Photographic Atlas of the Moon

S. M. Chong, Albert C. H. Lim, P. S. Ang

CAMBRIDGE

The Photographic Atlas of the Moon is a day-by-day photographic guide to observing the features of the Moon through a small telescope. Compiled by three keen amateur astronomers, each image was produced using a 40-cm telescope and high-resolution low-speed film. Whole Moon images are provided for each day of the 29-day lunar cycle, with labelled features and accompanying descriptive text. Selected lunar features are shown at high magnification to highlight and clearly illustrate certain regions. All lunar features are labelled using current IAU terminology. A comprehensive set of appendices detail the phases of the Moon, give a chronology of lunar selenography, and index all lunar features named in the text. This atlas is an invaluable reference guide for amateurs engaging in lunar observations with a small telescope.

The authors are all keen amateur astronomers, and have all been interested in astronomy from an early age.

Siew Meng Chong (centre) is a Fellow of the Royal College of Pathologists and is currently affiliated to the Department of Pathology of the National University of Singapore. He is a Fellow of the Royal Astronomical Society, and has been President of the Astronomical Society of Malaysia.

Albert Lim (right) holds a Masters Degree in Astronomy, is a Fellow of the Royal Astronomical Society, and the Singapore contact for the International Astronomical Union (IAU) Commission 46 (Astronomy Education and Development). He has been President of the Astronomical Society of Singapore since its foundation in 1992, and is an avid astrophotographer.

Poon Seng Ang (left) holds a degree in Computer Science and a diploma in Mechanical Engineering, and is currently the Vice President of the Astronomical Society of Singapore. He too is an avid astrophotographer.

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This book is dedicated to everyone who has an appreciation of things in nature.

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The views and opinions expressed in this publication are those of the author(s) and do not necessarily represent the views of the National University of Singapore or any of its subsidiaries or affiliates.

Introduction

The earliest idea for this book was a request made to a fellow committee member of The Astronomical Society of Singapore (TASOS) in 1992. He was given some rolls of slide film and given the task of photographing the Moon day by day for a complete lunar cycle. What we wanted was a set of daily Moon slides for society talks. Several years passed; that particular committee member became a celebrity as a successful radio DJ, but the set of lunar images was still not forthcoming. Many jokes were cracked about the project. Finally, in late 1997, a chance discussion between Albert and SM seriously mooted the idea of a Moon book. The concept of the book was discussed at length and eventually a preliminary working format was agreed to. What we wanted was a photographic guide to the Moon that would be complete day by day through an entire lunar cycle and that would be easy to use at the telescope. Although we knew of some excellent guidebooks to the Moon, none appeared to feature the Moon in colour or on a daily basis. Unfortunately, the colour concept had to be dropped because of cost issues. The final result is this book you are now holding.

The Moon is our nearest celestial neighbour, the second brightest celestial object in the sky and the Earth's only known natural satellite. As it appears so large and prominent, it must have attracted attention from the earliest humans and lunar stories and myths abound among ancient civilizations and cultures. It shows interesting phase changes that were cleverly used by the Chinese to construct the earliest known calendars. It is also the only celestial body that displays surface markings easily visible to the naked eye.

Since Galileo conducted the first telescopic observations of the Moon, many great selenographers have mapped the Moon to ever-increasing detail and accuracy. Men such as Michiel van Langren, Johannes Hevelius, Riccioli and Grimaldi, Tobias Mayer, Johann H. Schroter, Wilhelm G. Lohrmann, J. Madler and W. Beer, J.F. Julius Schmidt, Philipp Fauth, and J.N. Krieger have been responsible for defining and making modern Moon maps and nomenclature what they are today. Whilst it is true that their early techniques and equipment are crude by modern standards, their works stand out as monuments to motivate, inspire and spur us on to new heights and finally, to conquer the Moon.

Today, 12 human beings have walked the surface of the Moon and many robotic spacecraft have surveyed its surface at close range. These probes returned thousands of high-quality close-up pictures of the lunar surface and immediately rendered all previous Moon maps obsolete. Most of the lunar features visible in amateur telescopes have now been identified and named in accordance with internationally accepted nomenclature – a job that is supervised and administered by the International Astronomical Union's (IAU's) Lunar Task Group. There is no longer any scientific value in amateur Moon charts but Earthbound observers continue to be enchanted by the beauty, serenity and tranquillity of the stark lunar landscape. Simply observing the Moon and studying the regions once scrutinised by the late great selenographers is fun and educational and links us to their heritage.

Many earlier lunar atlases contained images obtained by the great observatories. With recent improvements in camera-film technology, however, we feel that it is now possible to obtain lunar images with a modest 40 cm telescope to comparable or better resolution than most of these early atlases. It was with this in mind that we embarked on this project to produce a new photographic lunar guide, a work that finally took 2 years to complete. Our basic photographic concept was to image an entire cycle of daily Moon phases in medium 6×7 format through a 40 cm telescope using high-resolution, low-speed film. This allowed excellent reproduction of essentially grainless lunar images to a scale of 25 cm in diameter, a size large enough to support the level of labelling necessary. Singapore is hardly a good astronomical site and so many images proved to be of only average quality. Eventually, more than 10,000 slides had to be examined to secure the best possible daily full phase Moon sequence. We regard our photographic lunar guide as complementary to, and certainly not as replacement to, the many other fine publications on the Moon in existence today.

In recent years, Charge Coupled Devices (CCDs) have become much cheaper and therefore, more popular with amateurs. In time, we believe that CCDs will replace film in most areas of astronomical imaging, except perhaps when extremely wide fields need to be imaged. We hope that our humble photographic lunar guide will remain a tribute to the closing days of good old film technology. Finally, because our work was completed at the close of the twentieth century, we hope that in some small way it will continue the legacy of the early selenographic giants.

Albert Lim, S.M. Chong and P.S. Ang

About this book

To begin with, the title proposed by the authors for this book was *The Realm of the Lunatic*. The Press, however, injected some Prozac and said that, with that title, it wouldn't sell. They're right, of course (would you, gentle reader, have even picked it up at the shops?) and so, regrettably we gave in to Mammon and agreed with the prosaic *Photographic Atlas of the Moon*. Because of the original title, however, there are assorted references to lunatics in the text. After all, to quote the OED (the Press allowed that, as there's no CED) a 'lunatic' is someone 'afflicted with the kind of insanity that was supposed to have recurring periods dependent on the changes of the Moon.' What a marvelously apt description for someone interested in the Moon!

Anyway, the sequence of photographs encompasses a complete lunar cycle from day 0 to day 29. For each day, there is a description of the features visible, together with a labelled black-and-white image of the Moon. This black-and-white image is reproduced from our colour image of that day. The first-day Moon is classified as that from 0.50 day to 1.49 day after New Moon, the second-day Moon is similarly from 1.50 day to 2.49 day, and so on. As the authors feel that the Moon is best viewed through a telescope, rather than with the naked eye or with binoculars, almost all full images are presented with a south-up, east-left orientation to match the view through an inverting telescope. All images have an approximate North indicator to assist orientation. A kilometre distance scale is also shown together with the labelled image. This scale shows distances from the Moon's centre to the different features. The age of the Moon to two decimal places is also given. A table of lunar features labelled and mentioned in the text is included in the lower box.

Depending on the day, one or more unlabelled full-phase Moon image or images are also presented. These images contain both lunar as well as photographic data. Under the column of 'lunar data', we have provided the time (local and Universal) and date when the image was acquired. The lunation number and the age and percentage illumination are also indicated. Lastly, the distance to the Moon in kilometres at the time the photograph was taken is mentioned.

In the 'photographic data' column, 'instrument' refers to the telescope used for photography. The technique is indicated, together with the type of film used and the exposure time. The altitude of the Moon, in degrees and minutes from the North or South horizon, at the time the photograph was taken is also indicated. We also provide the lunar diameter in arc minutes and seconds. Finally, an indication of the sky condition, according to an improvised scale, at the time the photograph was taken is included.

On some days, we have included a page containing enlarged photographs of selected regions of the Moon. These were included as an afterthought as we felt that they enhanced the text. Ironically, many of these projection photographs were originally fun shots taken when sky conditions were less than ideal for full phase photography! These images are all taken on 35 mm slides through a Nikon F3 at various projection focal lengths using a full range of Pentax XP projection eyepieces of 3.8 mm, 8 mm, 14 mm and 24 mm focal lengths.

The improvised sky condition scale employed by the authors is as follows:

Scale	*Descriptions*
1/10	Worst Sky, thick cloud covering 100% of sky – Moon totally invisible.
2/10	Very Bad Sky, thick cloud cover of 90% – Moon barely visible through cloud.
3/10	Bad Sky, cloud cover over 80% – Moon visible on and off but through cloud.
4/10	Average Sky, cloud cover 70% or less – Moon visible through clearings on and off.
5/10	Above Average Sky, about 50% cloud cover – Moon visible for extended periods.
6/10	Good Sky, about 40% cloud cover – Moon clearly visible with clouds at distance.
7/10	Very Good Sky, less than 30% cloud cover but Moon clearly visible in a dark sky.
8/10	Excellent Sky, less than 20% cloud cover and the Moon looks as good as it gets.
9/10	Near Perfect Sky, only traces of isolated thin clouds – average few days per year.
10/10	Perfect Sky, not a trace of clouds – we have yet to see this happen in Singapore!

How this atlas was done

From the beginning, it was decided that SM Chong, with whom cameras do not click, would write the daily text, while Albert Lim and PS Ang would focus on lunar photography. The first problem was to decide on the telescope required. Between us, we owned 14 good portable telescopes. Using any of them, however, would have entailed spending an inordinate amount of time on polar alignment before each session. Anyone who has tried polar alignment in the tropics knows that this is no easy task when neither pole star is visible. Unfortunately, time was the resource we never had enough of. In early 1998, we therefore approached Dr K.K. Cheong, divisional director of the Singapore Science Centre, and he generously gave permission for us to use the centre's 40 cm Cassegrain telescope. The optics of this superb instrument were ground to perfection by the famous Japanese comet discoverer, Mr Kaoru Ikeya. The telescope was mounted permanently and housed in a dome. The telescope was also compatible with the Pentax 6×7 medium format camera we planned to use. The focal length of the 40 cm at 5200 mm (*f*/13) turned out to be perfect to maximise the diameter of the Moon's image within our medium format 6×7 frame. On one occasion, the image of a Full Moon near apogee filled the 120 slide frame almost to the edge. The disadvantage was that our observing site would, like anywhere else in Singapore, be severely light polluted.

Choice of film was the next great debate. The authors have great admiration for the high-resolution photographic work of the famous French astrophotographer, Jean Dragesco and were haunted by a statement on page 49 of his book, *High Resolution Photography*, where he writes, 'I am hardly a supporter of colour photography when it comes to high resolution work: colour films (be they colour negatives or transparencies) have inadequate contrast and inferior resolving power.' Although the authors were painfully aware that Kodak's TP2415 is the film of choice for high-resolution lunar photography, we finally and with great reluctance chose another film. Essentially, we wanted colour images of the Moon that would match the naked-eye view as closely as possible. Also, the availability of TP2415 locally was a problem, as was the developing of TP2415, since none of the authors owned or had access to darkroom facilities. Our experience with a limited number of rolls of hypered and unhypered TP2415 suggested that the local commercial processing centres were unfamiliar with it and could not produce results that did justice to this magical film. Perhaps we should still have persevered and continued to employ TP2415 together with our main efforts with colour slides. We recognised very early, however, that there were simply not enough photographic windows at our suboptimal local site to allow us to capture the best possible lunar sequence in colour as well as in black and white. The prevailing cloudy conditions would have degraded photographic images far more than the difference in photographic latitude between TP2415 and our chosen colour film. The low ASA 120 colour slide films that we eventually chose had sufficient latitude to deliver the results we expected at the prime focus (Cassegrain focus) of our telescope.

The next problem, was the scheduling of observing sessions. Cloud and rain formed the major handicap – Singapore's situation within the tropics ensures that clear skies, like Pandas, are a very rare breed! Between 4th April 1998 and 25th April 1999, more than 100 attempts were made to photograph the Moon; on only 55 of these did we succeed in obtaining at least one photographic exposure. Thus, half of our observing nights were actually spent waiting for cloud to clear or rain to stop. Such nights were god-sent opportunities to catch up on lost sleep on the observatory floor, and sometimes these naps lasted until sunrise. For long periods also, we had to contend with haze from uncontrolled forest fires in Indonesia. On severe occasions, this haze limited line-of-sight visibility to a few hundred metres.

When conditions finally permitted, however, approximately 200 exposures were made on 120 films on average each night. Even so, many of the images presented here were either shot through some level of cloud cover or through small fortunate openings surrounded by thick cloud. In essence, most were shot through less than ideal conditions. We could not possibly have hoped for more. To acquire lunar images only under favourable conditions in Singapore would have extended the period of photography by many more years than we could afford. We did, however, attempt to replace less than satisfactory lunar images when opportunity allowed.

We attempted to photograph the Moon as near the zenith as possible to reduce image degradation by the Earth's atmosphere. Once again, weather conditions did not always allow this ideal. And of course, the first and last few days of any lunation, characterised by low-altitude Moons, were always problematic, with the first- and last-day Moon presenting significant challenges. Naked-eye sighting of these very early and very late crescents is difficult, photographing them even more so. The Moon is only a few degrees from the horizon, almost certainly obscured by cloud and the photographic window drops to a mere few minutes. The authors especially remember driving from home to the observatory on many early mornings to wait for that elusive last-day Moon.

On 4th April 1998, photography commenced with test exposures of the 7.5-day-old Moon. We exposed many different slide films – Kodak Ektachrome 25, 64, 200, 400, Kodak P1600 (processed at ASA400), Kodak TMax 400 (black and white), Fuji Velvia 50, Fuji Provia 400 and several others were all evaluated. Fuji Velvia 50 and Kodak Ektachrome 64 yielded the best results and both these slide films were subsequently used for prime focus (Cassegrain focus) photography.

During our initial photographic session, we employed the old photographer's 'hat trick' using a sheet of black cardboard approximately 0.7 by 1.0 metres in size. This proved impossible to sustain; handling a piece of cardboard this size while balancing on a tall ladder and trying to achieve shorter than quarter second exposures was virtually impossible. The whole act required extreme acrobatic skill!

We made test exposures using a cable release with the Pentax 6×7 camera's mirror locked up and were surprised to find no deterioration in image quality due to vibration. This we attributed to the instrument's weight, and in particular to its massive equatorial mount. The famous Japanese planetary

astrophotographer Isao Miyazaki has also reported similar experiences. He too has very successfully employed the simple cable release and mirror lock up technique on his very massive telescope system without problem with vibration. All our subsequent lunar exposures relied solely on the cable release and mirror lock up technique. This provided an added advantage in that accurate exposures could be controlled and recorded for different phases of the Moon. These were then used as references to minimise bracketing thus resulting in a higher number of correct exposures consistently obtained throughout the sessions. Even with the lunar tracking rate, the photographic results at any phase were seldom good when exposure times lasted longer than 2 seconds. It would appear that the atmospheric turbulence at our site simply does not allow recording of fine details during exposures longer than 2 seconds. Fortunately, there were very few occasions when such long exposures were required.

By April 1999, the photography was almost complete. Some images turned out better than others because of better sky conditions. While we would have liked to have obtained consistently good images for all the days in the cycle, it was deemed impractical given our local circumstances. There is an old Chinese saying: 'Were I to await perfection, my book would never be finished.'

Taking 10,000 slides of the Moon was an enormous effort; keeping accurate records of each and every image became a nightmare. Several months were required to sort through all the slides to select the best images. Eventually, we narrowed our selection to about 50 slides. These were scanned with a Minolta Dimage Scan Multi film scanner, bought solely for this purpose. PS Ang, being the most computer-experienced, was tasked to process, format and label the selected images using Adobe Photoshop 5.0 and Illustrator 8.0 respectively. The data presented in our photographic images was largely obtained from 'The Sky' software from Software Bisque. This excellent astronomy program was found to be most useful in helping us prepare for all our photographic sessions. We also used it to determine the exact time of new Moon for each lunation. Everything was finally complete by the end of December 1999. We hope that this book will interest more people to observe the Moon and render day by day lunar observations easier at the telescope.

Before we begin . . .

Beginners often think that the best time to look at the Moon is when it is full because craters will then be easily visible. Unfortunately, they are often disappointed – features are only easily identified when close to the terminator – the dividing line between night and day – when oblique illumination provides contrast and shadow. At Full Moon, the terminator is barely visible at the limb (edge) of the Moon and the vertical illumination, without shadows, over most of the visible surface wipes out the features so that everything looks ghostly. The few craters that can be easily identified are severely distorted (foreshortened) because they lie at the limb of the Moon. Full Moon, however, is the best time to familiarise oneself with the main features because all unnecessary detail is wiped out.

So, tonight, if you are a beginner, concentrate on identifying the dark patches – the maria – and then look for the bright and dark rings formed by the larger craters as well as the other dark and bright spots between the maria. Note how some of the bright crater rings seem to have rays radiating from them.

Now, if you look at the Moon with south up and east to the left, the maria outline a figure resembling a crab. This is most pronounced in the left (east) half of the Moon where one crab pincer is very obvious. It is easy to remember that Mare Crisium, the Sea of Crises, is the teardrop in the east and Mare Frigoris, the Sea of Cold, the elongated streak near the North Pole. The main difficulty lies with the central maria. Now, starting at Mare Nectaris, the right (west) half of the crab's pincer, proceed in a counter clockwise spiral ending at the centre of the visible surface, and repeat, 'Nectaris, Fecunditatis, Tranquillitatis, Serenitatis, Imbrium, Roris, Procellarum, Humorum, Nubium, Medii, Vaporum'. This is pretty horrible – how about this mnemonic instead? '**N**ow **F**irst, **T**hen **S**econd **I**n **R**ace **P**lace, **H**e's **N**ext, **M**ove **V**ictor.' That leaves only the limb maria – on the eastern limb, from north to south, Humboldtianum, Marginis, Smythii, Australe – remember **HMS A**ustralia and that Australia is in the southern hemisphere. What about the western limb? Well, the only mare on the western limb is Mare Orientale, the Eastern Sea! Its incongruous name results from a decision in the late 1960s to reverse the identities of the then eastern and western limbs of the Moon.

