
Moiseev	103.3	9.5	59	Richardson	100.5	31.1	141	Thomson	166.2	-32.7	117				
Moissan Montgolfier	137.4 -159.8	4.8 47.3	21 88	Riedel Rittenhouse	-139.6 106.5	-48.9 -74.5	47 26	Tikhomirov Tikhov	162.0 171.7	25.2 62.3	65 83				
Moore	-177.5	37.4	54	Ritz	92.2	-15.1	51	Tiling	-132.6	-53.1	38				
Morozov	127.4	5.0	42	Roberts	-174.5	71.1	89	Timiryazev	-147.0	-5.5	53				
Morse Moseley	-175.1 -90.1	22.1 20.9	77 90	Robertson Roche	-105.2 136.5	21.8 -42.3	88 160	Tiselius Titius	176.5 100.7	7.0 -26.8	53 73				
Moulton	97.2	-61.1	49	Romeo	122.6	7.5	8	Titov	150.5	28.6	31				
Murakami	-140.5	-23.3	45	Röntgen	-91.4	33.0	126	Trumpler	167.1	29.3	77				
Nagaoka Nansen	154.0 95.3	19.4 80.9	46 104	Rosseland Rowland	131.0 -162.5	41.0 57.4	75 171	Tsander (Zander) Tseraskiy (Ceraski)	-149.3 141.6	6.2 -49.0	181 56				
Nassau	177.4	-24.9	76	Rozhdestvenskiy	-155.4	85.2	177	Tsinger (Zinger)	175.6	56.7	44				
Necho	123.1	-5.0	30	Rumford	-169.8	-28.8	61	Tsiolkovskiy	128.9	-21.2	185				
Nernst Neujmin	-94.8 125.0	35.3 -27.0	116 101	Rutherford Rydberg	137.0 -96.3	10.7 -46.5	13 49	Tsu Chung-Chi Tyndall	145.1 117.0	17.3 -34.9	28 18				
Niepce	-119.1	72.7	57	Ryder	143.2	44.5	17	Valier	174.5	6.8	67				
Nijland	134.1	33.0	35	Rynin	-103.5	47.0	75	Van de Graaff	172.2	-27.4	233				
Nikolaev Nishina	151.3 -170.4	35.2 -44.6	41 65	Saenger Šafařík	102.4 176.9	4.3 10.6	75 27	Van den Bergh van den Bos	-159.1 146.0	31.3 -5.3	42 22				
Nobel	-101.3	15.0	48	Saha	102.7	-1.6	99	Van der Waals	119.9	43.9	104				
Nöther	-113.5	66.6	67	Sanford	-138.9	32.6	55	Van Gent	160.4	15.4	43				
Nu?1 Numerov	167.6 -160.7	32.3 -70.7	61 113	Sarton Scaliger	-121.1 108.9	49.3 -27.1	69 84	Van Maanen van Rhiin	128.0 146.4	35.7 52.6	60 46				
Nunn	91.1	4.6	19	Schaeberle	117.2	-26.2	62	Van Wijk	118.8	-62.8	32				
Oberth	155.4	62.4	60	Schjellerup	157.1	69.7	62	van't Hoff	-131.8	62.1	92				
Obruchev O'Day	162.1 157.5	-38.9 -30.6	71 71	Schlesinger Schliemann	-138.6 155.2	47.4 -2.1	97 80	Vashakidze Vavilov	93.3 -137.9	43.6 -0.8	44 98				
Ohm	-113.5	18.4	64	Schneller	-163.6	41.8	54	Vening Meinesz	162.6	-0.3	87				
O1cott	117.8	20.6	81	Schönfeld	-98.1	44.8	25	Ventris	158.0	4.9	95				
Olivier Omar Khayyam	138.5 -102.1	59.1 58.0	69 70	Schrödinger Schuster	132.4 146.5	-75.0 4.2	312 108	Vernadskiy Vertregt	130.5	23.2 -19.8	91 187				
Onizuka	-102.1	-36.2	29	Schwarzschild	121.2	70.1	212	Verifiegi Vesalius	171.1 114.5	-3.1	61				
Oppenheimer	-166.3	-35.2	208	Scobee	-148.9	-31.1	40	Vestine	93.9	33.9	96				
Oresme Orlov	169.2 -175.0	-42.4 -25.7	76 81	Seares Sechenov	145.8	73.5 -7.1	110	Vetchinkin Vil'ev	131.3	10.2 -6.1	98 45				
Oriov Ostwald	121.9	-25.7 10.4	104	Sechenov Segers	-142.6 127.7	47.1	62 17	Virtanen	144.4 176.7	-0.1 15.5	45				
Paneth	-94.8	63.0	65	Seidel	152.2	-32.8	62	Viviani	117.1	5.2	26				
Pannekoek Papaleksi	140.5 164.0	-4.2 10.2	71 97	Seyfert Shahinaz	114.6 122.4	29.1 7.5	110 15	Volkov Volterra	131.7 132.2	-13.6 56.8	40 52				
Paracelsus	164.0 163.1	-23.0	83	Sharonov	173.3	12.4	74	von B ékésy	126.8	51.9	96				
	ъ	C			1.00	4.6326	3.5	(1.6)	// 1	400A000A	565.5	,			

Content Cont		+Longi	itude =	East	- Longitude = West	+ Lati	itude =	North	- Latitude = South	Diam	eter (o	r long-s	side dimension) in km			
Contam Paright 172 169 29 187	Name	Long.	Lat.	Dia.	Name	Long.	Lat.	Dia.	Mame	Long.	Lat.	Dia.	Name	Long.	Lat.	Dia.
Celes Begins Cele	Catena				Mare Fecunditatis			0.00				200	Rimæ Godlenius	43.0		25000
Celes Derive 7.0 1.0 10 10 10 10 10 10									[15] [15] [15] [15] [15] [15] [15] [15]				\$1000 5000000 Dib			
Conta Factor 1970 150 60 100 1				23 - 22								317.55				
Contax Entern 720 150 60 Most Enterlation 730 75 731 8 Most Enterlation 730 75 731 8 Most Enterlation 730 74 74 75 75 75 75 75 75									Promontorium Tænarium	-8.0	-19.0	70				
Cetton Michighor 141 14 65 66 137 271									Rima Rimae							
Cettors Sylverties 481 186 29 1874 1874 1875 1875 29 28 1874 1874 1875 29 29 1744 42 29 1875 29 29 1875 29 29 29 29 29 29 29 2				10		86.1	13.3	420	Rima Agatharchides	-28.0		50	Rimae Hypatia	22.4	-0.4	
Celtres Telephore 462 614 73 Celtres Telephore 463 50 150 50 Celtres Telephore 460 50 150 50 Celtres Telephore 460 50 150 50 Celtres Telephore 460 50 Celtres 460 Celtres									1000 000 000 000 000 000 000 000 000 00							
Center Name 130 20 50 50 62 50 62 50 63 50 10 10 10 10 10 10 10				1000 TO 1								1000				8.66
Common Number Common Numbe												0.00				
Does Advisored 1									1 (C)							
Dona Alumonation 25 24 156 More Vigoroum 36 131 25 26 26 27 27 27 28 28 28 28 28				3.57	Mare Spumans	65.1	1.1	139	Rima Bradley	-1.2	23.8	161	Rimae Maupertuis	-23.0	52.0	60
Dona Alcandow			24.0	136												
Doors Derivant 150 150 120 100																
Done Demont 970 224 194 Mons Mons Again Mon					Oceanus Procellarum	-57.4	18.4	2568								
Dones Carbon 470 10 140 Mone Agene 33 186 1 Rime Cloqueta -338 300 14 Rime Fethit -226 59 Dones Ferring -304 102 214 Mone Anche 22 22 20 20 40 Rime Fethit -226 59 Part Cloqueta -348 40 22 40 Mone Anche 22 20 20 40 Rime Fethit -226 59 Part Cloqueta -348 40 20 20 20 20 20 20 20					Mons. Montes							5005				
Dones Peires 294 4102 141 Mona Arafes 52 1206 101 105					Mons Agnes				Rima Cleopatra				Rimae Pettit		-23.0	
Doors Orders																9.500
Doess Advance																
Doors Riveyon 30 70 125 Mona Delarie 358 295 30 Rums Elemanson 40 40 40 40 50 66 62 40 50 50 50 50 50 50 50									The state of the s							
Doors Relwy																1055
Does Strip	Dorsa Rubey	-42.0	-10.0	100	Mons Dieter	120.2	5.0		Rima Flammarion	-5.6	-2.8		Rimæ Repsold	-81.7	50.6	
Dona Telpew 42 19 70 80 Mone Genant 120 6 48 48 Rame Galabes -85 19 89 Rame Romer 50 70 10					2000 000 000 00 0 00											
Docum Arbano -56 294 85 100 Goutstained Gurma -40 366 20 Rimm Gey-Lusene -220 310 40 Rimm Sarains -61 -15 45 45																
Docum Arbaino																
Dozum Buchland 22 26 7 10 90 Mone Heldley Delha 38 258 15 Rim Harshen -50 1-12 25 Rims Residing * -137 10.5 62 10.0 20 20 20 20 20 20 20													450 H NAME 45			
Documu Deckland 28	Dorsum Azara	192	26.7	105	Mons Hadley Delta	3.8	25.8	15	Rima Hansteen	-53.0	-12.0	25	Rimae Stadius *	-13.7	10.5	
Docum Ceyence 12 16 84 Moor Huygence 2-9 201 40 Nime Annew 29 145 35 Rime Theesebers 60 330 90 Docum Ceyhrum 490 10 80 Moor 490 10 80 Moor 490 10 80 Moor 497 712 10 Moor 497 712 71																
Docum Cuburne				60.000	8.1982 (3.097)			2337.0					\$100.000 \$150 \$25.0000			
Docum Guetted 190 240 60 Mone Moro 197 -120 10 10 Name Prock 16 -120 154 28 Name Prock 190 100 140 Name Prock 190																
Docum Guetted		2 1 2 2 2 2						1000000		777.777.77						3155
Dorsum Hiems -298 320 148 done Fithm -1,1 406 25 Rima Marius -489 450 -10 100 Rupes Bonis -335 305 4	Dorsum Grabau				2023 2000											
Docum Higgsy 170 280 60 Mons Rimker 581 408 70 Rima Missier 450 -10 100 Rippes Datis -335 305 50 Docum Niggii -520 290 50 Mons Vinogradov -324 224 25 Rima Mischier 438 299 41 Rippes Datis -331 -321														22.6	-24 3	427
Docum Niggli	Dorsum Higazy	-17.0	28.0	60	Mons Rümker	-58.1	40.8	70	Rima Messier	45.0	-1.0	100	Rupes Boris	-33.5	30.5	4
Dorsum Oype S26 187 288 Mons Wittwins 308 194 15 Rims Oppolarer 1.0 -1.7 94 Rupes Liabig -460 -2.50 180 Dorsum Semila -604 328 108 Mont Blam 1.0 450 25 Rims Ptolemesus * -18 -9.2 153 Rupes Mercator -7.8 -2.21 134 Dorsum Termier -314 244 7 Monte Aginola -54.2 291 141 Rims Reislm -2.77 18.6 2 Rupes Recta -7.8 -2.21 134 Dorsum Termier -314 244 7 Montes Aginola -54.2 291 141 Rims Reislm -2.77 18.6 2 Rupes Recta -7.8 -2.21 134 Rupes Mercator -7.8 -7.21 Rupes Mercato					2000 MONTH 500				10015 MARKET ARE 1016				31 LOD 01 LODGE 01 LO			
Dorsum Sailla				V 0 5 0 5 0 7				1000000		113 655 7		330000				
Dorsum Termier																100
Dorsum Thera																
Dossum Zirkel -235 281 193 Montes Archimedes -4.6 25.3 163 Rims Sharp -70.5 467 107 Simus Amonis 39.1 181 130	Dorsum Thera	-31.4	24.4	7	Montes Alpes	-0.8	46.4	281	Rima Rudolf	29.6	19.6	8	165			
Montes Carpetus -44 14.5 361 Rims Sheepshanks 24.0 580 200 Simus Amonis 39.1 18.1 130														-88	10.9	200
Lacus Astatis	Dolsanizmer	200	20.1	100												
Lacus Bonitatis 437 232 99 171 110		ണ	150	00												
Lacus Doloris 90 17.1 110 Montes Jura -34.0 47.1 422 Rima Vladimir -0.7 25.2 14 Sinus Indum -31.5 44.1 236 Lacus Excellentiate -44.0 -35.4 184 Montes Pyreneus 41.2 -15.6 164 Rima War-Yu -31.5 20.0 12 Sinus Ludicus -14. 31.8 125 Lacus Felicitatis 50 190 Montes Recti -20.0 48.0 90 Rima War-Yu -31.5 20.0 12 Sinus Ludicus -14. 31.8 125 Lacus Gaudii 12.6 162 113 Montes Rephaeus -23.1 -7.7 189 Rima Vange! 4.6 167. 30 Sinus Rois -56.6 54.0 202 Lacus Hiemalis 14.0 15.0 50 Montes Rock -82.5 -20.6 791 Rima Zahia -29.5 25.0 16 Sinus Successus 79.0 0.9 132 Lacus Mortis -7.6 17.0 190 50 Montes Secchi 43.0 30.5 50 Rima Alphonsus -20.1 -14.0 80 Rima Alphonsus -47.5 -26.0 121 80																
Lacus Excellentiae -440 -35.4 184 Montes Pyreneeus 41.2 -15.6 164 Rima Wan-Yu -31.5 20.0 12 Simus Lunicus -1.4 31.8 126 Lacus Felicitatis 50 190 90 Montes Recti -20.0 48.0 90 Rima Wangell 4.6 16.7 30 Simus Romis -56.6 4.0 202 Lacus Gaudii 12.6 16.2 113 Montes Riphaeus -28.1 -7.7 189 Rima Vangell 4.6 16.7 30 Simus Romis -56.6 54.0 202 Lacus Lenitatis 120 14.0 80 Montes Rook -82.5 -20.6 791 Rima Alphonsus -20.0 -14.0 80 Lacus Lucuriae 176.0 190 50 Montes Spitzbergen -50.0 35.0 60 Rimae Alphonsus -3.0 50 Rimae Alphonsus -4.1 26.6 169 Vallis Alpes -76.2 45.9 90 121 Lacus Odii 70 190 70 Lacus Perseverantiae 62.0 80 70 Lacus Solitudinis 104.3 -27.8 139 Lacus Sommiorum 29.2 380 384 Palus Epidemiarum -28.2 -32.0 26.5 161 Rimae Bode -4.0 10.0 70 Vallis Boward -831 -383 284 Lacus Temporis 58.4 45.9 117 Lacus Timonis -7.7 3.96 117 Lacus Timonis -7.7 3.96 117 Lacus Timonis -7.7 3.96 117 Lacus Veris -861 -16.5 396 Promontorium Agassiz 18.4 42.0 20 Rimae Gassentii -40.0 -40																
Lacus Felicitatis 50 190 90 Montes Recti -200 480 90 Rima Widmamstatten 85.5 -6.1 46 Simus Medii 1.7 2.4 335 Lacus Gaudii 12.6 16.2 113 Montes Riphaeus -28.1 -7.7 189 Rima Vangel' 4.6 16.7 30 Simus Ronis -566 54.0 202 Lacus Hiemalis 12.0 14.0 80 Montes Rock -82.5 -20.6 791 Rima Zahia -29.5 25.0 16 Lacus Luxurise 1760 190 50 Montes Secchi 43.0 3.0 50 Rimae Alphomsus -20 -14.0 80 Lacus Mortis -72 450 151 Montes Tarurs 41.1 28.4 172 Rimae Anchimedes -4.1 26.6 169 Lacus Oblivionis -1680 -21.0 50 Lacus Perseverantiae 62.0 8.0 70 Lacus Ferseverantiae 62.0 8.0 70 Lacus Solitudinis 17 24 335 Montes Rock -22.5 -20.6 791 Rimae Alphomsus -20.0 -14.0 80 Lacus Solitudinis 17 24 335 Montes Rock -22.5 -20.6 791 Rimae Alphomsus -20.0 -14.0 80 Lacus Solitudinis -17 24 335 Montes Rock -22.5 -20.6 791 Rimae Alphomsus -20.0 -14.0 80 Lacus Solitudinis -17 24 335 Montes Rock -22.5 -20.6 791 Rimae Anchimedes -4.1 26.6 169 Vallis Alpes -72 24.5 166 Vallis Baade -72 24.5 90 Vallis Bohr -866 12.4 80 Lacus Solitudinis -72 -73 189 70 Lacus Solitudinis -72 -73																
Lacus Hiemalis 140 150 50 Montes Rook -82.5 -20.6 791 Rima Zahia -29.5 25.0 16 Simus Successus 59.0 0.9 132	Lacus Felicitatis	5.0	19.0	90	Montes Recti	-20.0	48.0	90	Rima Widmannstatten *	85.5	-6.1	46	Simus Medii	1.7	2.4	335
Lacus Luxurise 120 140 80 Montes Secchi 430 30 50 Rimse Alphonsus 530 50 230 Vallis																
Lacus Montis 772 450 151 Montes Taurus 41.1 28.4 172 Rimae Anthimedes -41 26.6 169 Vallis Alpes 32 48.5 166 Lacus Oblivionis -1680 -210 50 Montes Teneriffe -11.8 47.1 182 Rimae Anthimedes -47.5 26.9 121 Vallis Bade -762 45.9 203 Lacus Odii 70 190 70 Lacus Perseverantiae 62.0 8.0 70 Lacus Solitudinis 104.3 -27.8 139 Palus Epidemiarum -28.2 -32.0 286 Rimae Bode -40 10.0 70 Vallis Bouward -831 -383 224 Lacus Spei 650 43.0 80 Palus Putredinis 0.4 26.5 161 Rimae Boscovich 11.1 9.8 40 Vallis Capella 34.9 -7.6 49 Lacus Temporis 58.4 45.9 117 Lacus Temporis -27.3 -38.8 117 Lacus Venis -861 -16.5 396 Planitia Descensus -64.4 7.1 1 Rimae Darwin -69.5 -19.3 143 Vallis Planck 126.1 -58.4 451 Mare, Oceanus Mare Anguis 67.7 22.6 150 Promontorium Agarum 66.0 14.0 70 Rimae Gassendi -40.0 28.0 90 Vallis Schröteri -50.0 23.1 592 Mare Cognitum -23.1 -10.0 376 Promontorium Ancherusia 20.0 16.7 10 Rimae Gassendi -40.0 -18.0 70					Montes Secchi				Rimae Alphonsus					25.0	0.5	152
Lacus Oblivionis -1680 -210 50 Montes Teneriffe -118 47.1 182 Rimae Anistarchus -47.5 26.9 121 Vallis Baade -762 45.9 203														20	40 E	166
Lacus Odii																
Lacus Solitudinis 1043 -27.8 139	Lacus Odii	7.0	19.0	70					Rimae Arzachel	-2.0	-18.0		Vallis Bohr	-86.6	12.4	80
Lacus Somniorum 292 380 384 Palus Putredinis 0.4 26.5 161 Rimae Boscovich 11.1 9.8 40 Vallis Christel 11.0 24.5 2 Lacus Spei 650 43.0 80 Palus Somni 45.0 14.1 143 Rimae Biug 23.8 44.5 147 Vallis Inghiuami -72.2 43.8 148 Lacus Temporis -77.3 -38.8 117 Lacus Timonis -77.3 -38.8 117 Planitia Planitia Descensus -64.4 7.1 1 Rimae Darwin -69.5 -19.3 143 Vallis Planitka Descensus -64.4 7.1 1 Rimae Darwin -69.5 -19.3 143 Vallis Planitka Descensus -51.1 -24.6 93 Vallis Planitka Descensus -51.5 42.5 445 Mare Anguis 67.7 22.6 150 Promontorium Agarum 66.0 14.0 70 Rimae Gassendi -40.0 28.0 90 Vallis Schröteri -50.8 26.2 168 Mare Cognitum -23.1 -10.0 376 Promontorium Archerusia 22.0 16.7 10 Rimae Gassendi -40.0 -18.0 70						-28.2	-32 N	286								
Lacus Temporis 584 459 117 Lacus Temporis 584 459 117 Lacus Timonis -273 -388 117 Planitia -264 71 1 Rimae Danvin -695 -193 143 Vallis Flaitzsch 64.3 -264 132 Lacus Venis -661 -165 396 Planitia Descensus -64.4 7.1 1 Rimae Danvin -695 -193 143 Vallis Flaitzsch 1261 -584 451 Vallis Planck 1261 -584 451	Lacus Somniorum	292	38.0	384	Palus Putredinis	0.4	26.5	161	Rimae Boscovich	11.1	9.8	40	Vallis Christel	11.0	24.5	2
Lacus Timonis -273 -388 117 Planitia					Palus Somni	45.0	14.1	143								
Lacus Veris -86.1 -16.5 396 Planitia Descensus -64.4 7.1 1 Rimae Darwin -69.5 -19.3 143 Vallis Planck 126.1 -58.4 451					Planitia											
Mare, Oceanus Promontorium Rimae Doppelmayer -45.1 -25.9 162 Vallis Schrödinger 105.0 -67.0 310 Mare Anguis 67.7 22.6 150 Promontorium Agarum 66.0 14.0 70 Rimae Focas -98.0 -28.0 100 Vallis Schröteri -50.8 26.2 168 Mare Austale 93.0 -38.9 603 Promontorium Agassiz 1.8 42.0 20 Rimae Fresnel 4.0 28.0 90 Vallis Snellius 56.0 -31.1 592 Mare Cognitum -23.1 -10.0 376 Promontorium Archerusia 22.0 16.7 10 Rimae Gessendi -40.0 -18.0 70 Vallis Snellius 56.0 -31.1 592	Lacus Veris	-86.1	-16.5	396	Planitia Descensus	-64.4	7.1	1						126.1	-58.4	
Mave Anguis 67.7 22.6 150 Promontorium Agarum 66.0 14.0 70 Rimae Focas -98.0 -28.0 100 Vallis Schröteri -50.8 26.2 168 Mave Australe 93.0 -38.9 603 Promontorium Agassiz 1.8 42.0 20 Rimae Fresnel 4.0 28.0 90 Vallis Snellius 56.0 -31.1 592 Mave Cognitum -23.1 -10.0 376 Promontorium Archerusia 22.0 16.7 10 Rimae Gessendi -40.0 -18.0 70	Mare. Oceanus				Promontorium							33557				
Maue Cognitum -23.1 -10.0 376 Promontorium Archerusia 22.0 16.7 10 Rimae Gassendi -40.0 -18.0 70	Mare Anguis	67.7			Promontorium Agerum				Rimae Focas	-98.0	-28.0	100	Vallis Schröteri	-50.8	26.2	168
													Yallis Snellius	56.0	-31.1	592
													* IAU- d	ropped	name	