Several smaller dark rings catch the eye against the bright background of the Full Moon. Starting in the northeast corner, first note foreshortened Endymion, east of Mare Frigoris. Moving west from Endymion, note Plato against the northern margin of Mare Imbrium. Grimaldi, in the west, stands out adjacent to the west margin of Oceanus Procellarum. Look also for Riccioli, a smaller dark spot west and somewhat north of Grimaldi. Then, from Grimaldi, follow an arc south parallel to the southwest limb of the Moon. Note first Schickard and then an unnamed mare-like region between Schickard and the South Pole. Finally, south of Mare Nubium, and resembling Plato, note the dark ring, Pitatus.

The southern highlands occupy a vast stretch around the South Pole and drive two wedges northwards. The smaller eastern wedge separates Mare Fecunditatis and Mare Nectaris. The huge western wedge stretches as far north as Mare Serenitatis. Dominating everything in this southern hemisphere is the bright ring of Tycho, whose far-flung rays blot out much of the highland region and extend as a double ray onto Mare Nubium west of Pitatus. A multitude of bright spots are found in both the highland and mare regions in this southern hemisphere. In the east, Stevinus A and Furnerius A, both bright ray craters like Tycho, are obvious. They point to Polybius A, which lies on one of the Tycho rays. Facing each other on the eastern and western shores respectively of Mare Tranquillitatis, note Censorinus and Dionysius. North of Tycho, forming an equilateral triangle with it are two bright objects – to the east, the unofficially named Cassini Bright Spot, lying on a ray that reaches Mare Serenitatis, and to the west, Cichus B, lying on the more prominent western component of the Tycho double ray. Midway between Grimaldi and Schickard, identify another little bright ray crater, Byrgius A. Grimaldi and Byrgius A form a right-angled triangle with the bright ring of Gassendi, which guards the northern tip of Mare Humorum.

The arc of mountains rimming Mare Imbrium is outstanding. Most prominent are the Apennines (Montes Apenninus), which form the southeast border of the mare. Their southern end continues westwards, north of the bright crater Copernicus, as the Carpathians (Montes Carpatus). The northern end continues northwards as Montes Caucasus, with Mons Hadley separating them. The Alps (Montes Alpes) then arc westwards to form the northern boundary of the mare. Recognise amongst them dark Plato and the bulge of Sinus Iridum. On Mare Imbrium, just south of Plato, are the isolated bright mountains, Pico and Piton. A western arc from Pico parallel to the mare margin leads first to the Teneriffe mountains and then to the Straight Range (Montes Recti). All of these stand out prominently against the dark floor of Mare Imbrium, as do the rings of Archimedes, Autolycus and Aristillus. These three craters, together with Montes Spitzbergen, form a kite-shaped figure.

Copernicus and Kepler, close to each other on Oceanus Procellarum in the western hemisphere, form an easily identified pair of bright rings. Aristarchus, brightest of all features on the Full Moon, forms a right-angled triangle with them, the right angle occuring at Kepler. Euler, Pytheas and Timocharis lie north of Copernicus. The Aristarchus–Kepler axis produced southwards leads to Euclides, on the edge of Montes Riphaeus. The Kepler–Copernicus axis produced eastwards leads the eye successively to bright **M**anilius, **M**enelaus, **P**linius and **P**roclus, the last-named lying on the edge of Mare Crisium. Note how the Proclus rays delineate pale Palus Somni, the Marsh of Sleep. Two bright rings, Godin and Agrippa, form a parallelogram with Dionysius, Menelaus and Manilius. The same Kepler–Copernicus axis produced westwards leads, first, to Reiner Gamma on Oceanus Procellarum and then to another bright ray crater, Olbers A. From here, move along the northern limb to identify three ray craters – Anaximander, west of the pole, Anaxagoras adjacent to the North Pole, and Thales, east of the Pole. Continuing south along the east limb, Langrenus, adjacent to Mare Fecunditatis, has a bright fuzz around it. Still further south is Petavius B. The Langrenus–Petavius B line produced the

same distance further south leads us back to the close pair Furnerius A and Stevinus A.

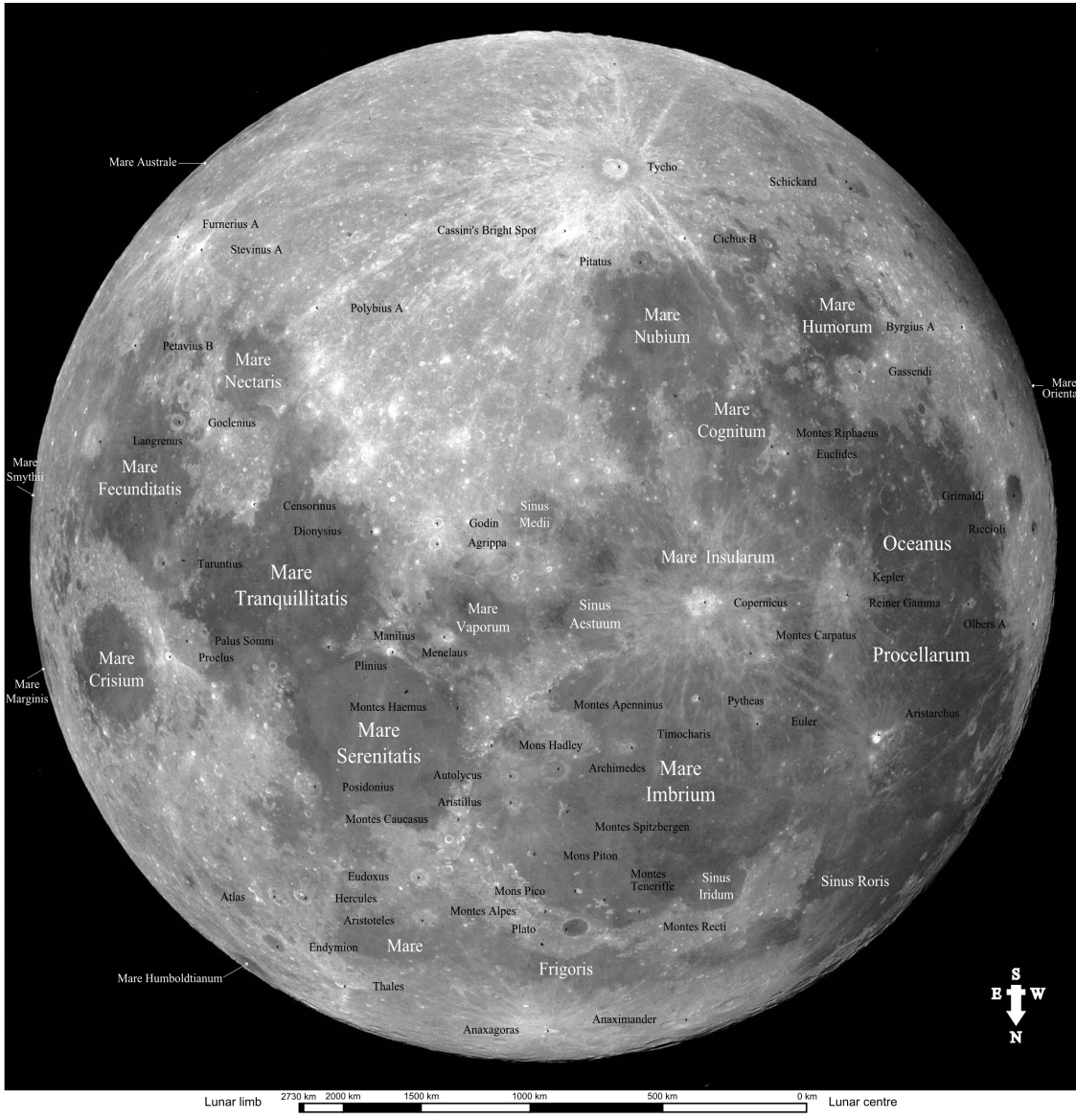
Now return to the north polar region. Look between Mare Serenitatis and Mare Frigoris for the ghostly bright rings of Aristoteles and Eudoxus. Adjacent to Endymion are equally ghostly Hercules and Atlas. Endymion, Eudoxus and the ring of Posidonius form an equilateral triangle. The narrows between Mare Tranquillitatis and Mare Fecunditatis are guarded by Taruntius while the ring of Goclenius stands sentinel across Mare Fecunditatis from Langrenus.

What does all this structure mean? What are we looking at when we look at the Moon? Let's ask the question another way – what do we see when we look at the Moon? Well, the age-old childhood answer is 'The Man in the Moon' and the adult answer is probably 'Craters'. Both answers are correct. The Man in the Moon refers to the resemblance of the dark portions of the Moon, the lowland maria (singular: mare, after the Latin word for 'sea'), to the figure of a man, perhaps sitting under a tree. The bright highland regions, now called terrae, form the bright background to The Man in the Moon. Look more closely at the maria – many of them have smooth dark floors and surrounding mountains. The mountain rim is easily recognised because it casts a discernible shadow. Now, look at a crater – it usually has a depressed floor surrounded by a raised rim. Some of the craters – those with smooth, dark floors – even look like miniature maria. They *are* little maria; or rather, the maria are just enormous craters, now distinguished as 'basins' because of their size. Both types of structure are impact-created; the only difference lies in size. Size of crater or mare basin is simply a function of size of impacting projectile, the bigger the impactor, the bigger the splash.

The entire Moon itself was probably impact-created some 4.6 billion years ago; the colliding objects being the young Earth and a Mars-sized planetesimal. The impact threw out a plume of terrestrial and impactor material that rapidly condensed to become the Moon. Over the years, more and more projectiles of various sizes have collided with the Moon, the larger ones creating the maria and the smaller ones the craters. And of course, there have been new impacts upon old impacts, so that one sees new craters lying on top of older ones. Knowing that maria and craters form a spectrum of impact-created structures, one can see how they merge one into another. The smallest craters (less than 20 km in diameter) are bowl-shaped. They are often young and may still be surrounded by a bright nimbus of ejecta flung out at the time of creation. Larger craters show slumping and terracing of the crater walls and often have a central peak. Several of these larger young craters also show traces of the ejecta from their origin. Because the splash was so large, this ejecta appears as bright rays that radiate for miles – sometimes halfway across the Moon's surface – from the crater of origin. Still larger craters start to show concentric rings in their floors. The largest objects, the maria, often show this multi-ringed structure and may resemble a target or a dart-board. Unfortunately, the best example of this – Mare Orientale – lies on the extreme west edge of the visible hemisphere of the Moon and is thus not easily seen as such.

After impact, lava sometimes wells up within the crater, eventually filling it and producing a smooth, dark floor, which will be younger than the surroundings. This is clearly what happened in the case of the maria. Compared to the highlands, the mare surfaces contain far fewer craters indicating that they are much younger than the highlands, which show the impact of many more cratering events. At times, the lava completely fills the crater to the brim, giving the appearance of a plateau rather than of a crater. And occasionally it spills over the rim and floods the surroundings. Other craters flooded by this overflow then appear just as ghost-craters with only portions of their rims visible. Sometimes the lava piles up and forms ridges. As the lava cools, it solidifies and cracks often start to appear, especially at the edge of the lava fields. These cracks now appear to us as arcuate rilles often located parallel to the mare boundaries. Underground lava tubes may also collapse and then give rise to another type of rille – a sinuous rille. Geological faulting is another event that occurs on lava beds. In that case, the result is a scarp or cliff – these are called rupes. Persistent volcanic activity through the ages has also resulted in little volcanic peaks – many of these appear as domes, often with a craterlet at their summit. Occasionally, these merge together to form dome complexes that appear as hills.

What we therefore see when we look at the Moon is a geological (selenological) record of impacts, and their aftermaths, since the creation of the Moon. Knowing this, let us now proceed to a more systematic tour of the Moon.



Names of lunar formations — **14.94-day-old Moon**

Crater
Agrippa
Anaxagoras
Anaximander
Archimedes
Aristarchus
Aristillus
Aristoteles
Atlas
Autolycus
Byrgius A
Censorinus
Cichus B
Copernicus
Dionysius
Endymion
Euclides
Eudoxus
Euler
Furnerius A
Gassendi
Goclenius
Godin
Grimaldi
Hercules
Kepler
Langrenus
Manilius
Menelaus
Olbers A
Petavius B
Pitatus
Plato
Plinius
Polybius A
Posidonius
Proclus
Pytheas
Riccioli
Schickard
Stevinus A
Taruntius
Thales
Timocharis
Tycho

Mare – sea
Mare Australe
Mare Crisium
Mare Fecunditatis
Mare Frigoris
Mare Humboldtianum
Mare Humorum
Mare Imbrium
Mare Marginis
Mare Nectaris
Mare Nubium
Mare Orientale
Mare Serenitatis
Mare Smythii
Mare Tranquillitatis
Mare Vaporum

Mons and montes
Mons Hadley
Mons Pico
Mons Piton
Montes Alpes
Montes Apenninus
Montes Carpatus
Montes Caucasus
Montes Recti
Montes Riphaeus
Montes Spitzbergen
Montes Teneriffe

Oceanus – ocean
Oceanus Procellarum

Palus – marsh
Palus Somni

Sinus – bay
Sinus Iridum
Sinus Medii
Sinus Roris

Others
Cassini Bright Spot
Reiner Gamma

The zero-day Moon

But you can't see the 0-day Moon; that's the New Moon when its unilluminated surface faces the Earth. Well, yes, that's true, but you certainly can see the New Moon. You may have to travel a bit and you certainly won't be able to see it every month, but it's probably much easier to see than the first-day Moon.

Now, the orbits of the Moon and the Earth aren't quite in the same plane – that of the Moon is tilted by about 5 degrees with respect to that of the Earth. This means that the New Moon usually passes north or south of the Sun – and then you certainly can't see it. Once in a while, however, at New Moon, the Moon will be at one of the two points in its orbit where the two orbital planes intersect. These points are called the ascending and descending nodes (see Figure 1). Then, the Moon will pass between the Earth and the Sun and we see an eclipse of the Sun (see Figure 2). And that's when you can see the New Moon.

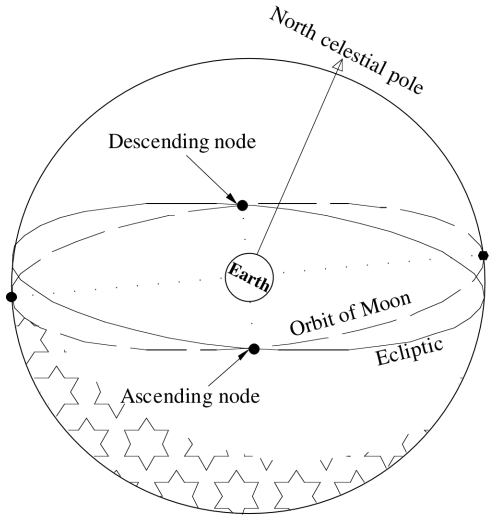


Figure 1 Orbit of the Moon

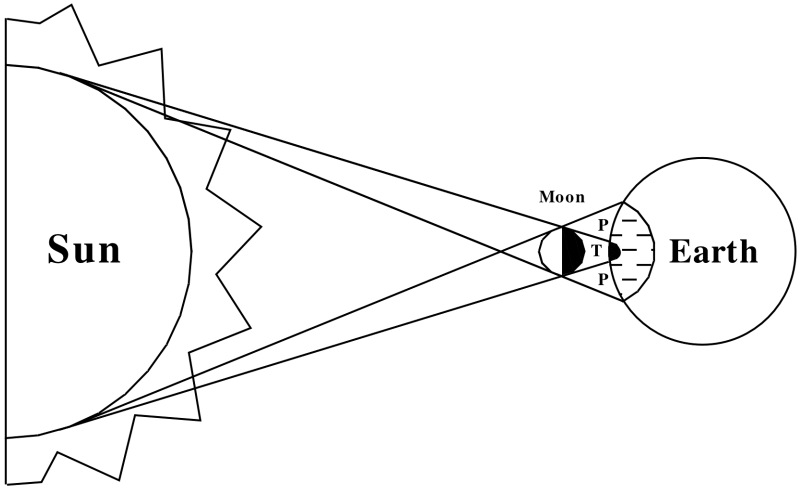
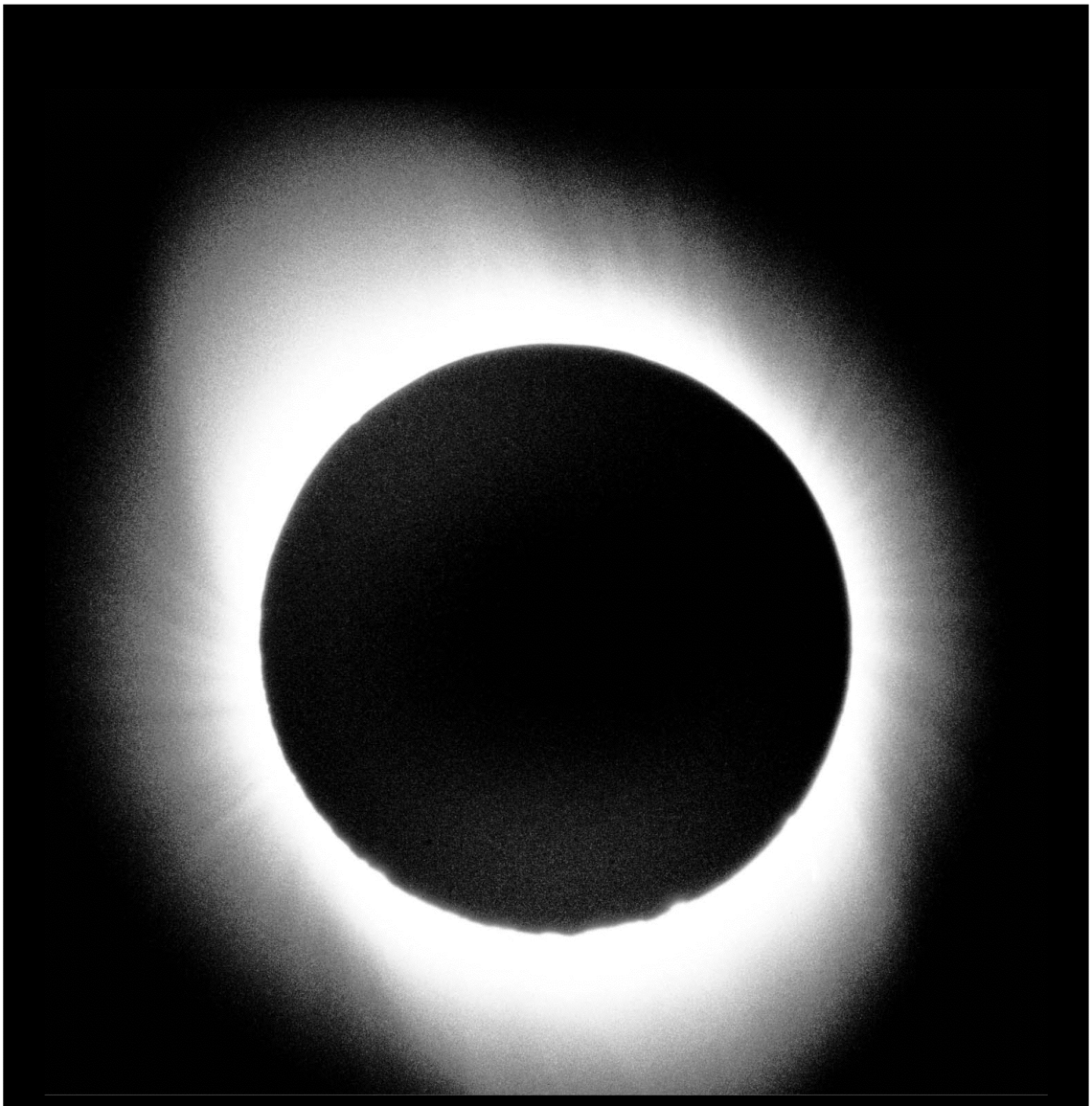


Figure 2 Total solar eclipse
A total eclipse is seen at T; while regions P will witness a partial eclipse.



Lunar data (total solar eclipse)

DTG (Local)	:	24 Oct. 95 (Tue.) 1051 hrs
DTG (UT)	:	24 Oct. 95 (Tue.) 0251 hrs
Lunation	:	No. 900
Age	:	0-day-old Moon
Illumination	:	0.0%
Diameter/dist.	:	32′48″/369,629 km
Location	:	Chai Badarn, Thailand

Photographic data

Instrument	:	3.5-inch f/16 Mak. Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Nikon F3 camera)
Slide film (135)	:	Kodak Ektachrome 200
Sky condition	:	9/10 (10/10 being perfect)
Moon altitude	:	58°19′ from N horizon

The 1st-day Moon

The first-day Moon is hard to find, really hard. From a religious point of view, it's important to Muslims because its sighting determines the beginning and the end of the fasting month of Ramadan. The youngest sighting, made in 1996, is of a crescent that is just over 12 hours old. To find this, you'll need to know exactly where to look just after sunset, in a still bright sky, for an extremely thin and incomplete crescent a few degrees above the horizon. Don't expect to see any significant detail on the illuminated portion; just finding this Moon is in itself a triumph. Savour it – you won't see it for more than a few minutes.

Notice that the Moon's cusps point toward the zenith and its convex eastern limb faces your western horizon. That's where the Sun is and obviously the illuminated portion is that which is closest to the Sun. Just think of how many artistic renderings you have seen where the artist had the horns of the crescent Moon pointing the wrong way.

Since there's so little to talk about the first-day Moon, let's discuss how much of the Moon one can actually see. Theoretically, because the Moon always keeps the same face toward the Earth, one should be able to see only that face. However, because of peculiarities in the Moon's motion, called librations, we can see a bit more than that – in total, therefore, 59% of the Moon's surface is visible, though, of course, at any one time, only 50% can be seen (see Figure 3).

There are three such librations – in longitude, in latitude, and diurnal. To get an idea of the first two, imagine a somewhat undecided person shaking his head from side to side while simultaneously nodding up and down. (You might want to try this yourself – it's a rather difficult movement to perform; until you recall those neck exercises recommended after long hours at the telescope eyepiece). Libration in longitude allows us to see more of the eastern (or western) margins of the visible lunar surface, up to as much as 8 degrees beyond the usual margins. Libration in latitude reveals more of the polar regions, tipping either pole towards us by 6 degrees every 2 weeks. Diurnal libration takes place between the rising and setting of the Moon each day, when the Earth's rotation carries the terrestrial observer from one side of the Earth–Moon line to the other. Using the same analogy, think of looking at the same person's cheeks from either side of his face. Occasionally, all these motions will coincide in such a way as to maximally reveal the appropriate limb regions.

Figure 3 Librations
Peculiarities of the Moon's motion around the Earth allow us to see its visible surface from a slightly different relative position every month. These periodic wobbles are called librations and are illustrated using a human face. The vertical sequence shows libration in latitude and the horizontal sequence shows libration in longitude. Diurnal libration would simply mean continuously shifting the camera position from one side of the model's face to the other on a daily basis.

DAY 1
(naked eye/binocular view)

Lunar data			**Photographic data**		
DTG (Local)	:	20 Nov. 98 (Fri.) 1928 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	20 Nov. 98 (Fri.) 1128 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 939	Exposure time	:	2 s (Pentax 67 camera)
Age	:	1.29-day-old Moon	Slide film (135)	:	Fujichrome Velvia 50
Illumination	:	1.7%	Sky condition	:	5/10 (10/10 being perfect)
Diameter/dist.	:	29′40″/403,132 km	Moon altitude	:	04°42′ from N horizon

The 2nd-day Moon

Finding the Moon tonight is easier than last night. Identifying anything on its surface, however, remains difficult. You'll see craters, but so few that they are hard to identify. They are all foreshortened (compressed in an east–west direction) because the Moon is spherical and curves away from us in that direction. It's hard to get one's bearings as the incompleteness of the crescent means that one is never sure how much, and exactly which part, of the limb is seen. There's very little time before the Moon sinks into horizon haze, or worse, sets. And of course, the sky background is still bright, lessening the contrast that is necessary for detail to be seen. Nevertheless, the persevering observer can, with care, identify the main features. Look for details along the terminator, the curve separating the sunlit, bright portions from the dark areas on which the Sun has still not risen. Most important of all, determine which direction is north and which is south on the Moon. These actually correspond to terrestrial north and south but because of the inversion of east and west on the Moon's surface you might get confused. This is further complicated by the inversion that occurs in a telescope eyepiece. So, to reiterate, the east limb is the illuminated convex limb. That means if you are in the Northern hemisphere and looking at the Moon with the naked eye or binoculars, the left horn is South and the right horn North.

We start our journey in the north and proceed south. The large craterlike object in the northeast is actually one of the lesser lunar seas, Mare Humboldtianum. Large but severely foreshortened Bel'kovich is located at its northeast aspect. Look for smaller Zeno south of the mare, and then move approximately the same distance further south, to the prominent walled plain, Gauss. The eastern portion of its floor remains in the shadow of the eastern crater rim. The elevated western rim catches more of the rising Sun's light and therefore appears bright. Riemann, slightly north and east of Gauss, appears brighter because of more direct illumination from the high Sun. Foreshortened Seneca and Plutarch are just discernible as elongated dark patches south of Gauss. To their east, try to locate, from north to south, Urey, Lyapunov and Hubble. Don't be too disappointed if you can't – they are at the limit of visibility, and a poor libration will certainly swing them out of view.

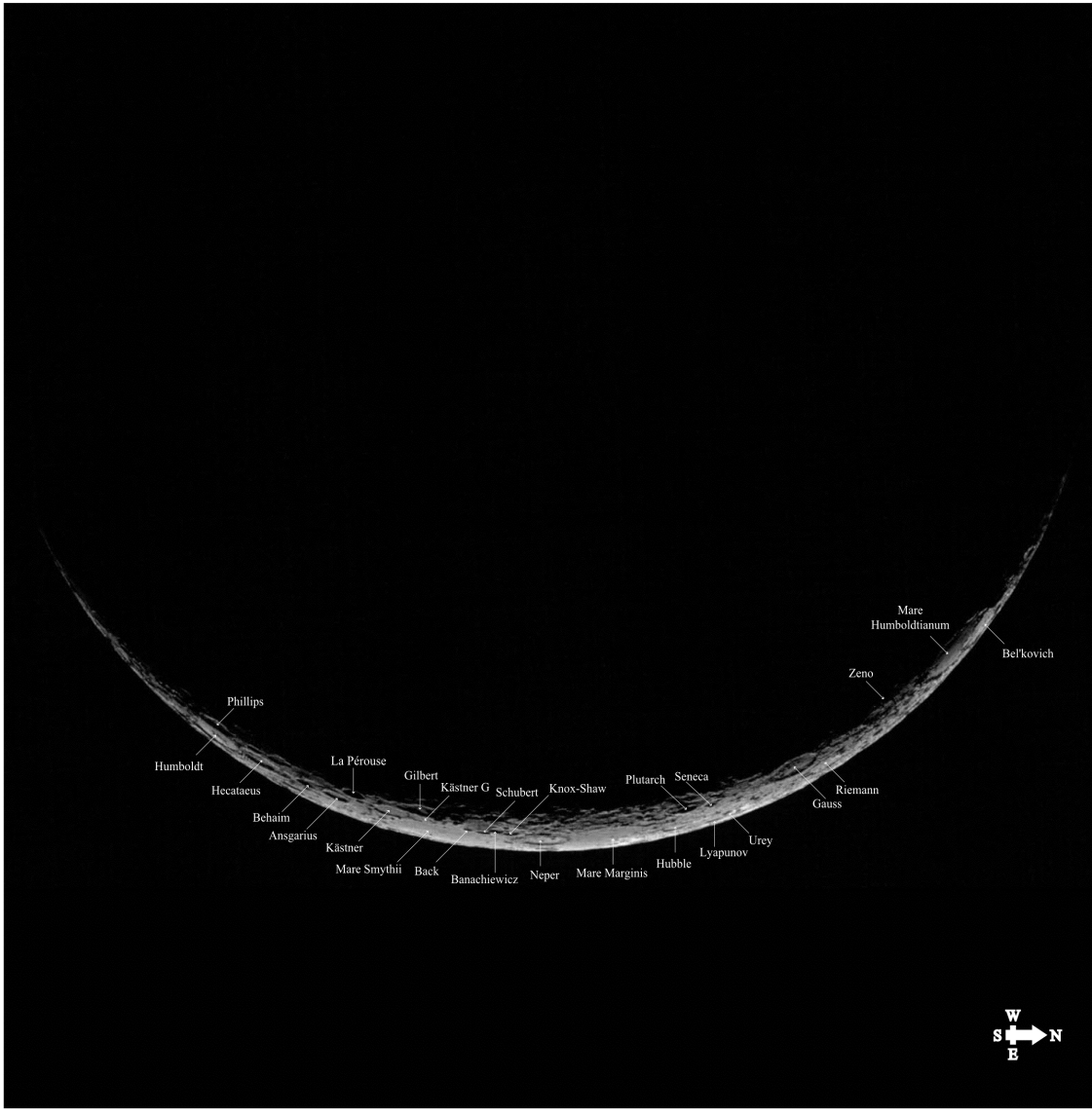
Just north of the Moon's equator is Neper – its central peak casts a shadow seen as a black dot that mars the bright crater floor. Neper separates two smooth areas on the limb. These are two more of the limb maria – Mare Marginis to the north and Mare Smythii to the south. Four smaller craters – Knox-Shaw, Banachiewicz, Schubert and Back – lie immediately south of the latter. You may only be able to see their dark eastern walls.

West of the midpoint of Mare Smythii is a mess of black and white made up of small craters. Flowing south from this mess is Gilbert, which is separated from Mare Smythii by Kästner G. Immediately south of G is Kästner, only slightly smaller than Gilbert and with a small crater on its northeastern wall. Still further south are, first, La Pérouse and then, Ansgarius. La Pérouse, further north but more west, has its floor almost completely dark, while the more easterly Ansgarius is much better lit. Both their raised western rims, however, catch the rising Sun and appear bright. Ansgarius seems to lie within a larger crater, the southern apex of which still appears dark. This dark patch is actually the crater Behaim.

The next easily recognisable structures south of Behaim are Hecataeus and Humboldt (do not confuse it with Mare Humboldtianum), both approximately the same size. Both contain elongated central mountain chains. These appear dark as we see their unilluminated western slopes. Between Humboldt and the terminator is Phillips, still mostly in darkness.

By now, recognising anything is becoming more difficult as the Moon becomes more obscured by horizon haze. But, there's always tomorrow night . . .

DAY 2
(naked eye/binocular view)



Names of lunar formations							1.67-day-old Moon
Crater Ansgarius Back Banachiewicz	Behaim Bel'kovich Gauss	Gilbert Hecataeus Hubble	Humboldt Kästner Kästner G	Knox-Shaw La Pérouse Lyapunov	Neper Phillips Plutarch Riemann	Schubert Seneca Urey Zeno	**Mare – sea** Mare Humboldtianum Mare Marginis Mare Smythii

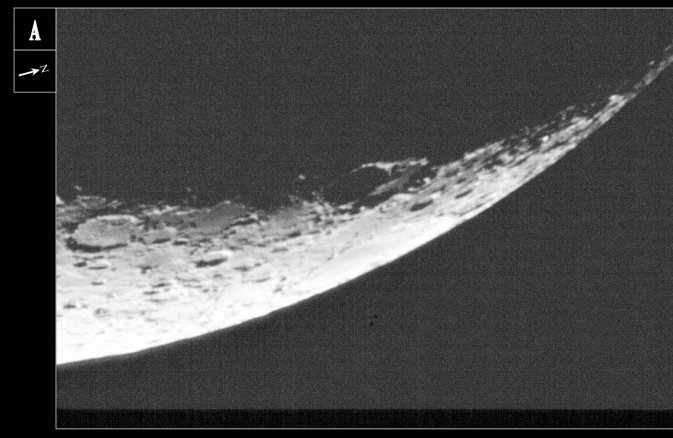


Photo A: Sunrise on the northeast limb
Mare Humboldtianum greets the rising Sun.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 27th Jun. 1998
Exp: 2 s (Nikon F3)
Sky: 6/10
Film: Kodak Ektachrome 400

Photo B: Messala to Mare Humboldtianum
Endymion shows the shadows of its east wall in the crater floor.

Photographic data
Instr: 40-cm f/13 Cassegrain
2× Barlow Projection yielding f/39
Date: 29th May 1998
Exp: 1 s (Nikon F3)
Sky: 6/10
Film: Kodak Elite II - 200

Photo C: Sunrise on the southeast limb
Furnerius, Petavius, Vendelinus and Langrenus greet the rising Sun.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 8th Mar. 2000
Exp: 1 s (Nikon F3)
Sky: 6/10
Film: Kodak Elite II - 400

DAY 2
(naked eye/binocular view)

Lunar data		
DTG (Local)	:	27 May 98 (Wed.) 1942 hrs
DTG (UT)	:	27 May 98 (Wed.) 1142 hrs
Lunation	:	No. 933
Age	:	1.67-day-old Moon
Illumination	:	4.0%
Diameter/dist.	:	32′21″/307,859 km

Photographic data		
Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	2 s (Pentax 67 camera)
Slide film (135)	:	Fujichrome Velvia 50
Sky condition	:	8/10 (10/10 being perfect)
Moon altitude	:	13°05′ from N horizon

The 3rd-day Moon

If you are a novice 'lunatic', we recommend that you start trying to identify objects tonight, rather than earlier in the lunation. The crescent is now complete and higher up, while the dark sky now provides sufficient contrast to view detail on this 3rd-day crescent. Look for 'the old Moon in the young Moon's arms'. This is earthshine – reflected light from the Earth brightening the dark portion west of the terminator, so that the unilluminated portion, the old Moon, appears cradled by the young crescent. You might even be able to see features on the old Moon.

The eastern portion of Mare Crisium, the Sea of Crises, separates the crescent into northern and southern halves. The north half is rather dull, with only one or two prominent craters present. In contrast, the southern half contains four impressive craters – Langrenus, Vendelinus, Petavius and Furnerius. This remains generally true throughout the lunar cycle – there are far more craters in the south of the Moon compared to the north. An engaging entertainment throughout the lunation is to watch the craters change in appearance as the Sun rises and the terminator moves westwards. If you watch the same crater over an extended period, you will appreciate how the shadows on the crater floor shorten as the Sun rises.

In the northern half of the Moon, Hayn lies immediately north of Mare Humboldtianum, while two unnamed craters lie to its west. Gauss has all its detail washed out by the high Sun. Berosus and Hahn are obvious to its west. The central peak in Hahn appears as a prominent black dot. Low-walled Messala lies between Gauss and Mare Humboldtianum and somewhat to their west. South of Messala is Schumacher. Between Messala and Mare Humboldtianum, Mercurius has its eastern wall in shadow although its western rim is bright. Geminus and Bernoulli remain veiled in darkness south of Messala. To their south, Burckhardt and Cleomedes are similarly concealed.