	, v		
Abbot 阿博特	2	Avery 艾弗里	Event 1 (T116)
Abel 艾貝爾	Event 1 (T056D), Farside	Azophi 阿索菲	31
Abenezra 阿拜內茲臘	31	Baade 巴德	Farside
Abulfeda 阿布費達	31	Babbage 畢德格勒	16, 17
Abundance of Elements 元素豐度	1	Back 貝克	Event 1 (T116)
Acosta 阿科斯特	3, Event 1 (T116)	Baco 培根	30
Adams 亞當斯	3, Farside	Baillaud 白勞德	Event 1 (T171)
Agatharchides 阿加撤契德	24, 25	Bailly 貝利	29, Event 1 (T197), Event 3
Age of the Moon 月齡	Overview, Event 2	Baily 貝里	10
Agrippa 阿格里巴	9, 13	Balboa 鮑保亞	23, Event 1 (T204)
Airy 艾里	20, 31	Ball 鮑爾	11 , 12
Alan 阿倫 (艾倫)	31	Balmer 巴爾默	3
Al-Bakri 艾爾巴克里	9	Banachiewicz 巴納切耶維奇	Event 1 (T160)
Albategnius 阿爾巴塔尼	12 , 31	Bancroft 班克羅夫特	14
Albedo 反照率	Overview, 20 , Moon Data	Banting 班丁	9
Aldrin 艾德林	8	Barkla 巴其阿	3, Event 1 (T160)
Alexander 亞歷山大	15	Barnard 巴納德	Event 1 (T056D), Farside
Alfraganus 阿法堅努斯	9, 31	Barocius 巴羅齊	30
Alhazen 阿哈辛	2	Barrow 巴羅	16
Aliacensis 阿里辛西斯	30 , 31	Bayer 拜爾	28
Almanon 阿耳曼農	31	Beals 比斯	Event 1 (T056D)
Al-Marrakushi 阿馬拉庫殊	3	Beaumont 博蒙特	• • •
Alpetragius 阿彼德拉基	3 12	Beer 比爾	5, 7
		7 31.13	14 , 31
Alphonsus 阿方索	Overview, 12	Beketov 貝其托夫	9
Ameghino 阿米欣奴	2	Belkovich 別爾科維奇	10, Event 2
Ammonius 埃蒙尼斯	12	Bellot 貝洛	3, 5
Amontons 埃蒙頓斯	6	Bernoulli 伯諾里	2 , 10
Amundsen 阿蒙遜	Event 1 (T202), Farside	Berosus 伯羅薩斯	10 , Event 1 (T056D),
Anaxagoras 阿諾薩哥拉斯	16 , 17, 33, Farside	Bertaud 伯陶 (former crater name)	27
Anaximander 亞諾芝曼德	16, 17	Berzelius 伯齊列斯	10
Anaximenes 亞諾芝門斯	16, 17	Bessarion 貝沙利翁	20, 21
Ancient Newton 古牛頓	16	Bessel 貝塞爾	9 , 33
Anděl 安德爾	31	Běla 貝勒	14
Angström 埃斯特朗	21	Bettinus 貝蒂納斯	29
Angular Diameter 角直徑	Overview	Bianchini 比安齊尼	16, 18
Angular Momentum 角動量	Overview, Moon Data	Biela 比拉	30
Anorthosite 斜長岩	Overview, 1, 30, 33	Bilharz 比爾哈澤	3
Ansgarius 安斯奎立阿	Event 1 (T056D)	Billy 比利	27
Anville 安維爾	6	Birmingham 伯明翰	16
Apianus 阿皮納	30, 31	Diet /HZEFIEL	
	JU, J I	Birt 伯爾特	12 , 24, 33
Apogee 遠地點	Overview	Biot 比奥	12 , 24, 33 3
Apogee 遠地點 Apollo Missions 阿波羅登月任務			
Apollo Missions 阿波羅登月任務	Overview	Biot 比奧 Black 布萊克	3
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯	Overview 21, Spacecraft	Biot 比奧 Black 布萊克 Blagg 布萊	3 Event 1 (T116) 12, 13
Apollo Missions 阿波羅登月任務	Overview 21, Spacecraft 2, Event 1 (T116)	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯	3 Event 1 (T116)
Apollo Missions阿波羅登月任務Apollonius阿波朗尼斯Arago阿拉果	Overview 21, Spacecraft 2 , Event 1 (T116) 8	Biot 比奧 Black 布萊克 Blagg 布萊	3 Event 1 (T116) 12, 13 11, 29
Apollo Missions阿波羅登月任務Apollonius阿波朗尼斯Arago阿拉果Aratus阿拉圖 (亞羅特)	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯	3 Event 1 (T116) 12, 13 11, 29 31
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮	3 Event 1 (T116) 12, 13 11, 29 31
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160)
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171)	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻章	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫 Asada 阿薩特	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12 6	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻章 Born 玻恩	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9 3, Event 1 (T160)
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫 Asada 阿薩特 Asclepi 阿斯克列皮	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12 6 30	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻達 Born 玻恩 Boscovich 波士高維	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9 3, Event 1 (T160) 13
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫 Asada 阿薩特 Asclepi 阿斯克列皮 Atlas 阿特拉斯	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12 6 30 10	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻章 Born 玻恩 Boscovich 波士高維 Bouguer 布格	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9 3, Event 1 (T160) 13 16
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫 Asada 阿薩特 Asclepi 阿斯克列皮 Atlas 阿特拉斯 Atwood 阿伍德	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12 6 30 10 3	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻章 Born 玻恩 Boscovich 波士高維 Bouguer 布格 Boussingault 布辛高爾特	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9 3, Event 1 (T160) 13 16 Overview, 30, Event 1, Farside
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫 Asada 阿薩特 Asclepi 阿斯克列皮 Atlas 阿特拉斯 Atwood 阿伍德 Autolycus 奧托利克	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12 6 30 10 3 9, 14, 15, 33	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻章 Born 玻恩 Boscovich 波士高維 Bouguer 布格 Boussingault 布辛高爾特 Bowen 鮑恩	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9 3, Event 1 (T160) 13 16 Overview, 30, Event 1, Farside 9
Apollo Missions 阿波羅登月任務 Apollonius 阿波朗尼斯 Arago 阿拉果 Aratus 阿拉圖 (亞羅特) Archimedes 阿基米德 Archytas 阿奇達斯 Argelander 阿格蘭德 Ariadaeus 阿麗阿黛 Aristarchus 亞利斯塔克 Aristillus 亞利斯基爾 Aristoteles 亞利斯多德 Armstrong 阿姆斯特朗 Arnold 阿諾德 Artsimovich 阿爾斯莫維奇 Aryabhata 阿亞哈特 Arzachel 阿爾扎赫 Asada 阿薩特 Asclepi 阿斯克列皮 Atlas 阿特拉斯 Atwood 阿伍德	Overview 21, Spacecraft 2, Event 1 (T116) 8 14 14, Overview 16 31 13, 33 21, 33, Event 3 9, 14, 15, 33 15, 16, 31 8 Event 1 (T171) 22 6 12 6 30 10 3	Biot 比奧 Black 布萊克 Blagg 布萊 Blancanus 布蘭薩努斯 Blanchinus 布蘭奇努斯 Bliss 布利斯 Blue Moon 藍月亮 Bobillier 博比利埃 Bode 波得 Boethius 波費斯 Boguslawsky 鮑古斯拉夫斯基 Bohnenberger 波蘭貝格 Bohr 玻爾 Bombelli 邦貝利 Bonpland 邦普蘭 Borda 玻達 Borel 玻章 Born 玻恩 Boscovich 波士高維 Bouguer 布格 Boussingault 布辛高爾特	3 Event 1 (T116) 12, 13 11, 29 31 16 Overview 9 13 Event 1 (T160) 30, Event 1 (T202), Farside 5, 7 23 2 12 5 9 3, Event 1 (T160) 13 16 Overview, 30, Event 1, Farside