Like the other maria, Mare Crisium is ringed by mountains. Distorted Eimmart lies against the northern mountain arc. East of Eimmart is a smooth and dark-floored strip of material, Mare Anguis. The southern arc ends in the east at Promontorium Agarum. Just east of this is Condorcet. Hansen and Alhazen lie north of Condorcet. The smooth floor of Mare Crisium, most appropriately for a sea, is interrupted by wave-like structures called wrinkle ridges. Against the southern mountains are Firmicus and Apollonius. Together with Dubyago further east and Condorcet in the north, they form the boundaries of Mare Undarum, which continues further southwards as Mare Spumans. Luna 20 landed here in the Apollonius highlands and returned soil samples to Earth. Luna 24 returned similar samples from the surface of Mare Crisium.

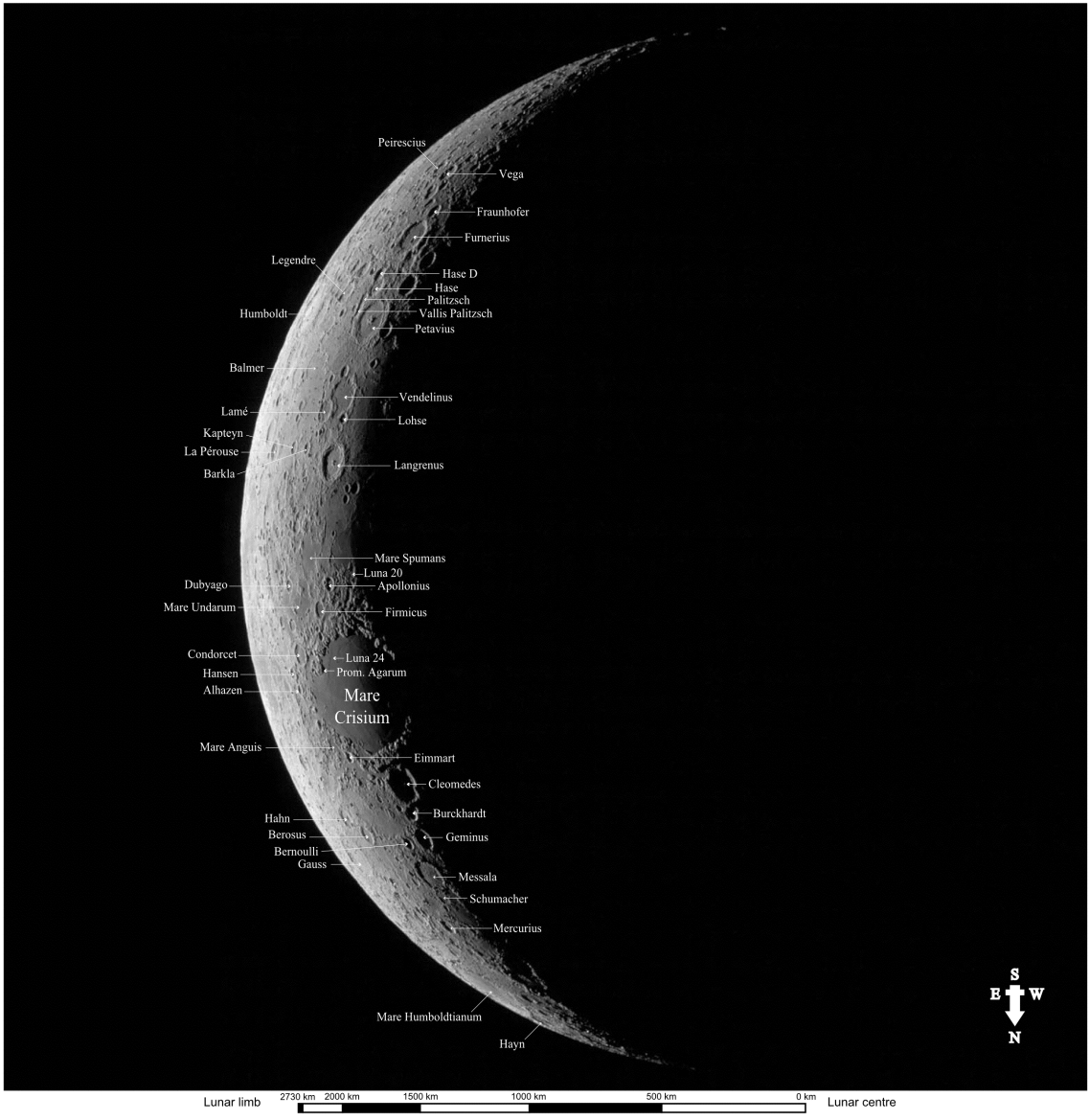
The first of the four large southern craters tonight is Langrenus, separated from La Pérouse by little Barkla and Kapteyn. Initially, the floor of Langrenus is dark and only its elevated rims are visible. As the Sun rises, however, the central peak catches the light before the crater floor and becomes visible as a point of light in the darkness. When completely exposed, the central mountain appears twin-peaked and the high crater ramparts show striations and terraces. Such complexities are the hallmark of a young, uneroded crater.

Compare this with Vendelinus, a much older crater. Its walls are low and incomplete, having been eroded by incessant bombardment. Its floor is lava-flooded and its central peak absent. As final indignities, its northeast wall is overlapped by Lamé, while Lohse encroaches on the northwestern wall. Both these craters must have been created later than Vendelinus. Balmer, an even more ruined crater, lies east of Vendelinus.

Petavius, the finest of the four, shows more similarity to Langrenus than to Vendelinus. The central mountain complex is so massive and high that it stands out easily from the dark crater floor. Once the floor is fully revealed, look for a dark cleft that runs like a straight highway from the central massif to the west wall. Just east of Petavius is the elongated complex of Palitzsch, and its northward extension, Vallis Palitzsch. Legendre separates Palitzsch from washed-out Humboldt.

Southernmost of the four is Furnerius, separated from Petavius by Hase, which, together with Hase D, forms a distorted figure eight. Just as Langrenus shows some similarity to Petavius, Furnerius shows some similarity to Vendelinus. Its north wall also appears incomplete, and its floor is also flooded and devoid of a central peak. Instead, there is the supreme insult of a craterlet in the floor. Three craters form a short chain running southeast from Furnerius. Only one of these has been dignified with a name – this is Fraunhofer, tangent to Furnerius. The chain leads to a pair of east-west kissing craters, western Vega and eastern Peirescius.

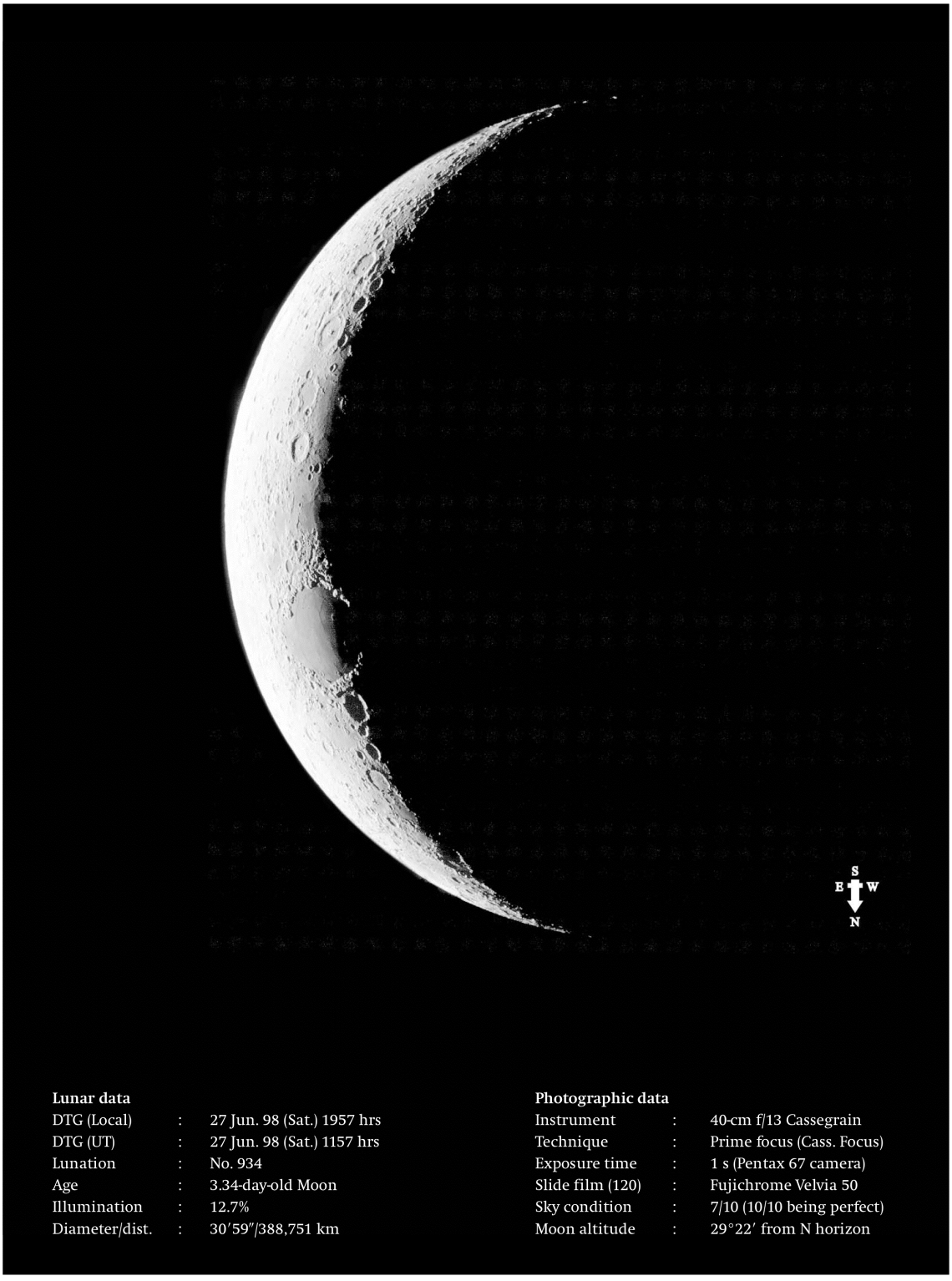
Severe distortion and the multitude of craters limit further identification southwards. If you have reached here, however, you have done well.



Names of lunar formations							3.34-day-old Moon
Crater Alhazen Apollonius Balmer Barkla Bernoulli Berosus	Burckhardt Cleomedes Condorcet Dubyago Eimmart Firmicus	Fraunhofer Furnerius Gauss Geminus Hahn Hansen	Hase Hase D Hayn Humboldt Kapteyn La Pérouse	Lamé Langrenus Legendre Lohse Mercurius Messala	Palitzsch Peirescius Petavius Schumacher Vega Vendelinus	**Mare – sea** Mare Anguis Mare Crisium Mare Humboldtianum Mare Spumans Mare Undarum	**Promontorium – promontory** Prom. Agarum **Vallis – valley** Vallis Palitzsch **Probe** Luna 20 Luna 24

DAY 3

Lunar data			**Photographic data**		
DTG (Local)	:	28 May 98 (Thu.) 1952 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	28 May 98 (Thu.) 1152 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	2 s (Pentax 67 camera)
Age	:	2.68-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	9.6%	Sky condition	:	5/10 (10/10 being perfect)
Diameter/dist.	:	31′59″/376,191 km	Moon altitude	:	23°51′ from N horizon



Lunar data			**Photographic data**		
DTG (Local)	:	27 Jun. 98 (Sat.) 1957 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	27 Jun. 98 (Sat.) 1157 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 934	Exposure time	:	1 s (Pentax 67 camera)
Age	:	3.34-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	12.7%	Sky condition	:	7/10 (10/10 being perfect)
Diameter/dist.	:	30′59″/388,751 km	Moon altitude	:	29°22′ from N horizon

The 4th-day Moon

All of Mare Crisium is visible this 4th night of the lunation. Foreshortening renders it apparently north–south elongated. Spacecraft photographs, however, show it as actually east–west elongated. It is unique among the major maria in being completely surrounded by mountains. In the west, the northern and southern mountain arcs end respectively at Promontorium Olivium and Lavinium. The rim of an obsolescent crater connects the two promontories. Just before sunset or sunrise, however, this crater rim looks like an artificially constructed bridge. In the mountains west of Promontorium Olivium is a small, and for tonight, completely undistinguished crater, Proclus. As the lunation continues, however, Proclus will brighten to become the centre of a system of bright rays and the second brightest spot on the surface of the Full Moon.

Several small craters intrude on the dark lava surface of the mare. Four of these form a parallelogram. Southernmost is flooded and incomplete Lick, which has a distinctly convex floor. Smaller Greaves lies to its north. These two craters form the southernmost vertex of the parallelogram. Still further north and just east of Promontorium Lavinium is the even more incomplete Yerkes. East of Yerkes is Picard, and completing the parallelogram northwards is Peirce. Swift lies immediately north of Peirce.

Continuing north from Mare Crisium, we reach Cleomedes. While the floor of Cleomedes is flooded, the central mountain still remains visible. A string of craterlets straddles the mountain. Adjacent to the northernmost craterlet, Tralles has encroached on the crater rim.

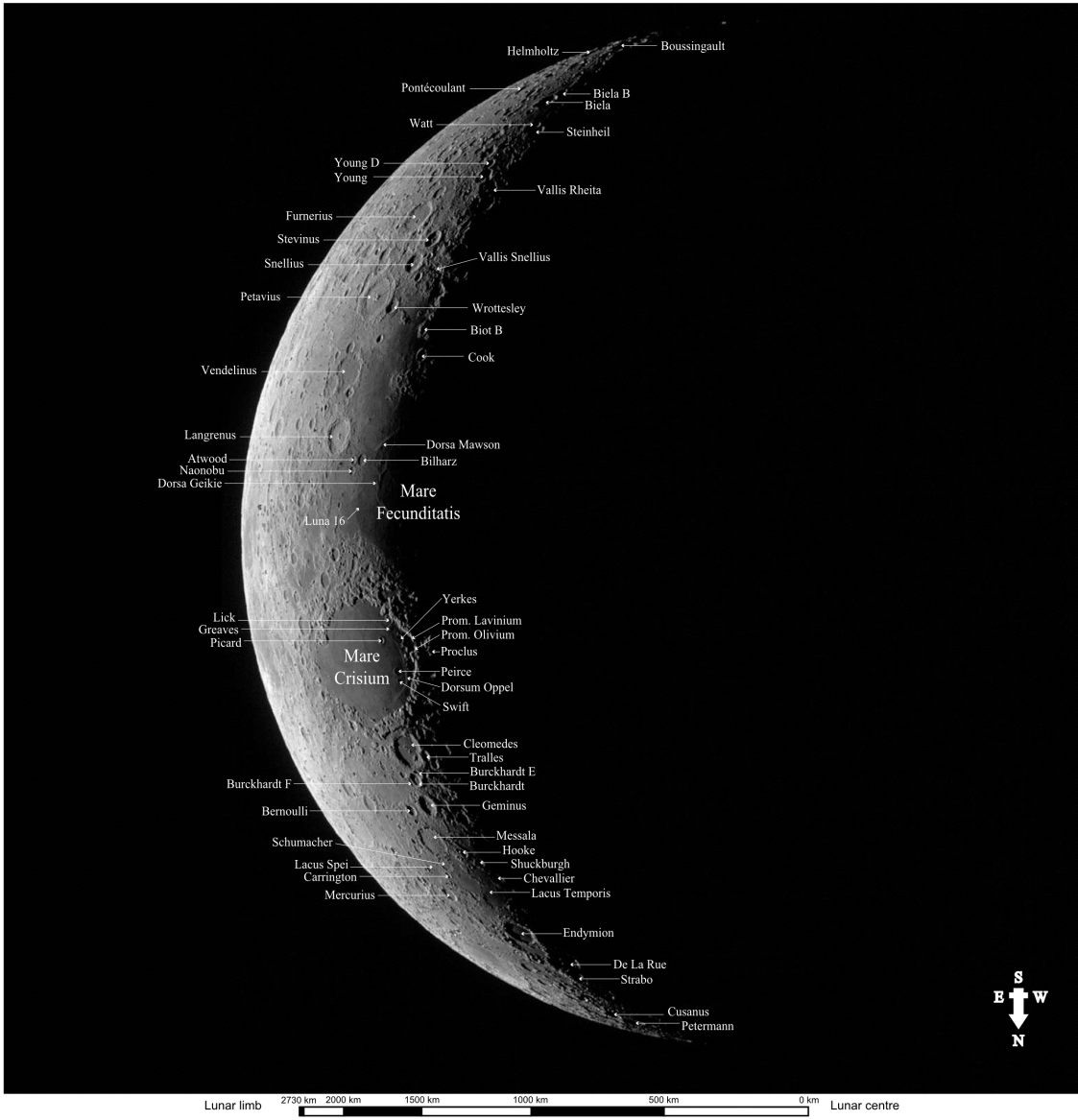
North of Cleomedes are the conjoint triple, Burckhardt, Burckhardt E and Burckhardt F. From this triplet, proceeding in a north, east and north zigzag, we reach first Geminus, then smaller Bernoulli and finally Messala, familiar from last night. Its interior is already looking washed out but its low walls are still easily identified. Forming a snowman shape with it on the north is the equally ruined Schumacher.