	,	, ,	
Breislak 布賴斯拉克	30	Clausius 克勞西斯	25
Brenner 布林納	4 , 5	Clavius 克拉維	11 , 29, 30
Brewster 布魯斯特	9	Clementine (Lunar Probe) 克萊門泰探月器	1, 33, Farside, Spacecraft
Brianchon 布賴恩松	Farside	Cleomedes 克努梅迪	2, Event 1 (T056D)
Briggs 布里格斯	23, Event 1 (T204)	Clerke 克萊克	9
Bright (White) Halo 光(白)暈	6, 8, 9, 12, 13, 20, 33	Cobra's head 響尾蛇頭	21
Brightness of the Moon 月面亮度	Overview, Event 4	Collins 柯林斯	8
Brisbane 布列斯本	4, Farside	Colombo 哥倫布	3, 5, 7
Brown 布朗	11 , 29	Colongitude 餘經度	Overview, Event 2
Bruce 布魯斯	12, 13	Compton 康普頓	Event 2, Farside
Bullialdus 布利奥杜	24 , 25	Condon 康唐	2, Event 1 (T116)
Bunsen 本生	Event 1 (T204)	Condorcet 康多塞	2 , Event 1 (T056D)
Burckhardt 布克哈特	2	Conon 科龍	14
Bürg 布龍格	10 , 15	Cook 庫克	3, 5, 7
Burnham 伯納姆	12 , 31	Copernicus 哥白尼	19 , 33, Event 2
Byrd 伯德	16 , Event 2, Farside	Crater Formation 環形山的形成	Overview, 19
Byrgius 伯朱斯	27 , 33, Event 1 (T203)	Crater Array 環形山陣	31
C. Herschel 卡羅琳·赫歇爾	18	Craters named after Chinese 環形山 (華人名)	Farside
C. Mayer 克里斯琴・梅耶	16	Crescent 娥眉月	Event 2, Event 3
Cabeus 卡比斯	29, Event 1 (T197)	Crile 克里	2
Calinnua 片刊並	9	Crozier 克羅澤	3
Calippus 卡利普	15	Crüger 羅卡	27 , Event 1 (T203)
Campanya 唐帕奴斯	6	Crust (Lunar) 月殼	1 Farside
Campanus 康帕努斯 Cannon 坎農	24 , 25	Curie 居里 Curtis 柯蒂斯	2
Capella 卡彼拉	Event 1 (T056D)	Curtius 柯第斯	29
Capuanus 卡普納斯	5, 6, 7 24 , 29	Cusanus 庫薩努斯	Event 1 (T171)
Cardanus 卡丹尼斯	23 , 31, Event 1 (T204)	Cuvier 居維頁	30
Carlini 卡利尼	18	Cyrillus 西里爾	5 , Event 2
Carmichael 卡邁克爾	2	Cysatus 西沙特	29
Carpenter 卡本特	16, 17	d'Arrest 達雷斯達	13, 33
Carrel 卡里	8, 9	da Vinci 達芬奇	2, 6
Carrillo 卡里羅	Event 1 (T116)	Daguerre 達蓋爾	7
Cartan 卡坦	2	Dale 戴爾	Event 1 (T116)
Casatus 卡薩圖斯	11, 29 , Event 1 (T197)	Dalton 多爾頓	23 , Event 1 (T204)
Cassini 卡西尼	15	Daly 戴利	2
Cassini's Bright Spot 卡西尼光斑	11, 33	Damoiseau 達毛西	26, 27
Catena Abuldeda 阿布費達環形山串	31	Daniell 丹尼爾	9, 10
Catena Davy 戴維環形山串	12, 31	Darney 達恩里	24
Catena Humboldt 洪堡環形山串	Farside	Dark Halo Crater 黑暈環形山	12, 19
Catena Krafft 克拉夫特環形山串	23 , 31	Dark Mantle Deposit 暗地幔澱積物	9 , 12, 33
Catana Timocharis 提莫恰里斯環形山串	14	Darwin 達爾文	27, Event 1 (T203)
Catharina 凱瑟琳娜	5 , 31	Daubrée 道比	9
Cauchy 科西	2, 6	Davy 戴維	12, 31
Cavalerius 卡瓦勒里斯	20, 26, Event 1 (T204)	Dawes 道斯	9
Cavendish 卡文迪	25 , Event 3	de Gasparis 德加斯帕里斯	25
Caventou 卡文陶	18	de la Rue 德拉呂	10
Cayley 凱利	13, 33	de Morgan 德摩根	13
Celsius 攝氏	5	de Sitter 德西特	16, Event 1 (T171), Farside
Censorinus 賽索瑞納斯	6	de Vico 德維科	27
Center of Mass 質心	Overview	Debes 德比斯	2
Central Peak 中央峰	Overview	Delambre 德朗布爾	8 , 13, 33
Cepheus 仙王	10	Delaunay 德朗尼	31
Chacornac 查科納克	9	Delia 迪莉婭	31
Challis 查理士	16	Delisle 德利爾	18, 21, 22
Chang Heng 張衡	Farside	Delmotte 德莫提	2
Chang-Ngo 嫦娥	12, Farside	Dembowski 德保斯基	13
Chang'e-1 (lunar probe) 嫦娥一號探月器	Spacecraft	Democritus 德蒙克特斯	Event 1 (T171)
Chevallier 薛瓦利埃	10	Demonax 德蒙勒斯	30 , Event 1 (T202), Farside
Ching-Te 正德 (暫譯)	9, Farside	Descartes 德卡蒂斯 (笛卡兒)	31
Chladni 克拉尼	13	Deseilligny 德塞利格尼	9
Clairent 声點	11	Deslandres 德朗達爾	11 , 12, 30, 31, 33
Clairaut 克勒羅	30	Diamondback Rille 達蒙布萊克溝紋	8

Differentiation (magma ocean) 分化(岩洋)	1	Fabbroni 法布朗里	9
Dionysius 迪奧尼修斯	9, 13 , 33	Fabricius 法彼里齊	4 , 5
Diophantus 迪奧芬塔斯	22	Fabry 法布里	Event 2, Farside
Dollond 多朗	31	Fahrenheit 華氏	2
Dome 拱形小山 (拱丘)	Overview, 31, 32	Faraday 法拉第	30
Donati 杜納提	31	Farside of the Moon 月背面	1, Event 2, Farside
Doppelmayer 多彼梅耶	25	Fauth 霍夫	19
Dorsa Aldrovandi 奧祖溫迪皺脊群	9	Faye 法伊	31
Dorsa Argand 阿蓋倫皺脊群	21	Fedorov 弗多沃	22
Dorsa Barlow 巴羅皺脊群	9	Fermat 弗麥克	5, 31
Dorsa Burnet 伯內特皺脊群	21	Fernelius 弗留利斯	30
Dorsa Cato 卡圖皺脊群	6	Feuillée 福伊利	14
Dorsa Harker 哈卡皺脊群	2	Finsch 芬施	9
Dorsa Lister 利斯特皺脊群	9	Firmicus 弗米卡斯	2, Event 1 (T160)
Dorsa Mawson 摩遜皺脊群	6	Flammarion 弗拉馬利翁	12
Dorsa Rubey 魯比皺脊群	20	Flamsteed 弗蘭斯蒂德	20
Dorsa Smirnov 史米爾諾夫皺脊群	9	Fontana 方塔納	27
Dorsa Stille 斯蒂爾皺脊群	18	Fontenelle 方提內里	16
Dorsa Tetyaev	2	Foucault 傅科	16, 18
Dorsum Bucher 巴查皺脊	22	Fourier 傅里葉	25, 28 , Event 3
Dorsum Buckland 巴克蘭皺脊	9	Fra Mauro 弗拉摩洛	12
Dorsum Cayeux	6	Fracastorius 弗卡斯托爾	5 , 7
Dorsum Cushman 庫曼皺脊	6	Franck 弗蘭克	9
Dorsum Gast 加斯皺脊	9	Franklin 富蘭克林	10
Dorsum Guettard 古特皺脊	12	Franz 弗朗斯	2 , 9
Dorsum Heim 海姆皺脊	18	Fraunhofer 夫琅和費	5 , Event 1 (T056D), Farside
Dorsum Higazy 海格西皺脊	14	Fredholm 弗雷德霍姆	2
Dorsum Nicol 尼科爾皺脊	9	Freud 弗洛伊德	21
Dorsum Niggli	21	Furnerius 弗內留斯	3 , 5, 33, Event 1 (T056D)
Dorsum Oppel 奧皮爾皺脊	2	G. Bond G・邦德	9
Dorsum Owen 歐文皺脊	9	Galen 加蘭	14
Dorsum Termier 特米亞皺脊	2	Galilaei 伽利略	23 , 26
Dorsum von Cotta 科塔皺脊	9	Gambart 加巴特	19
Dorsum Zirkel	18	Gardner 加德納	9
Draper 德雷珀	19	Gärtner 加特納	Event 1 (T171)
Drebbel 德雷貝爾	28	Gassendi 加桑迪	25
Drygalski 德賴蓋斯基	29, Event 1 (T197)	Gaudibert 高迪伯特	5, 7
Dubiago 杜比阿果	Event 1 (T160)	Gauricus 高里克	11, 12
Dunthorne 鄧桑	24, 25, 29	Gauss 高斯	10 , Event 1 (T056D), Event 2
Earth-Moon System 地月系統	Overview	Gay-Lussac 給呂薩克	19
Earthshine 地照	21, Event 3	Geber 賈貝爾	31
Eckert 埃克特	21, Event 3	Geissler 格西納	Event 1 (T160)
Eclipse (Lunar, Solar) 食 (蝕)	Event 4	Gemma Frisius 格馬弗里修斯	30
Eddington 愛丁頓		Geminus 杰米納斯	
Egede 愛格德	23 , Event 1 (T204) 15	Geologic Timescale, Lunar 月球地質紀年	2 , 10, 33, Event 1, Event 2
Eichstadt 埃斯達特	27, Event 1 (T203)	Ghost Crater 假環形山	1, 12, 19, 24 Overview, 7, 8, 12,15,19,20
Eimmart 埃馬特	27, Event 1 (1200)	Giant Impact Theory 大碰撞論	1
Einstein 愛因斯坦	23, Farside	Gibbs 吉布斯	Event 1 (T056D), Farside
Ejecta / Ejecta Blanket 噴出物 / 覆蓋物	Overview, 2, Farside	Gilbert 吉爾伯特	Event 1 (T160)
Elger 埃爾加	24, 29	Gill 吉爾	Farside, Spacecraft
Elmer 埃爾默	•	Gioja 宙雅	•
Elongated Crater 長形環形山	Event 1 (T116)	Glaisher 克萊謝	16 2
Encke 恩克	3, 4, 6, 12, 14, 20, 28	Glushko 格拉什科	
Endymion 恩迪米昂	20 0.40 Front 1 (T0ECD)		23 , 26, 33, Event 1 (T204)
,	9, 10 , Event 1 (T056D)	Goclenius 笱克蘭留斯 Goddard 戈達德	5, 7
Epigenes 愛皮吉尼斯	16	Godin 哥登	1, Event 1 (T056D)
Epimenides 愛皮曼尼迪斯	29		9, 13 , 33
Eppinger 愛皮格	20 Overview 14 10 21 22	Goldschmidt 戈爾德史密特	16, Farside
Eratosthenes 愛拉托遜	Overview, 14, 19 , 31, 33	Goodacre 古德卡	30
Esclangon 埃斯蘭戈	2, 9	Gould 古爾德 Groupes 故事土斯	24
Euclides 歐幾里得	20 , 33	Greaves 格雷夫斯	2 20 26 27 Event 1
Euctemon 尤地蒙	16, Event 1 (T171)	Grimaldi 格里馬第	2, 20, 26 , 27, Event 1
Eudoxus 歐多克斯	15 10 21	Grove 格羅夫	10
Euler 歐拉	19 , 31	1	