Extending northwards from Schumacher is a smooth mare-like area, Lacus Temporis. Hooke, Shuckburgh and Chevallier guard its western shores while Mercurius stands sentinel on the east shore. Little Carrington separates it from an even smaller lava flow, Lacus Spei to the south. At the northern apex of Lacus Temporis is beautiful Endymion. Its flooded floor remains partially in the shadow of the eastern rim walls. Immediately north of Endymion, ruined De La Rue lies almost completely dark. Adjacent to the northernmost aspect of De La Rue, the northern apex of sharp-walled Strabo forms a bright V. Northeast of Strabo, the black streaks of Cusanus and Petermann are barely perceptible.

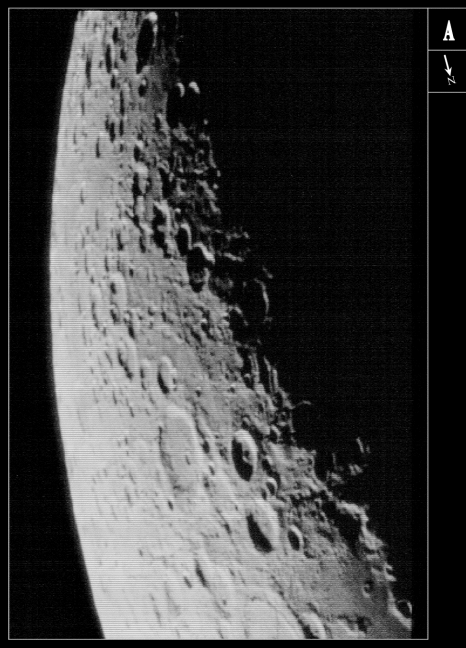
Returning to Mare Crisium and proceeding south, we see the eastern half of Mare Fecunditatis emerging from the lunar night. It is bordered on the east by the three craters, Langrenus, Vendelinus and Petavius, which were so conspicuous last night. A small right-angled triangle of craters is present on the mare adjacent to Langrenus. At the right angle is Atwood, while Naonobu and Bilharz are located to its north and west respectively. Some distance south of these craters, Luna 16 landed and returned another soil sample from the mare surface. In passing, notice the many swirling wrinkle ridges on the surface of the mare – Dorsa Geikie and Dorsa Mawson being the most conspicuous. A highland triangle protrudes from the terminator onto the mare surface west of Vendelinus. South of this protrusion, on the mare surface, is sharp-edged Biot B. In the highlands to its south is Cook.

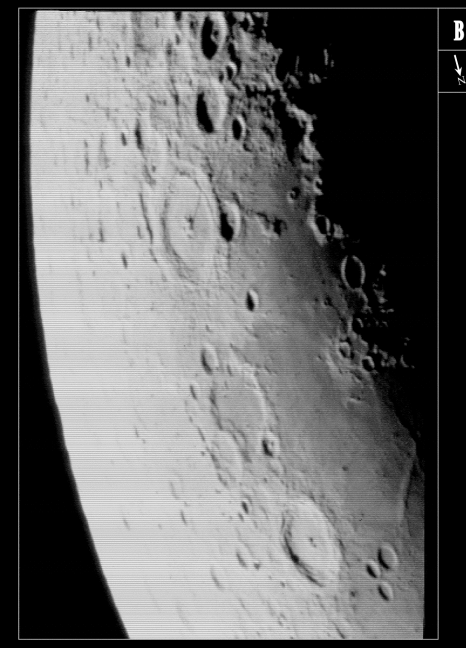
Wrottesley lies against the west wall of Petavius. Southwest of Petavius is the matched pair of Snellius and Stevinus, their only difference being that Stevinus possesses a central peak. Vallis Snellius, a groove that runs perpendicular to the long axis of Snellius, provides a welcome change from the usual north–south elongations of the craters here. Notice how it continues eastwards beyond the eastern margin of Snellius.

Further south, Young and Young D form a distorted, dark, figure-of-eight. Vallis Rheita, still mostly dark and better viewed tomorrow night, is oriented similar to Vallis Snellius and also seems to pass through Young. Steinheil and Watt form another matched pair on the terminator. Some distance further south and perpendicular to them is another figure-of-eight formed by Biela and Biela B. Look for Pontécoulant to their east – its dark east wall is a black streak tonight. Its west wall is inconspicuous but is marked out by a dark craterlet. Squeezed between the eastern limb and the terminator are Helmholtz and Boussingault. Even in this oblique lighting, a hint of concentric structure can be seen in the latter. Beyond this, in the deep south, no further structure can be identified. Notice, however, how the high points there still catch the light and appear like fireflies in the dark.



Names of lunar formations							3.70-day-old Moon
Crater Atwood Bernoulli Biela Biela B Bilharz Biot B Boussingault Burckhardt	Burckhardt E Burckhardt F Carrington Chevallier Cleomedes Cook Cusanus De La Rue	Endymion Geminus Greaves Helmholtz Hooke Langrenus Lick Mercurius	Messala Naonobu Peirce Petavius Petermann Picard Pontécoulant Proclus	Schumacher Shuckburgh Snellius Steinheil Stevinus Strabo Swift Tralles	Vendelinus Watt Wrottesley Yerkes Young Young D **Dorsa – wrinkle ridges** Dorsa Geikie Dorsa Mawson	**Lacus – lake** Lacus Spei Lacus Temporis **Mare – sea** Mare Crisium Mare Fecunditatis	**Promontorium – promontory** Prom. Lavinium Prom. Olivium **Vallis – valley** Vallis Rheita Vallis Snellius **Probe** Luna 16





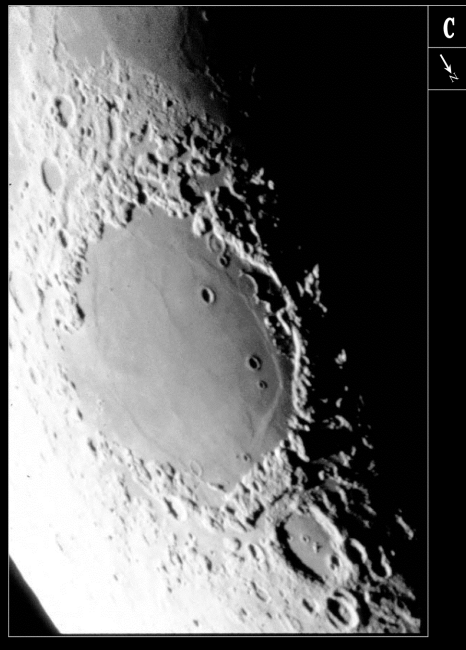


Photo A: Sunrise in the southeast
Furnerius, Snellius and Stevinus emerge from the lunar night.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 2 s (Nikon F3)
2× Barlow Projection yielding f/39 Sky condition: 6/10
Date: 29th May 1998 Film: Kodak Elite II - 200

Photo B: Petavius, Langrenus and Vendelinus
Note the dark rille running from the central peak in Petavius to the crater rim.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
2× Barlow Projection yielding f/39 Sky condition: 6/10
Date: 29th May 1998 Film: Kodak Elite II - 200

Photo C: Mare Crisium and Cleomedes
Wrinkle ridges create waves on the mare surface.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 2 s (Nikon F3)
2× Barlow Projection yielding f/39 Sky condition: 6/10
Date: 29th May 1998 Film: Kodak Elite II - 200

Lunar data			**Photographic data**		
DTG (Local)	:	29 May 98 (Fri.) 2015 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	29 May 98 (Fri.) 1215 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/2 s (Pentax 67 camera)
Age	:	3.70-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	17.0%	Sky condition	:	6/10 (10/10 being perfect)
Diameter/dist.	:	31′33″/382,054 km	Moon altitude	:	31°17′ from N horizon

The 5th-day Moon

Tonight, it is the turn of Mare Fecunditatis to be completely revealed southwest of Mare Crisium. Part of Mare Tranquillitatis is also visible northwest of Mare Fecunditatis, while Mare Nectaris peeks out from the terminator to its southwest. Located in the narrows between Fecunditatis and Tranquillitatis is ruined, old Taruntius, destined for better, brighter things as the lunation proceeds. Look carefully at Taruntius – besides its central peak, it contains a complete inner ring.

Northwest of Taruntius lies Mare Tranquillitatis. Two almost parallel grooves on the smooth mare surface are separated by the little crater Cauchy. The southern groove casts a dark shadow while its northern counterpart looks like a trench. Clearly, the southern object, Rupes Cauchy, must be raised above the mare surface and is a scarp, while the northern structure, Rima Cauchy, an example of a lunar rille, must be depressed below the surface. If you look carefully, however, you will see that the scarp transforms into a rille as it runs along. Two well-formed domes, Cauchy Omega and Tau, should also be noted here just south of Rupes Cauchy.

Move north from Taruntius back to Mare Crisium. West of Promotorium Olivium, little Proclus presents its bright western rim, a forerunner of things to come. Still further west, Palus Somni, the Marsh of Sleep, looks pretty rugged tonight – rather unusual for a marsh, don't you think? North of Proclus are Macrobius and its smaller eastern neighbour, Tisserand. Northeast of these, recognise Cleomedes again before it fades into the lunar day. Its little neighbour, Tralles, in turn has a double crater shaped like an hour-glass as a western neighbour. The southern half of the hour-glass is anonymous; the more conspicuous northern half is Debes. West of Debes, a range of hills forms a structure remarkably reminiscent of a tomahawk.

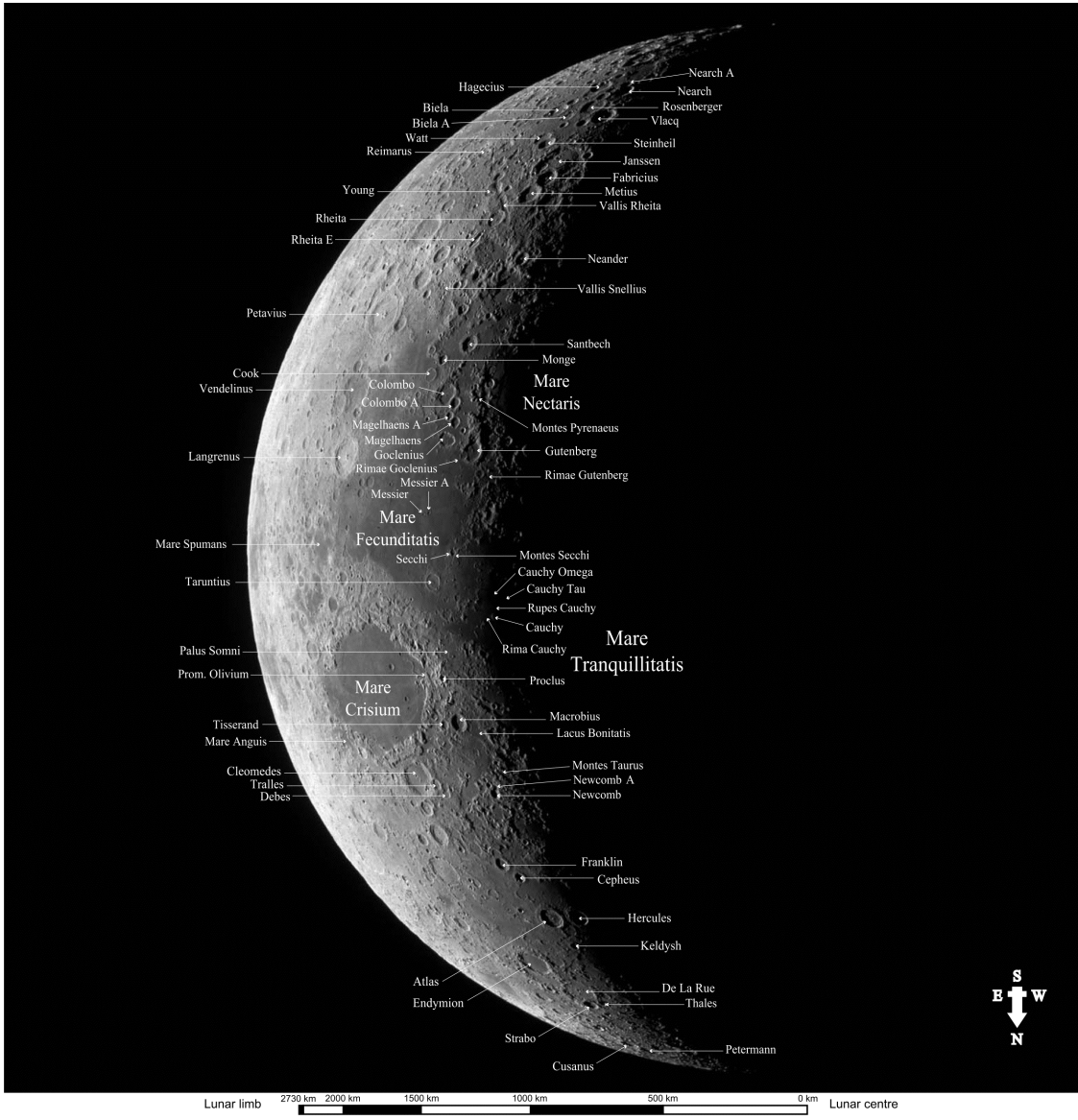
Contrast the rough terrain of the Taurus mountains (Montes Taurus) with adjacent, relatively smooth Lacus Bonitatis immediately north of Macrobius. Notice how the northwest margin of the Lacus forms an arc that parallels the corresponding boundary of Mare Crisium. Mare Anguis and Mare Spumans, both familiar from previous nights, also form part of this double-ringed arrangement. As the lunation proceeds, such a double-ringed structure will be seen to be characteristic of many of the maria.

At the northern apex of Lacus Bonitatis, a little chain of craters, progressively increasing in size, ends at Newcomb, easily recognised by the intruder, Newcomb A, on its south wall. At the northern margin of the Taurus range, identify Franklin and smaller Cepheus. A line through these two points north to the mythological rivals, Atlas and Hercules. Atlas is slightly larger and contains a central mountain. In contrast, his western counterpart, Hercules, contains an inner craterlet. Sharp-edged little Keldysh forms a triangle with Atlas and Hercules. Northeast of Atlas, look again at Endymion before it too fades away. Endymion, Atlas and Hercules are going to be important landmarks tomorrow night. Elderly De La Rue, with barely recognisable walls, should be contrasted with young (only several million years young) Strabo and Thales. As the lunation continues, Thales will become more prominent and show its bright rays. Near the northern tip of the crescent, Cusanus and Petermann, although severely foreshortened, are much easier to recognise tonight.

Well, having reached the deep north, it's time to jump back to Taruntius and head for the far south. Tarry a while, however, at Mare Fecunditatis, the Sea of Fertility. Along its eastern margin, recall Langrenus, Vendelinus and Petavius. Tonight, all three are merely pale semblances of their former brilliant selves. The rising Sun lights, and having lit, washes out, at least until the next lunation. The western border of the mare consists of two mountain ranges – the northern Montes Secchi – that peter out at Secchi southwest of Taruntius, and the southern Pyrenees (Montes Pyrenaeus), which also separate Mare Fecunditatis from Mare Nectaris. The gigantic claw of Gutenberg more-or-less divides the two ranges. On the mare surface is the eye-catching pair of small craters, Messier and Messier A (formerly called Pickering), from which two bright rays radiate westwards, giving the whole complex a resemblance to a comet or a searchlight beam. East of Gutenberg, still on the surface of the mare, is flooded Goclenius. From Goclenius, a series of rilles, Rimae Goclenius, passes through and across the northeastern border of Gutenberg. Some of these continue towards Mare Tranquillitatis as Rimae Gutenberg. South of Goclenius, Magelhaens, Magelhaens A, Colombo A and Colombo form a small parallelogram. Flooded Cook, southeast of Colombo, should easily be compared with Monge immediately to its south.

As we leave the mare to enter the southern highlands, young Santbech is prominent in a mare-like area. A long jump south leads to an unusual crater chain, Rheita E, that looks uncannily like a rolling-pin. The long axis of this points towards Rheita, and its companion Vallis Rheita. Like Vallis Snellius last night, this Rheita valley also stands out as a gash perpendicular to the long axis of the other foreshortened craters in this region. Trace it through Young before it ends in another little rolling pin. The other end of the valley points towards Neander, which is sited in a highland region.

Continuing south, the piling up of the craters gives this southeast sector of the Moon a close resemblance to a First World War battlefield. Prominent here is Metius, with Fabricius closely attached to its south. Fabricius is actually part of a larger crater, Janssen, easternmost of the colossal craters that inhabit the southern half of the visible surface of the Moon. Look for the arcuate rille in its floor. Another little east–west groove is present east of Janssen. The reason for the orientation of all these valleys will become apparent tomorrow night, when we can see what they all point to. Immediately south of this valley are the kissing couple, Steinheil and Watt, caught again in the act. Rosenberger and Vlacq form yet another intimate couple further south. To the east is the distorted snowman shape formed by Biela and Biela A. Nearch and Nearch A produce a similar configuration to their south. Hagecius lies east of the last two craters.



Names of lunar formations — **4.70-day-old Moon**

Crater
Atlas
Biela
Biela A
Cauchy
Cepheus
Cleomedes
Colombo
Colombo A
Cook
Cusanus
De La Rue
Debes
Endymion
Fabricius
Franklin
Goclenius
Gutenberg
Hagecius
Hercules
Janssen
Keldysh
Langrenus
Macrobius
Magelhaens
Magelhaens A
Messier
Messier A
Metius
Monge
Neander
Nearch
Nearch A
Newcomb
Newcomb A
Petavius
Petermann
Proclus
Rheita
Rheita E
Rosenberger
Santbech
Secchi
Steinheil
Strabo
Taruntius
Thales
Tisserand
Tralles
Vendelinus
Vlacq
Watt
Young

Lacus – lake
Lacus Bonitatis

Mare – sea
Mare Anguis
Mare Crisium
Mare Fecunditatis
Mare Nectaris
Mare Spumans
Mare Tranquillitatis

Mons and montes – mountain(s)
Cauchy Omega (dome)
Cauchy Tau (dome)
Montes Pyrenaeus
Montes Secchi
Montes Taurus

Palus – marsh
Palus Somni

Promontorium – promontory
Prom. Olivium

Rima and rimae – rille(s)
Rima Cauchy
Rimae Goclenius
Rimae Gutenberg

Rupes – scarp
Rupes Cauchy

Vallis – valley
Vallis Rheita
Vallis Snellius

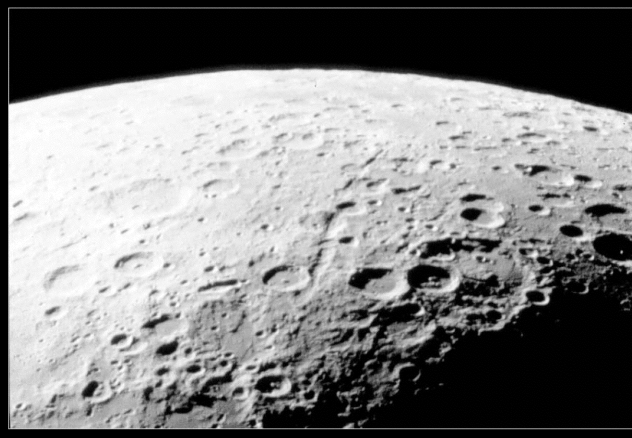


Photo A: Vallis Rheita
A prominent valley in the southeast. The valley starts near Rheita, continues past Young and ends near Reimarus. Southwest of the valley, Metius and Fabricius lead to Janssen.

Photographic data
Instr: 40-cm f/13 Cassegrain
2× Barlow Projection yielding f/39
Date: 30th May 1998
Exp: 1/2 s (Nikon F3)
Sky: 7/10
Film: Kodak Ektachrome 400

Photo B: Messier to Macrobius
Diverging rays radiate west from Messier A on Mare Fecunditatis. Taruntius guards the straits between Mare Fecunditatis and Mare Tranquillitatis. Proclus shows a bright west rim.

Photographic data
Instr: 40-cm f/13 Cassegrain
2× Barlow Projection yielding f/39
Date: 30th May 1998
Exp: 1/2 s (Nikon F3)
Sky condition: 7/10
Film: Kodak Ektachrome 400

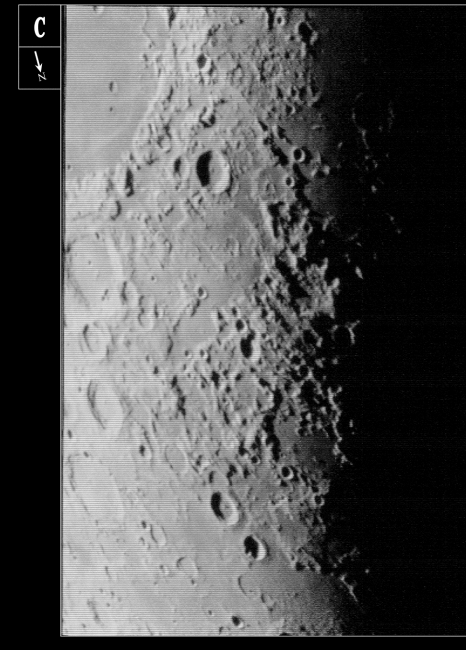
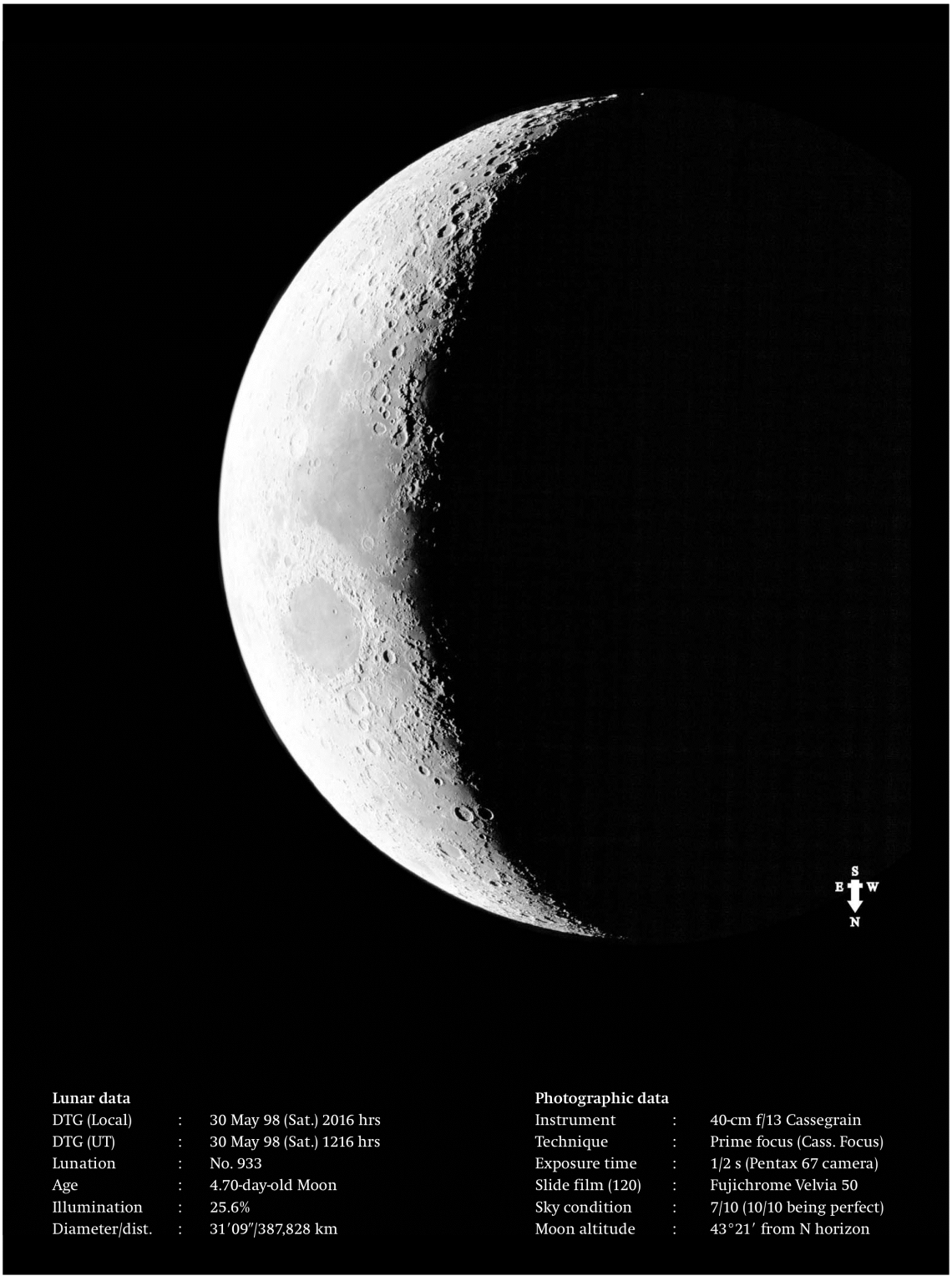


Photo C: Striated terrain northwest of Mare Crisium
Note radial striations on the surface between Cleomedes and Macrobius.

Photographic data
Instr: 40-cm f/13 Cassegrain
2× Barlow Projection yielding f/39
Date: 30th May 1998
Exp: 1/2 s (Nikon F3)
Sky condition: 7/10
Film: Kodak Ektachrome 400



Lunar data			**Photographic data**		
DTG (Local)	:	30 May 98 (Sat.) 2016 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	30 May 98 (Sat.) 1216 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/2 s (Pentax 67 camera)
Age	:	4.70-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	25.6%	Sky condition	:	7/10 (10/10 being perfect)
Diameter/dist.	:	31′09″/387,828 km	Moon altitude	:	43°21′ from N horizon

Rounded Mare Nectaris, southwest of Mare Fecunditatis, is the most obvious newcomer tonight. Can you see that the prominent valleys seen earlier in this region are arranged radially with respect to this mare? What happened was that the impact that created Mare Nectaris hurled out ejecta that gouged these radial grooves on the Moon's surface. Once again identify the double ring stucture due to the concentric arrangement of the ridges around the mare – most prominent of these is bright, wrinkled Rupes Altai, towards the terminator. North of Mare Nectaris is Mare Tranquillitatis, nowadays the most well-known of the Moon's seas. Still further north, eastern Mare Serenitatis is coming into view. On its northeastern margin is the great walled plain, Posidonius.

There's a lot to see tonight and we'll start where it's simple – immediately north of Posidonius. Identify again the Atlas–Hercules pair, Endymion, De La Rue, Strabo and Thales. They bound the eastern end of Mare Frigoris, which continues westwards into the terminator. On its northern border, incomplete Gärtner is easily identified. North of Gärtner is sharp-bordered, smaller Democritus. Two large foreshortened craters, Arnold and Baillaud, are conspicuous between Democritus and the northern limb.

Atlas and Hercules point westwards towards smooth, pentagonal Lacus Mortis. Bürg, easily recognised by its central peak, sits uneasily off-centre in this Lake of Death. Now Hamlet said, 'To die, to sleep; to sleep, perchance to dream', and the Lake of Dreams, Lacus Somniorum, dreams peacefully south of Lacus Mortis, the two lakes being separated by elderly Mason and Plana.

Dreams leads first to serenity and then to tranquillity, nightmares being outlawed from this placid eastern half of the Moon. Lacus Somniorum flows south into Mare Serenitatis, the confluence being watched by majestic Posidonius, and his companion Chacornac. Don't you think Posidonius, with its inner ring and central craterlet, resembles Taruntius? Before leaving this area, take a quick look at Kirchoff, in the Taurus mountains, about midway between Posidonius and Newcomb.

We pass quickly over Mare Serenitatis, leaving it for tomorrow night, when it can be seen in its entirety, noting only that its confluence with Mare Tranquillitatis contains another sentinel crater, Plinius. Lest you think that all sentinels are similar, Plinius, a young crater with terraced walls, is distinctly different from the others hitherto encountered.

Serenity to tranquillity is but a small step south. We've already seen the eastern portion of Mare Tranquillitatis, but just to refresh the memory, Lacus Bonitatis and Palus Somni are at the southeastern boundary and the Montes Secchi at the northeastern boundary. Look for isolated Maskelyne on the mare surface adjacent to Montes Secchi. In the highlands to its southeast, minute Censorinus is starting to light up. It is one of the little craters that, when illuminated by the high Sun, shine in a manner totally out of proportion to their size.

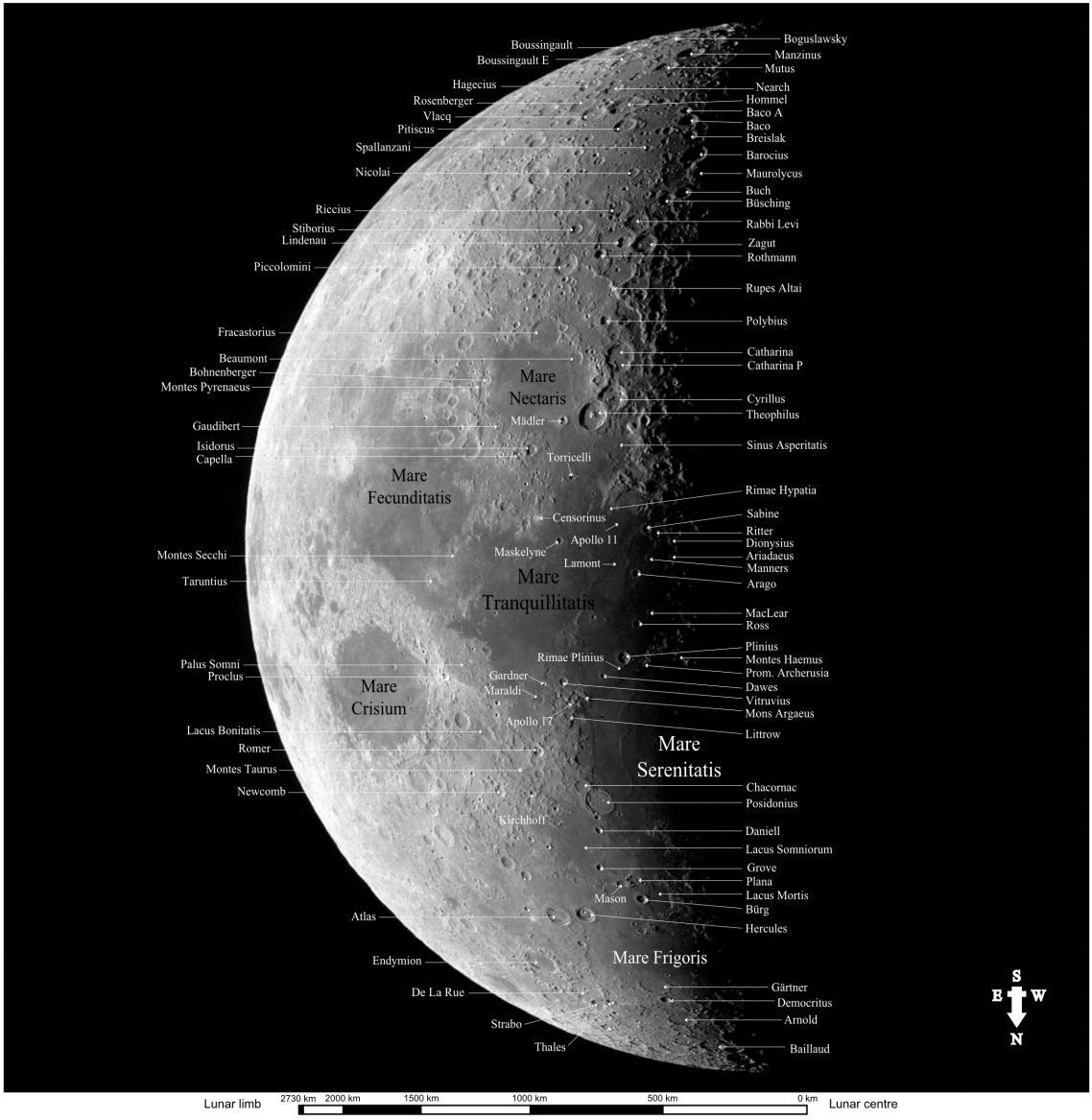
If there is one place on the Moon that everyone wants to see, it is Tranquillity Base, on which was impressed 'one giant leap for mankind' in 1969. That leap is located in the southwest corner, near the twin craters Sabine and Ritter. Follow Rima Hypatia, eastwards to Tranquillity Base, located 2 Sabine-diameters east of the southern apex of the rim of Sabine. A plaque there on the remnant of the lunar module, Eagle, triumphantly proclaims, 'Here men from the planet Earth first set foot upon the Moon. We came in peace for all mankind.' Sabine and Ritter also point northwest to Dionysius, with Ariadaeus to its north. Several more rilles run northwards parallel to the western border of the mare. They lead to Promontorium Archerusia, the western tip of the Montes Haemus that separates Tranquillitatis from Serenitatis. Between Sabine–Ritter and Plinius, four small craters form a parallelogram on the mare. Arago and Manners make up the northern pair, and Ross and MacLear the southern pair. Adjacent to Arago, a system of wrinkle ridges outlines ghostly Lamont. A step across the confluence with Serenitatis leads us past Dawes to Mons Argaeus. Here, near Littrow, Vitruvius and Maraldi in the Taurus mountains, on the remnant of a lunar module once named Challenger, is another plaque with the sad message, 'Here man completed his first explorations of the Moon, December 1972 AD. May the spirit of peace in which we came be reflected in the lives of all mankind.'

Well, mankind may have left the Moon but we still have much of it to explore. Before proceeding to Mare Nectaris and the southern highlands, look south of Censorinus for Isidorus and Capella. A little crater chain spears the latter. It actually runs through Capella but this continuation is much harder to see. The chain finally ends at Gaudibert, a crater so split up by its internal mountain ridges and central peak that it is extremely inconspicuous. Continuing along the Pyrenean border of the mare, look for Bohnenberger, a crater with an uneven, somewhat convex floor. Diametrically opposite Isidorus and Capella, is immense Fracastorius, carved out of the southern pole of the mare. Although large portions of its wall are flooded, the complete ring of the crater can still be traced out. As we return to Isidorus along the western margin of the mare, identify Beaumont with its interrupted eastern wall. The southern outpouching of Mare Tranquillitatis that points at Mare Nectaris is now called Sinus Asperitatis, the Bay of Asperity. Between Mare Nectaris and the Altai scarp lies the magnificent, unmistakable trio, Theophilus, Cyrillus and Catharina. They are served on either side by lesser craters, Mädler in the northeast and Polybius in the south. Northernmost Theophilus displays the usual features of a young crater and overlaps Cyrillus, which must then be older. Compare the central mountains of these two lovely craters. Eldest is Catharina, with eroded walls and no central mountain. Instead, a fairly large crater, Catharina P rudely intrudes.

Now trace Rupes Altai from where it begins between Cyrillus and Catharina to its southeastern terminus at Piccolomini. The scarp appears bright tonight, but will be dark during the second half of the lunation. This means that its lower edge must be on the Mare Nectaris side. Look carefully at Piccolomini – its central mountain is actually triple.