Gruemberger 格魯貝格	11, 29	Ibn Battuta 伊布恩・帕托塔	6
Gruithuisen 格魯蘇申	21, 22	Ibn Rushd 伊布恩・拉什德	5 , 31
Guericke 格里克	12 , 24	Illumination 照度	Event 2
Gum 甘姆	Farside	Imbrium Sculpture 雨海刻蝕	12 , 31
Gutenberg 古坦堡	5, 7	Impact Basin 隕擊盆地	Overview, 1, 5, 10, 26, 28
Gyldén 吉爾當	12	Ina 艾娜 (艾那)	9
Hagecius 哈格修斯	30	Inghirami 英希拉米	28, Farside
Hahn 哈恩	10 , Event 1 (T056D)	Isidorus 伊西多爾	5, 6, 7
Haidinger 海丁格	29	J. Herschel 約翰·赫歇爾	16, 17
Hainzel 海恩舍爾	25, 29	Jacobi 雅各比	30
Haldane 霍爾丹	Event 1 (T116)	Jansen 贊生	8, 9
Hale 海爾	30 , Event 1 (T202), Farside	Janssen 贊桑	3, 4 , 5
Hall 霍爾	9	Jeans 金斯	Farside
Halley 哈雷	12, 31	Jehan 杰漢	19
Hamilton 漢密爾頓	4, Event 1 (T056D), Farside	Jenkins 詹金斯	Event 1 (T160)
Hanno 韓諾	4 , Farside	Jenner 詹納	Farside
Hansen 漢森	2	Joliot 約里奧	Event 2 , Farside
Hansteen 韓斯坦	26, 27	José 荷西	12
Hargreaves 哈格雷夫斯	Event 1 (T116)	Joy 喬伊	14
Harold 哈羅德	31	Julius Caesar 儒略凱撒	13
Harpalus 哈巴勒斯	16	Kaiser 凱撤	30
Hartwig 赫惠	26 , Event 1 (T203)	Kane 凱恩	
		Kant 康德	Event 1 (T171)
Harvest Moon 穫月	Overview		5 , 31
Hase 哈斯	3 40 Frant 2	Kao (Kao Ping-Tse) 高平子	Event 1 (T029), Farside
Hayn 海恩	10, Event 2	Kapteyn 卡普坦	3, Event 1 (T160)
Hecataeus	Event 1 (T056D), Farside	Kästner 卡斯特納	Event 1 (T116)
Hedin 希迪	20, 26 , Event 1 (T204)	Keldysh 科爾迪斯	10
Heinrich 亨理	14, 19	Kepler 開普勒	20 , 33
Heis 希斯	18, 22	Kies 基斯	11, 24 , 25
Helicon 黑利康	18	Kiess 凱斯	Event 1 (T116)
Hell 赫爾	11 , 12	Kirch 基歇	15
Helmert 赫默	Event 1 (T116)	Kircher 基歇爾	29 , Event 1 (T197)
Helmet, The 頭盔	24 , 25	Kirchhoff 基爾霍夫	9
Helmholtz 赫姆霍兹	30 , Event 1 (T202)	Klaproth 克拉普羅特	11, 29 , Event 1 (T197)
Henry 亨利	27	Klein 克蘭	12 , 31
Henry Frères 亨利普羅斯珀	27, Event 1 (T203)	König 孔尼格	24 , 25
Heraclites 赫拉克里斯	30	Krafft 克拉夫特	23, 31, Event 1 (T204)
Hercules 赫庫列斯	10	Krasnov 克拉斯諾夫	Event 1 (T203), Farside
Herigonius A 赫里戈尼斯 A	25		
		KREEP 克里普岩	1
Hermann 赫爾曼	26	Kreiken 克拉肯	Event 1 (T116)
Hermite 赫爾米	26 Farside	Kreiken 克拉肯 Krieger 克奈格	Event 1 (T116) 21
Hermite 赫爾米 Herodotus 赫羅多特	26 Farside 21	Kreiken 克拉肯 Krieger 克奈格 Krishna (<i>IAU-dropped name</i>)	Event 1 (T116) 21 9
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾	26 Farside 21 12	Kreiken 克拉肯 Krieger 克奈格 Krishna (<i>IAU-dropped name</i>) Krogh 克羅赫	Event 1 (T116) 21 9 2 , Event 1 (T160)
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特	26 Farside 21 12 11	Kreiken 克拉肯 Krieger 克奈格 Krishna (<i>IAU-dropped name</i>) Krogh 克羅赫 Krusentern 克魯辛斯坦	Event 1 (T116) 21 9 2 , Event 1 (T160) 31
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯	26 Farside 21 12 11 20, 26 , Event 1 (T204)	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯	Event 1 (T116) 21 9 2 , Event 1 (T160) 31 20
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 <i>Highlands</i> 高地	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德	Event 1 (T116) 21 9 2 , Event 1 (T160) 31 20 12 , 24
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12 , 31	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12 , 31	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160)
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12, 31 3 30	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12, 31 3 30 10	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Aestatis 夏湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203)
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12, 31 3 30 10 9	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Aestatis 夏湖 Lacus Autumni 秋湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡	26 Farside 21 12 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12, 31 3 30 10 9 17	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Autumni 秋湖 Lacus Bonitatis 好湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡 Horrocks 霍羅克斯	26 Farside 21 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12, 31 3 30 10 9 17 12, 31	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Aestatis 夏湖 Lacus Bonitatis 好湖 Lacus Doloris 悲湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2 9
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡 Horrocks 霍羅克斯 Hortensius 賀坦西斯	26 Farside 21 11 20, 26 , Event 1 (T204) 1 2 12, 31 , 33 24, 25 12, 31 3 30 10 9 17 12, 31	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Autumni 秋湖 Lacus Bonitatis 好湖 Lacus Doloris 悲湖 Lacus Excellentiae 優湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2 9 25
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡 Horrocks 霍羅克斯 Hortensius 賀坦西斯 Hubble 哈勃	26 Farside 21 12 11 20, 26, Event 1 (T204) 1 2 12, 31, 33 24, 25 12, 31 3 30 10 9 17 12, 31 19 Event 1 (T056D), Event 2	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Autumni 秋湖 Lacus Bonitatis 好湖 Lacus Excellentiae 優湖 Lacus Felicitatis 福湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2 9 25 9
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡 Horrocks 霍羅克斯 Hortensius 賀坦西斯 Hubble 哈勃 Huggins 哈金斯	26 Farside 21 12 11 20, 26, Event 1 (T204) 1 2 12, 31, 33 24, 25 12, 31 3 30 10 9 17 12, 31 19 Event 1 (T056D), Event 2 11, 30	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Autumni 秋湖 Lacus Bonitatis 好湖 Lacus Excellentiae 優湖 Lacus Felicitatis 福湖 Lacus Gaudii 喜湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2 9 25 9 9
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡 Horrocks 霍羅克斯 Hortensius 賀坦西斯 Hubble 哈勃 Huggins 哈金斯 Humboldt 洪堡	26 Farside 21 11 20, 26, Event 1 (T204) 1 2 12, 31, 33 24, 25 12, 31 3 30 10 9 17 12, 31 19 Event 1 (T056D), Event 2 11, 30 3, Event 1 (T056D), Farside	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Autumni 秋湖 Lacus Bonitatis 好湖 Lacus Excellentiae 優湖 Lacus Felicitatis 福湖 Lacus Gaudii 喜湖 Lacus Hiemalis 冬湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2 9 25 9 9
Hermite 赫爾米 Herodotus 赫羅多特 Herschel 赫歇爾 Hesiodus 赫斯特 Hevelius 赫維留斯 Highlands 高地 Hill 希爾 Hind 欣德 Hippalus 依巴勒斯 Hipparchus 依巴谷 Holden 荷頓 Hommel 霍梅爾 Hooke 胡克 Hornsby 霍恩斯比 Horrebow 赫瑞堡 Horrocks 霍羅克斯 Hortensius 賀坦西斯 Hubble 哈勃 Huggins 哈金斯	26 Farside 21 12 11 20, 26, Event 1 (T204) 1 2 12, 31, 33 24, 25 12, 31 3 30 10 9 17 12, 31 19 Event 1 (T056D), Event 2 11, 30	Kreiken 克拉肯 Krieger 克奈格 Krishna (IAU-dropped name) Krogh 克羅赫 Krusentern 克魯辛斯坦 Kuiper 柯伊伯 Kundt 昆德 Kunowsky 昆諾斯基 Kuo Shou Ching 郭守敬 la Caille 拉卡爾 la Condamine 拉孔達米恩 la Pérouse 拉佩魯斯 Lacroix 拉克魯阿 Lacus Autumni 秋湖 Lacus Bonitatis 好湖 Lacus Excellentiae 優湖 Lacus Felicitatis 福湖 Lacus Gaudii 喜湖	Event 1 (T116) 21 9 2, Event 1 (T160) 31 20 12, 24 20 Farside 12, 31 16, 18 Event 1 (T160) 28 27, Event 1 (T203) 1, Event 1 (T203), Farside 2 9 25 9 9