With some imagination, one can see the upper half of a face south of the scarp. Piccolomini forms the left ear; the two eyes are Rothmann and Lindenau and the large, bilobed right ear is formed by Zagut in the north and Rabbi Levi in the south. Lindenau lies within a huge, ruined unnamed crater, the edge of which is intruded on by Rothmann. At the southern end of this entity is Riccius, which is peppered with craterlets. Stiborius, which also lies within an unnamed old crater, forms an isosceles triangle with Riccius and Piccolomini. West of Riccius, on the terminator, is a pair of goggles composed of Buch and Büsching. A high rim, the eastern boundary of Maurolycus, leads south to Barocius. From Barocius, Brieslak, Baco and Baco A form a chain that points southwards to two large, foreshortened craters, Manzinus and Mutus.

Jumping south from Riccius, we pass over Nicolai and Spallanzani to reach Pitiscus. Owl-like Hommel lies to its south. Hommel, Vlacq and Rosenberger, east of Pitiscus, and Hagecius and Nearch, to its south, complete a circle of five large craters that surround three small craterlets in a triangle. Nearch points south to two more large craters, Boussingault and Boussingault E, both close to the limb. The more southerly Boussingault shows a triple concentric structure than can just be perceived. To its west is Boguslawsky and as we approach the pole, the relief dissolves once again into a chaos of light and shade.



Names of lunar formations — **6.14-day-old Moon**

Crater
Arago
Ariadaeus
Arnold
Atlas
Baco
Baco A
Baillaud
Barocius
Beaumont
Boguslawsky
Bohnenberger
Boussingault
Boussingault E
Breislak
Buch
Bürg
Büsching
Capella
Catharina
Catharina P
Censorinus
Chacornac
Cyrillus
Dawes
De La Rue
Democritus
Dionysius
Endymion
Fracastorius
Gärtner
Gaudibert
Hagecius
Hercules
Hommel
Isidorus
Kirchhoff
Lamont
Lindenau
Littrow
MacLear
Mädler
Manners
Manzinus
Maraldi
Maskelyne
Mason
Maurolycus
Mutus
Nearch
Newcomb
Nicolai
Piccolomini
Pitiscus
Plana
Plinius
Polybius
Posidonius
Rabbi Levi
Riccius
Ritter
Rosenberger
Ross
Rothmann
Sabine
Spallanzani
Stiborius
Strabo
Taruntius
Thales
Theophilus
Vitruvius
Vlacq
Zagut

Lacus – lake
Lacus Bonitatis
Lacus Mortis
Lacus Somniorum

Mare – sea
Mare Fecunditatis
Mare Frigoris
Mare Nectaris
Mare Serenitatis
Mare Tranquillitatis

Mons and montes – mountain(s)
Mons Argaeus
Montes Haemus
Montes Pyrenaeus
Montes Secchi
Montes Taurus

Palus – marsh
Palus Somni

Promontorium – promontory
Prom. Archerusia

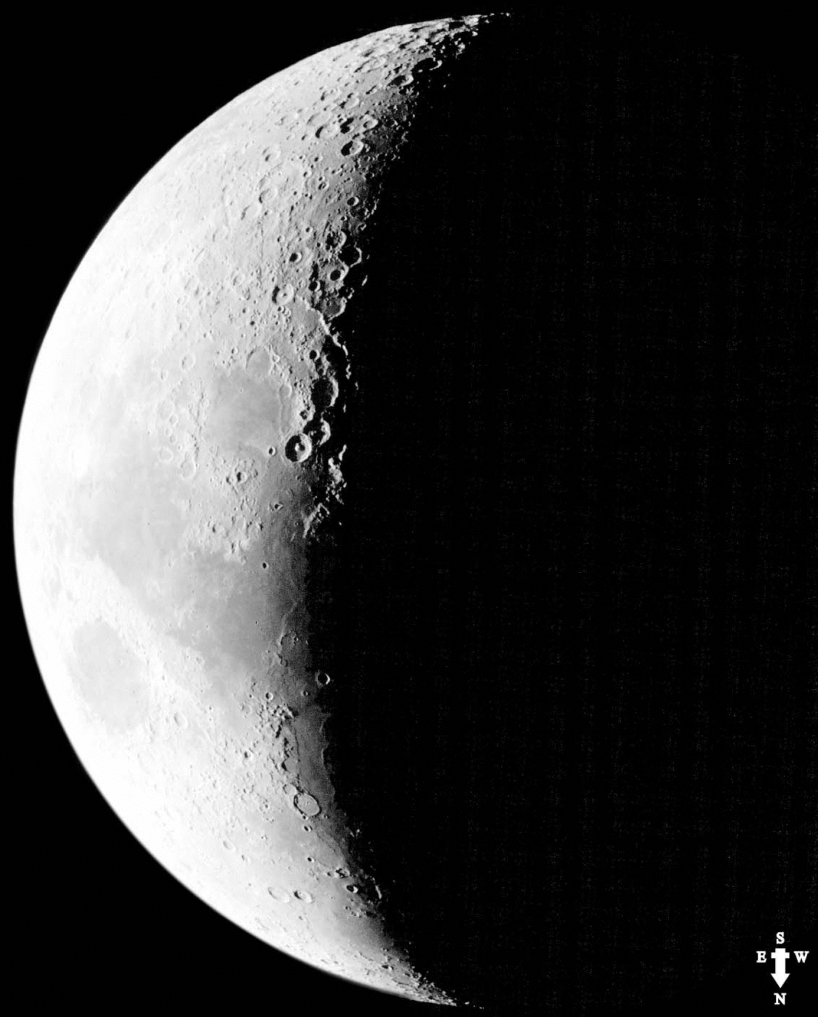
Rima and rimae – rille(s)
Rimae Hypatia
Rimae Plinius

Rupes – scarp
Rupes Altai

Sinus – bay
Sinus Asperitatis

Probe
Apollo 11 (LM Eagle)
Apollo 17 (LM Challenger)

DAY 6



Lunar data			**Photographic data**		
DTG (Local)	:	29 Jul. 98 (Wed.) 2119 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	29 Jul. 98 (Wed.) 1319 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 935	Exposure time	:	1/2 s (Pentax 67 camera)
Age	:	5.98-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	32.0%	Sky condition	:	4/10 (10/10 being perfect)
Diameter/dist.	:	29′51″/403,735 km	Moon altitude	:	33°35′ from N horizon

Lunar data

DTG (Local)	:	2 May 98 (Sat.) 2303 hrs
DTG (UT)	:	2 May 98 (Sat.) 1503 hrs
Lunation	:	No. 932
Age	:	6.14-day-old Moon
Illumination	:	42.1%
Diameter/dist.	:	30′54″/389,073 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	3/10 (10/10 being perfect)
Moon altitude	:	22°53′ from N horizon

The 7th-day Moon

First Quarter Moon tonight . . . wait a minute, wait a minute, this is clearly a half Moon, how can it be called a quarter Moon? Well, a complete lunation consists of two weeks of the waxing Moon, followed by two weeks of the waning Moon, so this half Moon marks the first quarter of the lunation.

Mare Frigoris continues to reveal more of itself tonight. To its south, Mare Serenitatis is now a large smooth oval. And then, extending south all the way to the pole, we see, with some trepidation, a battlefield of craters.

As usual, we start at a prominent landmark. Tonight, that is Mare Serenitatis, and we begin at Posidonius. Tracing the margin of the mare southwards, pause first at dark-floored Le Monnier, a flooded crater that forms a prominent bay in which the lunar rover, Luna 21, landed, and then continue until you reach Mons Argaeus. Then, jump across the confluence with Mare Tranquillitatis to Promontorium Archerusia, while reacquainting yourself with Plinius and the Rimae Plinius complex. From Promontorium Archerusia, the Montes Haemus curve smoothly west and then north, separating Serenitatis from Mare Vaporum, which protrudes from the terminator. On the crest of the mountains, identify small, sharp-bordered Menelaus. Even smaller Sulpicius Gallus lies just on the surface of the mare to the northwest of Menelaus. A rather sharp turn north marks the junction of the Haemus mountains with the northern end of the Apennines range. Crossing the confluence with Mare Imbrium, where for once there is no sentinel crater, we reach the mountains of the Caucasus.

Calippus is easily recognised here but its eastern neighbour, large ruined Alexander is more likely to be overlooked. A range of low hills, forming the northern boundary of Serenitatis, breaks off in the region of Alexander and runs eastwards towards Posidonius, Chacornac and Lacus Somniorum. The Caucasus mountains continue north to the beautiful young pair, Eudoxus and Aristoteles, situated in the rugged region separating Mare Serenitatis from Mare Frigoris.

The only prominent crater on the surface of Mare Serenitatis is little Bessel. Take note, however, of a little white speck just east of the confluence with Mare Imbrium. This is Linné, formerly one of the most puzzling of objects on the Moon. It is a small and undistinguished craterlet surrounded by a nimbus of bright material. Because of this nimbus, the appearance of Linné under different illumination conditions is so variable that there have been suggestions that actual physical change had occurred. The only other noteworthy feature on the mare is the wrinkle ridge, Dorsa Smirnov, (formerly the Serpentine Ridge) meandering in a north–south direction, east of Bessel.

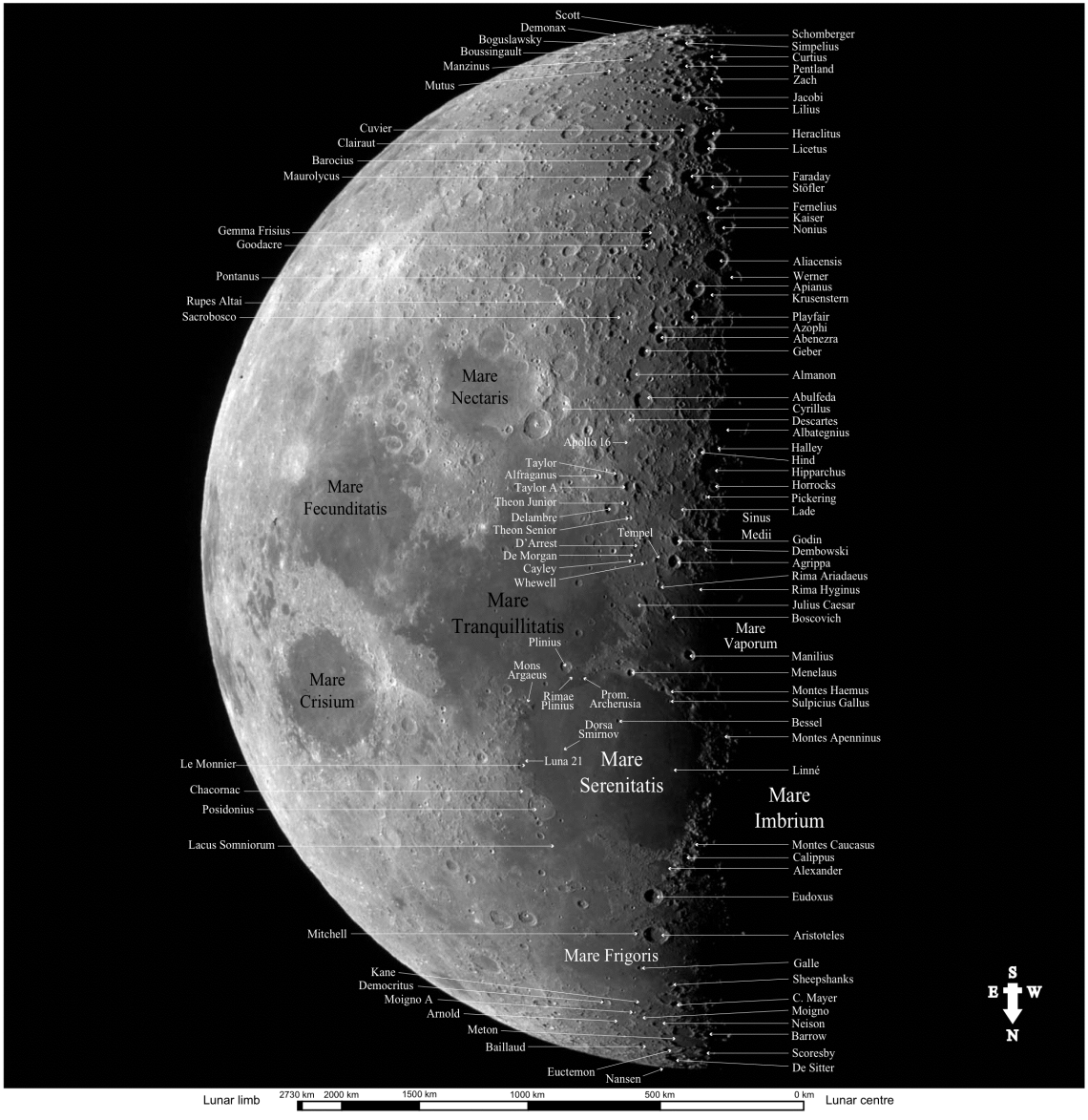
Both Eudoxus and its larger neighbour, Aristoteles, have terraced walls and central peaks. Small Mitchell lies alongside Aristotle. Further north, note bright-rimmed little Galle on the surface of Mare Frigoris. Almost identical Sheepshanks resides in the foothills northwest of Galle. C. Mayer, north of Sheepshanks, appears to be part of a larger ruined crater. Smooth-floored Kane lies midway between C. Mayer and Democritus. Similarly smooth-floored Neison forms an isosceles triangle with Kane and C. Mayer, while inconspicuous Moigno, containing a floor craterlet, forms another isosceles triangle with Kane and Neison. You will probably find it easier to identify its neighbour, sharp-bordered Moigno A. Adjacent to Neison is peculiar, trilobed Meton, also smooth-floored. Large Barrow and smaller Scoresby sit on the terminator, respectively south and north of Meton. Also north of Meton are the very similar foreshortened pair, Euctemon and De Sitter. Just east of Euctemon is Baillaud, easily recognised by the craterlet in its floor. Nansen forms an irregularity right on the limb north of Baillaud.

Returning now to the Haemus mountains, Menelaus, the similar-sounding Manilius and Julius Caesar form a conspicuous triangle in the complicated highland region near the centre of the Moon. Menelaus lies midway between Plinius and Manilius. Do not confuse the two; Menelaus is within the mountains, Manilius lies in Mare Vaporum. The third member of the triad, Julius Caesar, is larger and older than the other two. Boscovich to its west is even more eroded. Agrippa and disintegrated eastern Tempel form a right-angled triangle with Julius Caesar and Manilius. A complicated series of rilles lies in this area. Look between Agrippa and Julius Caesar for Rima Ariadaeus, an east–west running rille. Rima Hyginus, incompletely seen tonight, continues in a similar direction slightly west of Rima Ariadaeus. Smaller Godin lies north of Agrippa. They separate another pair of elderly craters, Dembowski in the west and D'Arrest in the east, while simultaneously pointing south to equally ancient Lade. North of D'Arrest reside three English mathematicians, De Morgan, Cayley and Whewell.

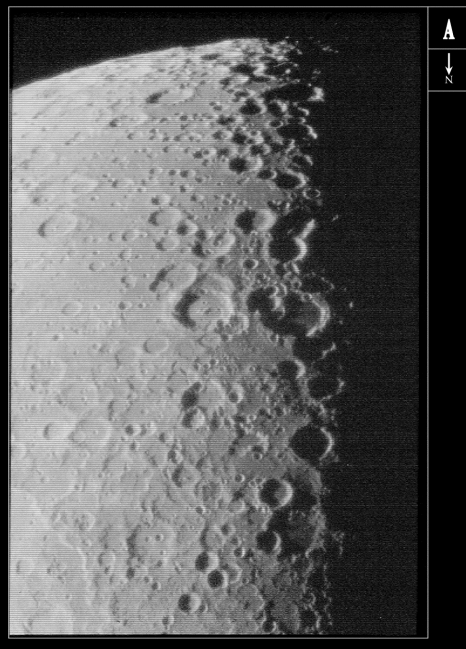
Now crater piles on crater as we enter the southern half of the Moon. East of Lade, two small bright-rimmed craters with the unusual names Theon Senior and Theon Junior serve to draw attention to larger terraced Delambre further to their east. Taylor A, Taylor and Alfraganus lie on an arc south of Delambre. Looming in the shadows of the terminator are the north–south pair, Albategnius and Hipparchus, best reserved for tomorrow night. Between them, a curved chain of four craters, decreasing in size, catches the eye; the two largest are respectively named Halley and Hind; the other two remain anonymous. Continuing further south, Abulfeda is prominent midway between Albategnius and Cyrillus. Much-eroded Descartes lies to its northeast. Apollo 16 landed here slightly north of Descartes. South of Abulfeda, Almanon and Geber lead to the goggle-eyed pair, Abenezra and Azophi, an important landmark in this jumbled and chaotic region. To their northeast, Sacrobosco is somewhat eroded but remains prominent because of the triangle of craterlets in its floor, while to their northwest, Playfair and Apianus impinge on another large, ruined anonymous crater. Low-walled Krusenstern lies west of Apianus. Pontanus, again much eroded, forms an isosceles triangle with Apianus and Sacrobosco.

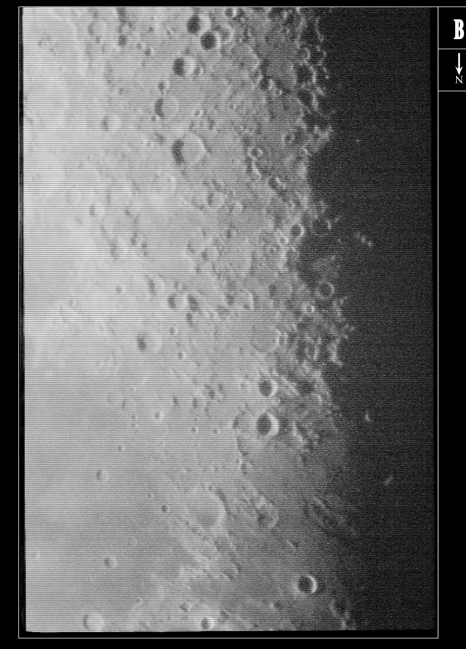
A long jump south from Pontanus over Gemma Frisius and Goodacre takes us to enormous Maurolycus, completely revealed tonight adjacent to Barocius, and distinguished by its central peak. Another immense southern crater, Stöfler, lies west of Maurolycus. Note how Faraday intrudes on it. South of Maurolycus is Clairaut. Forming a triangle south of Stöfler are Licetus, Heraclitus and Cuvier. The last is easily identified by an arc of small craters to its south and east. Look for the central ridge in Heraclitus.