	(Ellian yearan es	u. c sy 11 2up 110u)	
Lacus Odii 恨湖	9	Luther 路德 (盧瑟)	9 , 10
Lacus Perseverantiae 久湖	2	Lyell 萊爾	2, 6
Lacus Somniorum 夢湖	1, 9, 10	Lyot 李約	4, Event 1 (T056D), Farside
Lacus Spei 願望湖	2 , 10	Maclaurin 馬克洛林	Event 1 (T160)
Lacus Timorous 懼湖 (恐湖)	25, 29	Maclear 馬克利爾	8
Lacus Veris 春湖	1, Event 1 (T203), Farside	MacMillan 麥克米爾	14
Lade 拉德	13	Macrobius 馬克羅比	2
Lagalla 拉格拉	29	Mädler 馬德勒	5 , 7
Lagrange 拉格朗日	28	Maestlin 馬士連	20 , 31
Lagrangian Point 拉格朗日點	Moon Data	Magelhaens 麥哲倫	5, 7
Lalande 拉朗德	12 , 19, 33	Maginus 馬紀努斯	11 , 30
Lamarck 拉馬	27, Event 1 (T203)	Magma 岩漿	1 , 20, 28
Lamb 蘭姆	Farside	Main 梅恩	16
Lambert 蘭伯特	18 , 19	Mairan 梅蘭	16, 21, 22
Lamé 拉美	3	Malapert 馬拉珀特	Event 1 (T197), Farside
Laméch 萊麥克	15	Mallet 莫萊特	4 , 5
Lamont 拉蒙	8	Manilius 曼尼林	9 , 33
Landslide (Landslip) 山崩	12, 15, 16 , 25	Manners 曼納斯	8 , 13, 33
Langrenus 朗格努斯	3 , 6, 33, Event 1 (T056D)	Manzinus 曼仙尼	Event 1 (T202)
Lansberg 蘭斯堡	19 , 20	Maraldi 馬拉迪	9
Laser Ranging 激光測距	8, Spacecraft, Moon Data	Marco Polo 馬可勃羅	14
Lassell 拉塞爾	12	Mare Anguis 蛇海	1, 2 , Event 1 (T056D)
Lavoisier 拉瓦錫	Event 1 (T204)	Mare Australe 南海	1, 4 , Event 1, Farside
Lawrence 勞倫斯	6	Mare Basalt 月海玄武岩	Overview, 1
le Gentil 勒喬恩泰	Event 1 (T197)	Mare Cognitum 知海	1 , 12, 20
le Monnier 勒蒙尼亞	9	Mare Crisium 危海	Overview, 1, 2, Event 1, Event 2
le Verrier 勒威耶	18	Mare Fecunditatis 豐富海	1, 2, 3, 6 , Event 2
Leakey 利基	5, 6	Mare Frigoris 冷海	1 , 10, 15, 16, 17
Lee 李	25	Mare Humboldtianum 洪堡海	1, 10 , Event 1, Event 2
Legendre 勒讓德	3, Event 1 (T056D), Farside	Mare Humorum 濕海	1, 25
Lehmann 萊曼	28	Mare Imbrium 雨海	1 , 9, 14, 15, 16, 18, 19, Event 2
Leibnitz Mountains 萊布尼茲山脈	Event 1 (T197)	Mare Ingenii 智海	Farside
Lepaute 萊潘特	29	Mare Insularum 島海	1 , 19
Letronne 利賽尼	20 , 25	Mare Marginis 界海	1, Event 1, Event 2
Lexell 萊克塞爾	11 , 12	Mare Moscoviense 莫斯科海	Farside
LHB 後期猛烈碰撞	1	Mare Nectaris 酒海	1, 3, 4, 5 , 7
Libration 天平動	Overview, Event 1	Mare Nubium 雲海	1, 11, 12, 24 , 25
Licetus 利塞塔斯	30	Mare Orientale 東海	1, 28, Event 1 (T203), Farside
Lichtenberg 利坦堡	Event 1 (T204)	Mare Serenitatis 澄海	1, 9 , 14, 15, Event 2
Lick 利克	2	Mare Smythii 史密斯海	1, 6, Event 1, Event 2
Liebig 萊比	25	Mare Spumans 泡海	1, 2, 6, Event 1 (T056D)
Lilius 利呂斯	30	Mare Tranquillitatis 靜海	1, 6, 8, 9, Event 2
Lindbergh 林保	6	Mare Undarum 浪海	1, 2, 6, Event 1 (T056D)
Lindenau 林丹努	5	Mare Vaporum 汽海	1, 9, 13, 14, 33
Lindsay 林賽	31	Marinus 馬里努斯	Farside
Linné 林列	9 , 15	Marius 馬里烏斯	20
Liouville 萊昂維爾	Event 1 (T160)	Markov 馬可夫	16
Lippershey 利珀什	12	Marth 馬庫	24 , 25, 29
Littrow 利特洛	9	Mascon 質量瘤 (重力異常區)	2 , 8, 12, 25, 26, 28, Farside
Loewy 洛威	24, 25	Maskelyne 馬斯奇連	6 , 8
Lockyer 洛克耶	4 , 5	Mason 梅森	10
Lohrmann 羅曼	26 , Event 1 (T204)	Maupertuis 莫佩圖斯	18
Lohse 羅西	3	Maurolycus 莫羅利卡斯	30
Longomontanus 朗哥芒坦	11, 29	McClure 麥居爾	3
Louise 路易絲 (露易絲)	22	McDonald 麥克唐納	18
LTP 月面暫變現象	Overview, 3, 9, 21, 22	Mee 米	29
Lubbock 盧博	6, 7	Megadome 大拱形結構	32
Lubiniezky 呂班尼茲基	24 , 25	Menelaus 門尼勒斯	9 , 33
Lucian 盧西恩	2, 6 , 9	Menzel 門素	6
Luna Probe 月球探測器 (蘇聯)	2, 14, 26, Spacecraft	Mercator 梅卡托	24 , 25
Lunar Prospector 月球勘探者	21, Farside, Spacecraft	Mercurius 默柯里斯	2, 10, Event 1 (T056D)
Lunar Orbiter 月球軌道探測器	Overview, 23, Event 1, Spacecraft	Mersenius 默爾謝尼	25 , Event 3
Lunation 朔望月	Overview	Messala 梅薩拉	2 , 10, 33, Event 1 (T056D)

		, ,	• •	
M	lessier, Messier A 梅西葉	Overview, 6, 31, 33	Mouchez 莫切斯	16
M	etius 梅蒂斯	4 , 5	Mount Schneckenberg 施勒肯堡山	13
M	eton 默多	16, Event 1 (T171)	Müller 默勒	12 , 31
M	lg-suite 富鎂結晶岩套	1	Multi-ring feature 多環結構	1, 5, 10, 26, 28, Farside
M	lilichius 米利切斯	19 , 20	Murchison 默其森	13
M	iller 米勒	11, 30	Nansen 南生	Event 2, Farside
M	litchell 米切爾	15	Naonobu 內奧諾布	3
M	oigno 莫伊格諾	Event 1 (T171)	Nasireddin 納酉列丁	11, 30
M	oltke 毛德	8	Nasmyth 內史密斯	28
	loment of Inertia 慣性矩	1, Moon Data	Natasha 納塔莎	19
	onge 蒙日 (蒙奇)	3, 5, 7	Neander 尼安德	4 , 5
	onira 蒙尼華	12	Nearch 尼爾希	30
	ons Ampère 安培山	14	Nearside of the Moon 月正面	Overview, 1, Event 2
	ons Argaeus 阿格厄斯山	9	Neison 尼森	16 , Event 1 (T171)
	ons Blanc 布蘭克山	15	Neper 尼泊	1, Event 1 (T056D)
	ons Bradley 布拉德利山	14	Neumayer 紐梅耶	30 , Event 1 (T202), Farside
	ons Delisle 德利爾山	22	Newton 牛頓	11 , 29, Event 1 (T197), Farside
	ons Esam 伊薩姆山	9	Nicolai 尼科萊	5
	ons Gruithuisen Delta 格魯蘇申德爾塔山	22	Nicollet 尼科勒	12 , 24
	ons Gruithuisen Gamma 格魯蘇申伽傌山	Overview, 16, 21, 22	Nobili 諾比利	Event 1 (T160)
	ons Hadley 哈德利山	14	Nonius 諾尼斯	30 , 31
	lons Hadley Delta 哈德利德爾塔山 lons Hansteen 韓斯坦山	Overview, 14 27	North Pole of the Moon 月球北極 Occultation 掩	16, Event 2, Farside Event 4
	lons Herodotus 赫羅多特山	21	Oceanus Procellarum 風暴洋	
	lons Huygens 惠更斯山	14	Oenopides 奧諾皮德斯	1, 20, 21, 22, 23, 26, Farside 16, 17
	lons La Hire 拉希爾山	1, 18 , 19	Oersted 奧斯特	10, 17
	lons Maraldi 馬拉迪山	1, 16 , 19	Oken 奧肯	4, Event 1 (T056D), Farside
	lons Moro 莫羅山	12 , 24	Olbers 奥伯斯	20, 23 , 26, 33, Event 1 (T204)
	lons Penck 彭克山	5	O'Neill's Bridge 奥紐橋	2
	lons Pico 比科山	16	Opelt 奧培	24
	lons Piton 比同山	Overview, 15 , 16	Oppolzer 奥伯爾茲	12 , 13
	lons Rümker 呂姆克爾山	22	Orontius 奥朗塔斯	11
	lons Usov 尤蘇山	2	Osman 奥斯曼	31
	ons Vinogradov 文諾格杜夫山	19	Palisa 帕利薩	12
	lons Vitruvius 維特留夫山	9	Palitzsch 帕利茨希	3
	lons Wolff 沃爾夫山	14	Pallas 帕拉斯	13
	ontanari 蒙塔納里	29	Palmieri 帕爾米耶里	25, 28
	ontes Agricola 阿根哥拉山脈	21	Palus Epidemiarum 疫沼	1, 11, 24, 25, 29
	ontes Alpes 阿爾卑斯山脈	1, 15 , 33	Palus Putredinis 腐沼 (凋沼)	1, 14
	ontes Apenninus 亞平寧山脈	1, 9, 14 , 15, 33	Palus Somni 夢沼	1, 2 , 6, 9
M	ontes Archimedes 阿基米德山脈	14	Parrot 帕羅特	12, 31
M	ontes Carpatus 喀爾巴阡山脈	19 , 31	Parry 帕里	12
Μ	ontes Caucasus 高加索山脈	1, 9, 15	Pascal 帕斯卡	16, 17 , Farside
M	ontes Cordillera 科迪勒拉山脈	1, Event 1 (T203), Farside	Peary 皮爾里	16, Event 2, Farside
M	ontes Haemus 海瑪斯山脈	9	Peek 彼爾	Event 1 (T116)
M	ontes Harbinger 哈賓格山脈	21	Peirce 皮爾斯	2
M	ontes Jura 侏羅山脈	18	Peirescius 皮里修斯	4, Event 1 (T056D), Farside
M	ontes Pyrenaeus 比利牛斯山脈	7	Pentland 彭蘭	Event 1 (T202)
M	ontes Recti 直列山脈	16, 18	Perigee 近地點	Overview
	ontes Riphaeus 里菲山脈	20	Petavius 佩塔維斯	3, 33, Event 1 (T056D)
	ontes Rook 盧克山脈	1, Event 1 (T203), Farside	Petermann 彼得曼	Event 1 (T171), Farside
	ontes Secchi 塞奇山脈	6	Peters 彼得斯	Event 1 (T171)
	ontes Spitzbergen 斯皮茲柏金山脈	14 , 15	Petit 彼迪	2, Event 1 (T116)
	ontes Taurus 金牛山脈	9	Petrov 彼特羅夫	Farside
	ontes Teneriffe 泰納里夫山脈	16	Phase 月相	Event 2
	loondust 月塵	1	Phillips 菲利普斯	3, Event 1 (T056D), Farside
	loon Landing 月登陸	Spacecraft	Philolaus 菲洛勞斯	16, 17 , Farside
	oon Maiden 月上少女	Overview, 18	Phocylides 佛齊利德	28 , Event 3
	loonrise 月升	Overview	Piazzi 皮亞齊	1, 28 , Farside
	loonquake 月震	1	Piazzi Smyth 皮亞齊史密夫	15
	oretus 莫雷塔斯	11, 29 , Event 1 (T116)	Picard 皮卡爾	2
	orley 莫利	Event 1 (T116)	Piccolomini 皮哥洛米尼	5
IV	östing 莫斯丁	12	Pickering 皮克林	9, 12, 31

		I	
Pictet 皮特	11	Rhaeticus 雷提庫斯	13
Pingré 平格雷	28	Rheita 里伊塔	4 , 5
Pitatus 皮塔特	11 , 12, 24	Riccioli 里希奧利	20, 26 , 27, Event 1 (T204)
Pitiscus 皮提斯卡斯	5, 30	Riccius 里絮斯	5
Procellarum KREEP Terrane PKT 區域	1	Rille, Sinuous & Linear 月溪 (溝絞)	13 , 20
Plana 普朗納	10	Rima Agatharchides 阿加撤契德月溪	24, 25
Planitia Descensus 沙漠平原	26	Rima Archytas 阿基塔斯月溪	16
Plaskett 普拉斯基特	Farside	Rima Ariadaeus 阿麗阿黛月溪	13
Plato 柏拉圖	16	Rima Billy 比利月溪	27
Playfair 莆勒費薾	31	Rima Birt 伯爾特月溪	12
Plinius 普林尼	9	Rima Bradley 布拉德利月溪	14
Plutarch 普路塔	Event 1 (T056D), Event 2	Rima Calippus 卡利普月溪	15
Poisson 泊松	30	Rima Cardanus 卡丹尼斯月溪	23
Polybius 波利比斯	5	Rima Carmen 卡門月溪	9
Pomortsev 波莫特斯夫	2, Event 1 (T116)	Rima Cauchy 科西月溪	6
Poncelet 龐西列	17	Rima Cleomedes 克努梅迪月溪	2
Pons 龐斯	5, 31	Rima Conon 科龍月溪	14
Pontanus 龐坦尼斯	31	Rima Delisle 德利爾月溪	22
Pontécoulant 龐特庫蘭特	4, Farside, Spacecraft	Rima Diophantus 丟番圖斯月溪	22
Porter 波特	11	Rima Flammarion 弗拉馬利翁月溪	12
Posidonius 波西多尼	9 , 10	Rima Furnerius 弗內留斯月溪	3
Posidonius Gamma 波西多尼伽傌	9	Rima Gärtner 加特納月溪	Event 1 (T171)
Prinz 普斯	21	Rima Gay-Lussac 給呂薩克月溪	19
Priscilla 普麗西拉	31	Rima G. Bond G·邦德月溪	9
Proclus 普羅克爾	2, 33, Event 1 (T056D)	Rima Hadley 哈德利月溪	14 , 20
Proctor 普托	11	Rima Hansteen 韓斯坦月溪	27
Promontorium Agarum 阿格魯姆海角	2	Rima Hesiodus 赫斯特月溪	11 , 24
Promontorium Agassiz 阿加西斯海角	15	Rima Hyginus 海金努斯月溪	Overview, 13 , 31, 33
Promontorium Archerusia 阿切魯西亞海角		Rima Jansen 贊生月溪	9
Promontorium Deville 德維爾海角	15	Rima Mairan 梅蘭月溪	22
Promontorium Fresnel 彿斯內海角	14 , 15	Rima Marius 馬里烏斯月溪	20
Prom. Heraclides 赫拉克萊特海角	Overview, 18	Rima Messier 梅西葉月溪	6
Promontorium Kelvin 開爾文海角	25	Rima Oppolzer 奥伯爾茲月溪	12, 13
Promontorium Laplace 拉普拉斯海角	18	Rima Réaumur 列奥繆爾月溪	12, 13
Promontorium Lavinium 拉文尼厄姆海角	2	Rima Rudolf 魯道夫月溪	9
Promontorium Olivium 奧利維厄姆海角	2	Rima Schröter 施洛特月溪	12
Prom. Taenarium 泰納里厄姆海角	12	Rima Sharp 沙爾普月溪	22
Protagoras 普塔哥拉斯	16	Rima Suess 蘇斯月溪	20 2. Faraida
Ptolemaeus 托勒玫	2, 12 , 31	Rima Sung-Mei 宋梅月溪 (暫譯)	9, Farside
Puiseux 皮瑟	25	Rima Wan-Yu 萬玉月溪 (暫譯)	19, Farside
Pupin 普賓	14	Rima W. Bond W・邦徳月溪	16
Purbach 普爾巴赫	11, 12 , 30, 31	Rimae Alphomsus 阿方索月溪	12
Pythagoras 畢達哥拉斯	16, 17	Rimae Archimedes 阿基米德月溪	14
Pytheas 皮特阿斯 Rabbi Levi 臘拜利維	19 5	Rimae Aristarchus 亞利斯塔克月溪 Rimae Arzachel 阿爾扎赫月溪	21
			12
Radiometric Dating 放射性同位素計年 Raman 雷曼	Spacecraft	Rimae Atlas 阿特拉斯月溪 Rimae Bode 波得月溪	10 13
Ramsden 拉姆斯登	21 24 , 25, 29	Rimae Bode 被特月英 Rimae Boscovich 波士高維月溪	13
Ranger (Lunar Probe) 徘徊者探月器	12, Spacecraft	Rimae Bürg 布龍格月溪	10
Rankine 蘭金	Event 1 (T160)	Rimae Chacornac 查科納克月溪	9
Ravi 拉韋	12	Rimae Daniell 丹尼爾月溪	10
Rays (Lunar Rays) 輻射紋	Overview, 11, 29, 33	Rimae Darwin 達爾文月溪	27
Réaumur 列奧繆爾	12, 13	Rimae Doppelmayer 多彼梅耶月溪	25
Regiomontanus 勒吉奧蒙塔努斯	11 , 12, 30, 31	Rimae de Gasparis 德加斯帕里斯月溪	25
Regolith, Lunar 月壤	1, 12, 30, 31 1, Event 2	Rimae Fresnel 彿斯內月溪	14 , 15
Reichenbach 勒秦巴赫	4, 5	Rimae Gassendi 加桑迪月溪	25
Reimarus 萊因馬臘斯	4 , 5, Event 1 (T056D)	Rimae Goclenius 笱克蘭留斯月溪	6, 7
Reiner 萊因納	20 , 26	Rimae Grimaldi 格里馬第月溪	26 , 27
Reiner Gamma 萊因納伽傌	20 , 23, 26, 33	Rimae Gutenberg 古坦堡月溪	7
Reinhold 萊因霍德	19	Rimae Hase 黑斯月溪	3
Remote Sensing 遙感	Map 1, Spacecraft	Rimae Herigonius 赫里戈尼斯月溪	20, 25
Resolving Power 鑒別率 (解像力)	Overview	Rimae Hevelius 赫維留斯月溪	26
Respighi 萊斯庇基	Event 1 (T160)	Rimae Hippalus 依巴勒斯月溪	24, 25
• • • • • • • •	` '		•

	(200000 jeunum en	<i>a.e. o oy m</i> p 1.00 <i>y</i>	
Rimae Hypatia 愛帕蒂亞月溪	8	Schlüter 施具特爾	26, Event 1 (T203), Farside
Rimae Janssen 贊桑月溪	4	Schmidt 施密特	8 , 13, 33
Rimae Littrow 利特洛月溪	9	Schomberger 順拜貝格	Event 1 (T202), Farside
Rimae Maclear 馬克利爾月溪	8	Schorr 索柯	Farside
Rimae Maestlin 馬士連月溪	20	Schrödinger 施洛丁格	Farside
Rimae Mersenius 麥爾謝尼月溪	25	Schröter 施洛特	12
Rimae Opelt 奧培月溪	12 , 24	Schubert 許伯特	Event 1 (T116)
Rimae Palmieri 帕爾米耶里月溪	28	Schumacher 舒麥徹	2
Rimae Parry 帕里月溪	12	Schwabe 施瓦布	Event 1 (T171)
Rimae Petavius 佩塔維斯月溪	3	Scoresby 斯科士比	16 , Event 1 (T171)
Rimae Pitatus 皮塔特月溪	11	Scott 司各脫	Event 1 (T202), Farside
Rimae Plato 拍拉圖月溪	16	Secchi 塞奇	6
Rimae Plinius 普林尼月溪	9	Secondary Crater 次級隕擊坑	Overview, 19
Rimae Posidonius 波西多尼月溪	9	Seeliger 西拉格	13 , 31
Rimae Prinz 普斯月溪	21	Segner 謝格納	28 , 29
Rimae Ramsden 拉姆斯登月溪	24	Selene (Lunar Probe) 月亮女神探月器	Spacecraft
Rimae Riccioli 里希奧利月溪	26	Selenographic Coordinates 月面座標	Overview
Rimae Ritter 里特爾月溪	8	Seleucus 謝列克	23 , Event 1 (T204)
Rimae Römer 羅邁月溪	9	Seneca 西尼卡	Event 1 (T056D)
Rimae Secchi 塞奇月溪	6	Serpentine Ridge 蛇脊	9
Rima(e) Sirsalis 希薩利斯月溪	27	Shapley 沙普利	2
Rimae Sosigenes 索西琴尼月溪	8	Sharp 沙爾普	16, 18
Rimae Sulpicius Gallus 薩爾皮瑟所月溪	9	Shackleton 沙克爾頓	Farside
Rimae Theaetetus 西特圖斯月溪	15	Sheepshanks 希普香克斯	16
Rimae Triesnecker 特斯納卡月溪	13	Shi Shen 石申	Farside
Rimae Zupus 侏伯斯月溪	27	Shock Wave 激波	1
Ritchey 里奇	31	Shoemaker 蘇梅克	Farside
Ritter 里特	8 , 13, 33	Short 雪特	11, 29, Event 1 (T197)
Robinson 魯賓遜	17	Shuckburgh 肖白	10 Overview Event 1
Rocca 羅卡 Rocco 羅科	20, 26, 27, Event 1 (T203) 21	Sidereal Month 恒星月 Sikorsky 西科基斯	Overview, Event 1 Farside
Roche Limit 洛希極限	1	Silberschlag 西別什拉格	13
Römer 羅邁	9	Simpelius 辛普路斯	Event 1 (T202)
Rosenberger 羅桑貝格	30	Sinas 辛納斯	6
Ross 羅斯 (James C. Ross)	8 , 9	Sinus Aestuum 暑灣 (浪灣)	1, 14 , 33
Rosse 羅西 (William Parsons Rosse)	7	Sinus Amoris 愛灣	1, 9
Rost 羅斯特	28	Sinus Asperitatis 粗糙灣	5, 7
Rothmann 羅夫曼	5	Sinus Concordiae 和諧灣	2 , 6
Rozhdestvenskiy 羅兹德茨芬斯基	Farside	Sinus Fidei 忠誠灣	9, 14
Rubble Pile 碎石堆	12, 31	Sinus Honoris 榮譽灣	1, 8
Rupes Altai 阿爾泰峭壁	5 , 31	Sinus Iridum 虹灣	1, 16, 18, Event 2
Rupes Cauchy 科西峭壁	6	Sinus Lunicus 月灣	14
Rupes Kelvin 開爾文峭壁	25	Sinus Medii 中央灣	Overview, 1, 12, 13
Rupes Liebig 萊比峭壁	25	Sinus Roris 露灣	1, 16
Rupes Mercator 梅卡托峭壁	24	Sinus Successus 成功灣	2
Rupes Recta 豎直峭壁 (直壁)	Overview, 12	Sirsalis 希薩利斯	20, 26, 27 , 33
Rupes Toscanelli 托斯卡里尼峭壁	21	Smart-1 (lunar probe) 智能一號探月器	25, Spacecraft
Russell 羅素	23, Event 1 (T204)	Smithson 史密森	2 , 6
Ruth 盧恩 (魯恩)	21	Snellius 斯內拉斯	3, 5, 33, Event 1 (T056D)
Rutherfurd 盧塞福	11	Somerville 薩默維爾	3 , Event 1 (T160)
Sabine 薩比	8 , 13, 33	Sömmering 澤默靈	12
Sacrobosco 薩克羅博斯科	31	Soraya 索拉雅	12
Santos-Dumont 桑托斯杜蒙	14	Sosigenes 索西琴尼	8 , 13
Santbech 桑特貝克	5, 7 , Event 1 (T056D)	South 索斯	16, 17
Sarabhai 撤拉遜	9	South Pole - Aitken 南極艾肯盆地	1, Farside
Saros 沙羅周期	Event 4	South Pole of the Moon 月南極	Overview, Event 1, Farside
Sasserides 扎西里德	11	Southern Highlands 南面高地	11, 30
Saunder 桑德 Saunder 桑德	31	Spörer 斯帕雷爾	12
Saussure 索絮爾	11	Spurr 斯普爾 Stadius 斯太沖	14 Overview 14 19
Scheele 舍爾 Schoiner 刘伊姆	20	Stadius 斯大迪	Overview, 14, 19
Scheiner 沙伊納 Schiaparelli 斯吉業巴列里	11, 29	Stag's Horn Mountains 斯達霍山 Statio Tranquillitatis 密熱其地	12
Schickard 西卡爾德	23, Event 1 (T204) 28 , Event 3, Farside	Statio Tranquillitatis 寧靜基地 Steinheil 斯泰哈爾	8 4 , 5
Schiller 席勒	28 , 29	した 日間 対応	 , ∪
בעד נון וו	_0, _0	1	

	(Ettitui jettitui es	une ey 11 2.1 p 1 vev)	
Stella 斯特拉	9	Vallis Inghirami 英希拉米月谷	Farside
Stevinus 斯蒂文	3 , 5, 33, Event 1 (T056D)	Vallis Krishna 克利須那月谷	9
Stewart 史圖爾特	2 , Event 1 (T160)	Vallis Palitzsch 帕利茨希月谷	3
Stiborius 斯蒂波里鳥斯	5	Vallis Rheita 里伊塔月谷	3, 4 , 5
Stöfler 史托福勒	11, 30 , 31	Vallis Schröteri 施洛特月谷	21
Strabo 斯托雷波	10	Vallis Snellius 斯內拉斯月谷	3, Event 1 (T056D)
Straight Range (= Montes Recti)	16, 18	van Albada 范阿巴達	2 , Event 1 (T160)
Straight Wall (= Rupes Recta)	Overview, 12	Van Biesbroeck 范比斯波羅可	21
Street 斯特里特	11	Van Vleck 范菲萊克	Event 1 (T160)
Struve 斯特魯維	23, Event 1 (T204)	Vasco da Gama 瓦斯科達伽馬	23, Event 1 (T204), Farside
Suess D 蘇斯 D	20	Vega 維格	Event 1 (T056D), Farside
Sulpicius Gallus 薩爾皮瑟所・蓋洛斯	9	Vendelinus 文德林	3, Event 1 (T056D)
Surface Gravity, Lunar 月面重力	1, 20, 33	Vera 維拉	21
Surface Temperature, Lunar 月面溫度	Overview, 1, Event 2	Very 威里	9
Surveyor (Lunar Probe) 測量員探月器	11, 20 , Spacecraft	Vieta 維特	28 , Event 3
Susan 蘇姍	31	Vitello 維特洛	25 , 31
Swift 斯威夫特	2	Vitruvius 維特留夫	9
Synodic Month 朔望月	Overview, Event 2	Vlacg 弗拉格	30
T. Mayer T・梅耶	19	Vogel 沃格爾	12, 31
Tacitus 特西圖斯	5 , 31	von Behring 馮白令	3, Event 1 (T160)
Tacchini 特智里	Event 1 (T116)	W. Bond W·邦德	16
Tacquet 特奎	9	Wallace 華萊士	14
Tannerus 坦納臘斯	30	Walled Plain 環壁平原	Overview
Taruntius 塔朗提斯	6 , 33, Event 1 (T056D)	Walter 華爾特	11 , 12, 22, 30, 31
Taylor 泰勒	31	Walther 華爾頓	11 , 12, 22, 30, 31
Tebbutt 特巴特	2	Wan-Hoo 萬戶	Farside
Tempel 頓泊爾	13	Waning Crescent 殘月	Event 3
Terminator 明暗界線	Overview, Event 2	Wargentin 瓦根廷	28
Terraced Walls 台地牆	Overview, Event 2	Watt 瓦特	4 , 5
Thales 法列斯	9, 10 , 33	Watts 互特斯	4 , 5
Theaetetus 西特圖斯	15	Waxing Crescent 娥眉月	Event 2
Thebit 錫比特	12	Webb 韋布	2, 6, Event 1 (T116)
Theon Junior 小塞翁	13	Weierstrass 韋爾斯特拉斯	Event 1 (T160)
Theon Senior 大塞翁	13	Weigel 韋杰爾	28 , 29
Theophilus 菲奧費勒	5 , 7, 33	Weiss 韋斯	20 , 29 11
Theophrastus 西翁菲斯德斯	5 , 7, 33	Weinek 魏內克	5
Tide (Perigean Spring Tide) 近地點大潮	Overview	Werner 沃納	30 , 31
Tidal Force 引潮力 (起潮力)	1	Wexler 威斯拿	Farside
Timaeus 提勒致	16	Whewell 維韋	13
Timocharis 提莫恰里斯	14, 19, 31, 33	Wichmann 威治曼	20
Tisserand 蒂塞朗	2	Widmanstätten 魏德曼	Event 1 (T116)
Tolansky 杜蘭斯基	12 , 24	Wildt 懷爾德	
Torricelli 拖麗西里	5, 6, 7 , 8	Wilhelm 威廉	Event 1 (T160) 11, 29
Toscanelli 托斯卡內尼	21	Williams 威廉斯 (威廉士)	10
Townley 湯尼	2 , Event 1 (T116)	Wilson 威爾遜	29 , Event 1 (T197)
Tralles 特拉斯	2, Event 1 (1110)	Winthrop 溫夫羅	20 20
Triesnecker 特斯納卡	13	Wöhler 韋勒	4 , 5
Trouvelot 特勞維洛特	15 , 16	Wolf 沃爾夫	4 , 3 24
Tsiolkovsky 齊奧爾科夫斯基	Farside	Wollaston 沃萊士頓	21
Tsu Chung-Chi 祖沖之	Farside	Wrinkle Ridge 皺脊	1, 2, 8 , 9 , 18, 19, 20, 22, 25
Turner 特納	19	Wrottesley 羅特斯勒	3
Tycho 第谷	Overview, 11 , 29, 30, 33	Wurzelbauer 維澤包爾	11
Ukert 烏開特	13 , 33	Yakovkin 雅克菲肯	28
Ulugh Beigh 烏魯白格	Event 1 (T204)	Yangel'楊格爾	9
Unmanned Lunar Probe 不載人探月器	Spacecraft	Yerkes 葉凱士 (耶基斯)	2
Urey 尤里	Event 1 (T056D)	Young 楊格	4 , 5
Väisälä 維薩拉	21	Zagut 扎古特	4 , 3
Valentine Dome 瓦倫丁拱形山	15	Zähringer 札林格	6
Vallis Alpes 阿爾卑斯月谷	15 , 16	Zeeman 塞曼	Farside
Vallis Baade 巴德月谷	Farside	Zeno 澤諾	2 , 10, Event 1 (T056D)
Vallis Bouvard 波瓦德月谷	Farside	Zöllner 澤爾納	31
Vallis Capella 卡彼拉月谷	7	Zucchius 侏奇鳥斯	28, 29
Vallis Christel 克里斯特爾月谷	9	Zupus 侏伯斯	20, 23 27
- THE CHILD AND LINE WAY 1. TH	•	I	

Lunar Photograph and Illustration Credits

Label	Credits		
CNSA 001	China National Space Administration 國家航天局		
NASA 001 - NASA 026	National Aeronautics and Space Administration, USA.		
P001 - P003	Y. Perelman, Astronomy for Entertainment, 1958, Moscow.		
P004	David A. Hardy (UK)		
USGS 001- USGS 004	U.S. Geological Survey		
W001 - W007	Anonymous (retrieved from web and reprocessed)		

Version History

<u>Version</u>	Date	Major Changes
1.1	2003 Oct	- First release with 90 photos and illustrations, 62 pages.
1.7	2004 Feb	 - 150 photos and illustrations, 95 pages. - Expanded Overview, Maria, Event & Method of Imaging pages. - Added Lunar Rays, Farside of the Moon & Moon Landing maps. - Rechecked Moon Age.
1.9	2004 Aug	P001 reprocessed to show true slope of the Straight Wall.Added Map 30 to cover southeastern region.Canceled Romantic Moon.
2.1	2005 Jan	- Extensive refinement, over 200 images, 184 pages, additions including mosaic images & illustrations on lunar geology.
3.0	2006 Feb	- Map 22 & Map 23 interchanged.- Over 250 original Moon images including mosaics.- Over 900 named surface features, 209 pages.
3.1	2007 Jan	 Renewed crater diameters & coordinates as IAU/USGS publications. Marked Krishna, Sung-Mei as IAU-dropped names. Rechecked Data of Lunar Images & Index. Added Lunar Spacecraft & Crater List (Nearside + Farside). Added/renewed 40 images, 225 pages.
3.2	2008 Jan	 Regrouped Map 15, 16, 29 with NP or SP images. Updated Farside Map & Spacecraft page. Added Lunar Geologic Timescale, Global Maps & Non-Crater List. Minor changes in feature descriptions, 231 pages.

^{***} The latest version is free for download in http://www.alanchuhk.com ***