The complex region south of Cuvier is best sorted out tomorrow night. Lilius, Jacobi and Zach, however, form an easily recognisable triangle here, while Curtius is a dark splotch south of Zach. We will finish off with the craters at the southeast limb of the Moon. First, identify Manzinus and Mutus from last night. Southeast of Mutus, the concentric terraces in Boussingault are much better defined tonight while the floor of Boguslawsky immediately west of Boussingault is also easily seen. Demonax appears as a black streak on the limb south of Boguslawsky. Even closer to the south pole and pointed out by the line joining Manzinus and Mutus is Schomberger with Scott, to its south, deforming the southern limb just like Nansen does to the northern.



Names of lunar formations							7.16-day-old Moon
Crater						**Mare – sea**	**Promontorium – promontory**
Abenezra	Boscovich	Democritus	Jacobi	Moigno	Sulpicius Gallus	Mare Frigoris	Prom. Archerusia
Abulfeda	Boussingault	Demonax	Julius Caesar	Moigno A	Taylor	Mare Imbrium	
Agrippa	C. Mayer	Descartes	Kane	Mutus	Taylor A	Mare Serenitatis	
Albategnius	Calippus	Euctemon	Krusenstern	Nansen	Tempel	Mare Tranquillitatis	
Alexander	Cayley	Eudoxus	Lade	Neison	Theon Junior	Mare Vaporum	**Rima and rimae – rille(s)**
Alfraganus	Chacornac	Faraday	Le Monnier	Playfair	Theon Senior		
Almanon	Clairaut	Galle	Licetus	Plinius	Whewell	**Mons and montes – mountain(s)**	Rima Ariadaeus
Apianus	Curtius	Geber	Lilius	Pontanus	Zach		Rima Hyginus
Aristoteles	Cuvier	Gemma Frisius	Linné	Posidonius		Mons Argaeus	Rimae Plinius
Azophi	Cyrillus	Godin	Manilius	Sacrobosco	**Dorsa – wrinkle ridges**	Montes Apenninus	
Baillaud	D'Arrest	Goodacre	Manzinus	Schomberger	Dorsa Smirnov	Montes Caucasus	
Barocius	De Morgan	Halley	Maurolycus	Scoresby		Montes Haemus	**Probe**
Barrow	De Sitter	Heraclitus	Menelaus	Scott	**Lacus – lake**		Apollo 16
Bessel	Delambre	Hind	Meton	Sheepshanks	Lacus Somniorum		Luna 21 (Lunokhod 2)
Boguslawsky	Dembowski	Hipparchus	Mitchell	Stöfler			





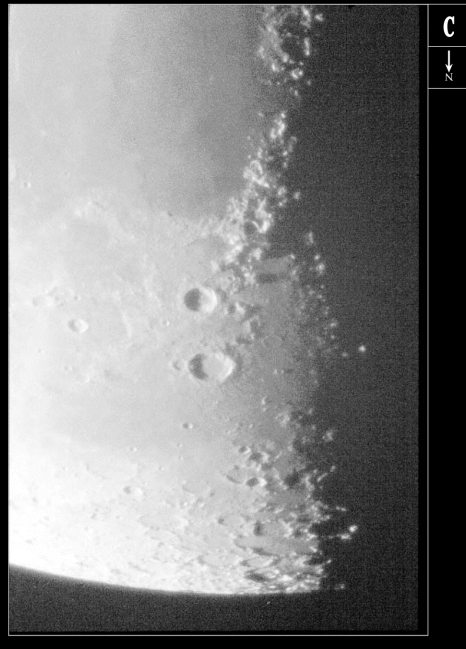


Photo A: A battlefield of craters
The crater field extending southwards from the triangle of Geber, Abenezra and Azophi. Rupes Altai wrinkles brightly in the northeast corner. Maurolycus shows prominent central peaks.

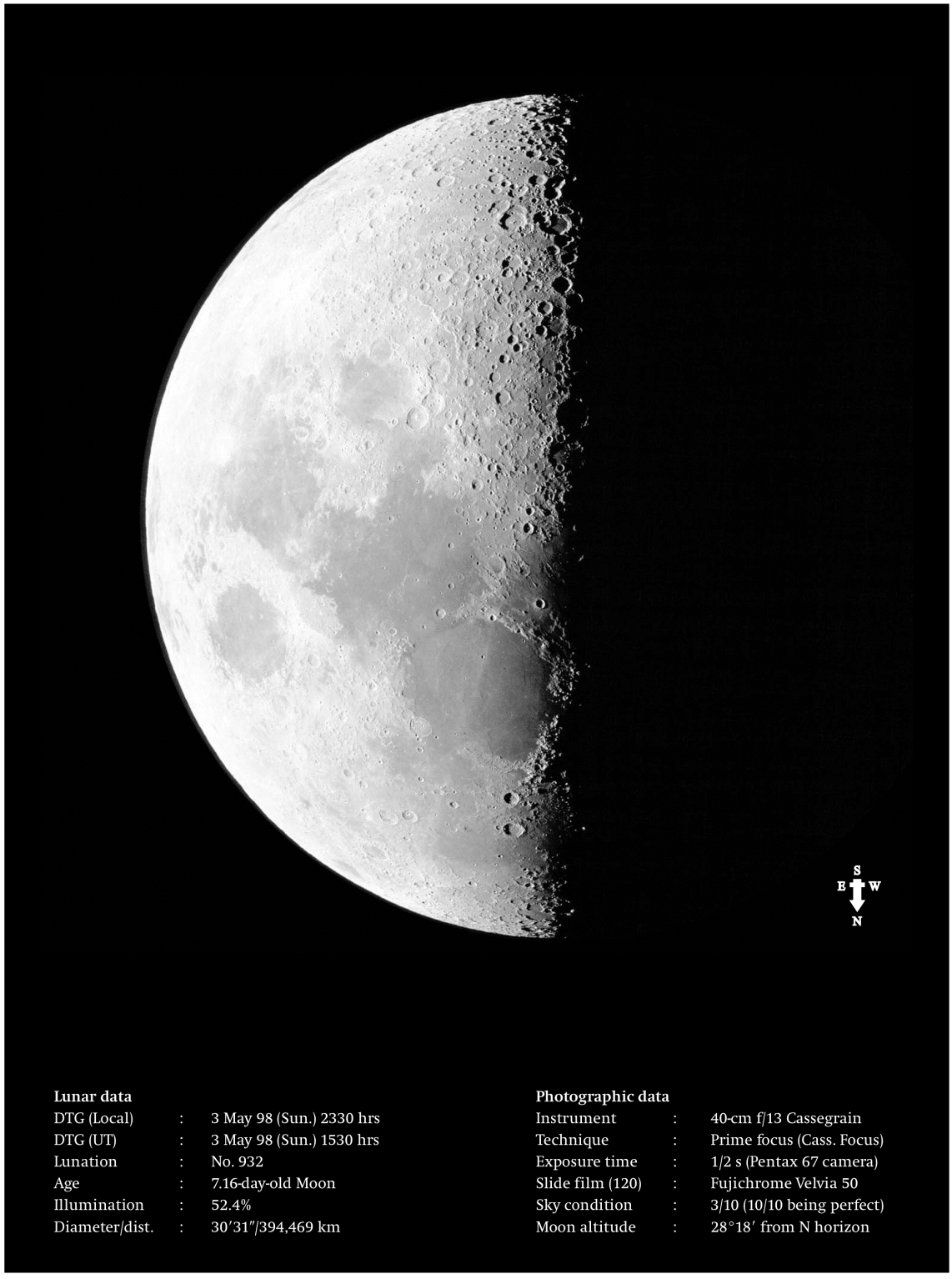
Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 3/10
Date: 3rd May 1998 Film: Kodak Ektachrome 200

Photo B: Mare Tranquillitatis
This southwest corner of Mare Tranquillitatis is where Apollo 11 landed. Sabine (east) and Ritter are easily recognised twins. Tranquillity Base lies two Sabine-diameters east of the southern apex of Sabine's rim. Notice the wrinkle of Rupes Altai in the upper left corner.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 3/10
Date: 3rd May 1998 Film: Kodak Ektachrome 200

Photo C: North polar region to Mare Serenitatis
Eudoxus and Aristoteles in the highlands separating Mare Serenitatis and Mare Frigoris. Montes Caucasus point south. Bürg lies in Lacus Mortis east of the two prominent craters. North of Mare Frigoris, foreshortening distorts crater outlines.

Photographic data
Instr: 15-cm f/15 Apo Refractor Exp: 2 s (Nikon F3)
24 mm XP eyepiece projection yielding f/60 Sky condition: 3/10
Date: 3rd May 1998 Film: Kodak Ektachrome 200



Lunar data

DTG (Local)	:	3 May 98 (Sun.) 2330 hrs
DTG (UT)	:	3 May 98 (Sun.) 1530 hrs
Lunation	:	No. 932
Age	:	7.16-day-old Moon
Illumination	:	52.4%
Diameter/dist.	:	30′31″/394,469 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	3/10 (10/10 being perfect)
Moon altitude	:	28°18′ from N horizon

The 8th-day Moon

On this 8th night of the lunar cycle, we enter the western half of the Moon as the gibbous phase commences. 'Gibbous' means 'convex' and the term refers to the convex border of the terminator. As you will note, the western maria have very turbulent appellations, while their eastern counterparts have very serene and tranquil names. This is related to an old belief that the waxing crescent was related to fine weather and its waning counterpart to bad weather.

This being the start of the second week of the lunation, it's a good time to take stock of what's happened on the eastern half of the Moon. Many prominent craters have disappeared into the sunlight, to be replaced by pale blurs. Bright ray systems radiating from some of these craters fling themselves across the dark maria. See if you can identify those around Petavius, Proclus and Taruntius. There's also a single bright ray that originates from Menelaus to cross Mare Serenitatis. Another crosses Mare Nectaris from a point still concealed in the southern darkness.

The obvious new feature, west of Mare Serenitatis, is Mare Imbrium, the Sea of Rains, with the Caucasus mountains separating the two seas. Two other mountain chains also bound this largest of maria – the Apennines, grandest of all lunar mountains, continue the line of the Caucasus south and west, while the Alps demarcate the northern boundary.

Let's begin in the northern regions again, starting at the Alps. They commence in the east at Promontorium Agassiz and march westwards into the terminator. A wonderful tourist attraction here is the Alpine Valley (Vallis Alpes), an obvious gash in the mountains. A narrow rille runs through its floor but it is unlikely that you will ever be able to perceive it. This being the Alps, look also for Mons Blanc in the peaks south of Alpine Valley.

Look at Protagoras and Archytas in Mare Frigoris and then jump across the mare to the diamond shape of W. Bond. Numerous ancient craters lie in this north polar region, and W. Bond is no exception. Equally elderly Barrow lies between W. Bond and Meton. Contrast, however, the appearance of young Scoresby north of the western tip of Meton. To its north, Challis and Main form a close pair. A short distance further north is Byrd, essentially only a dark blob tonight.

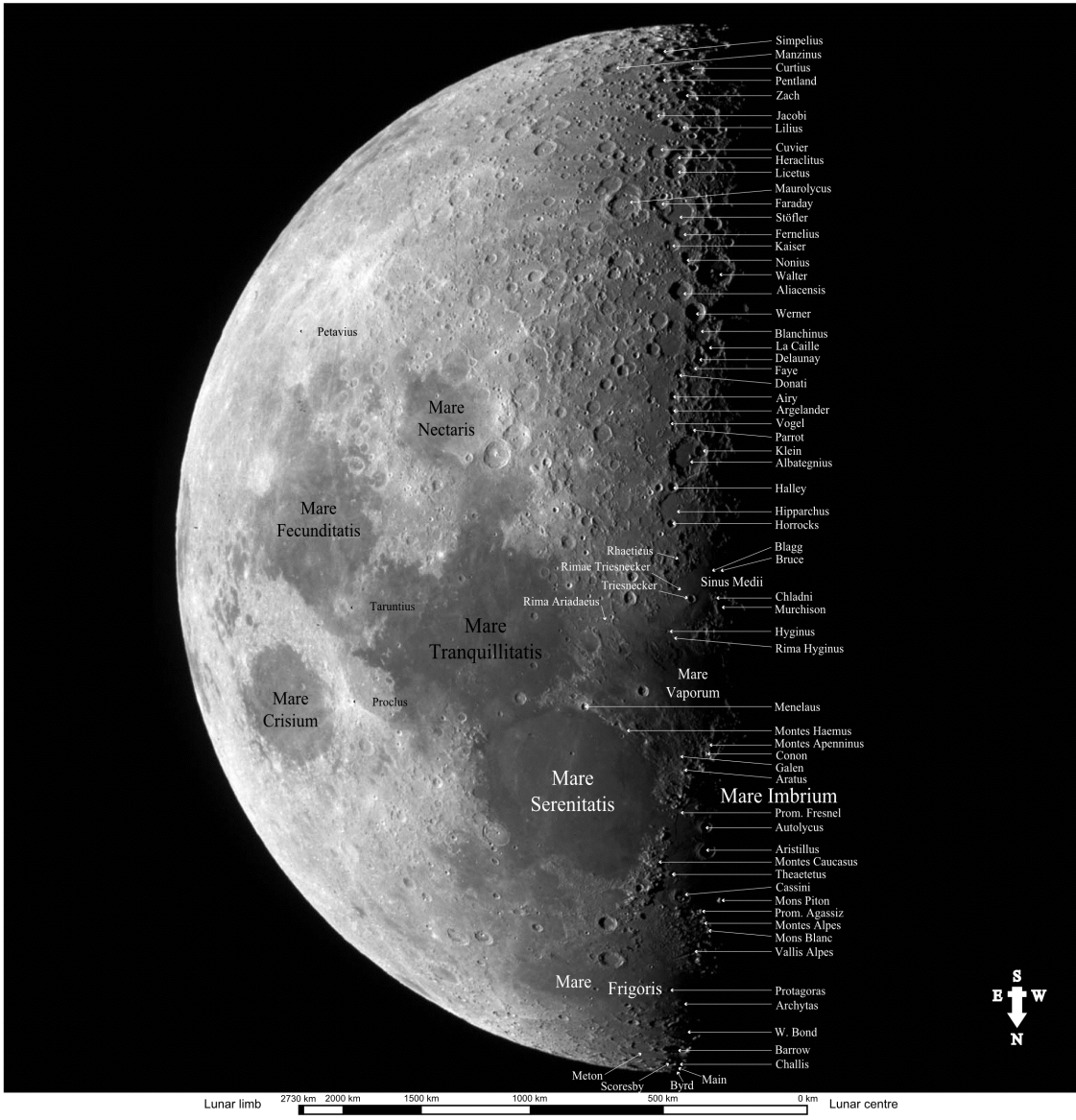
Return now to Mare Imbrium. In the gap between the Caucasus and the Alps, identify Cassini by its low walls and the two floor craterlets. Southeast lies Theaetatus, and to its west, the isolated mountain Piton rises like a spark from the dark mare surface. Two young craters, Aristillus and Autolycus, lie south of Piton.

The Apennines begin at Promontorium Fresnel. Their gradually rising eastern slopes are bright tonight while the more precipitous western slopes remain in shadow. Nestled in this eastern portion of the range is little Conon and its even smaller western neighbours Galen and Aratus. North of the Serenitatis–Imbrium confluence, the Haemus and Apennines mountains delineate Mare Vaporum, the Sea of Vapours.

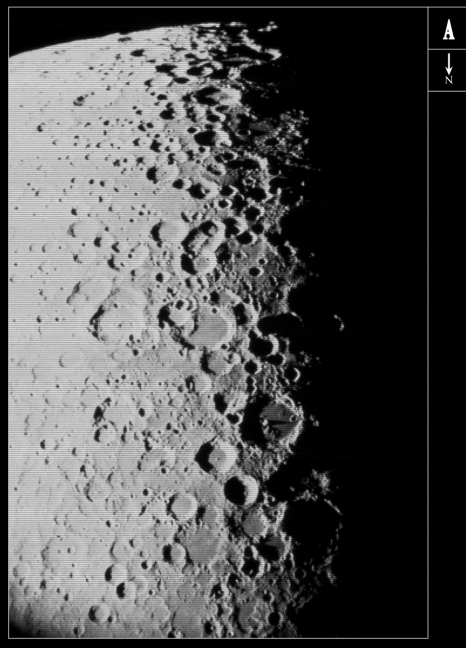
A southwest prolongation, Sinus Medii, the Central Bay, is so named because in it lies the centre of the visible face of the Moon. In this region identify again the Ariadaeus and Hyginus rilles and notice how the Hyginus rille changes direction after passing through Hyginus. Immediately to its north, there is an interesting region that looks like it has been furrowed. It has, and once you realise that the furrows are radial to Mare Imbrium, you can guess the cause. South of Hyginus is a complex of north–south running rilles, Rimae Triesnecker, that take their name from adjacent Triesnecker in Sinus Medii. West of Triesnecker, little Chladni stands on an outcrop of the central highlands. Its immediate western neighbour, Murchison, shows only its bright rim. Two tiny craters, Bruce and Blagg, are worth noting on Sinus Medii, if only because the centre of the Moon's visible surface is situated just south of the former.

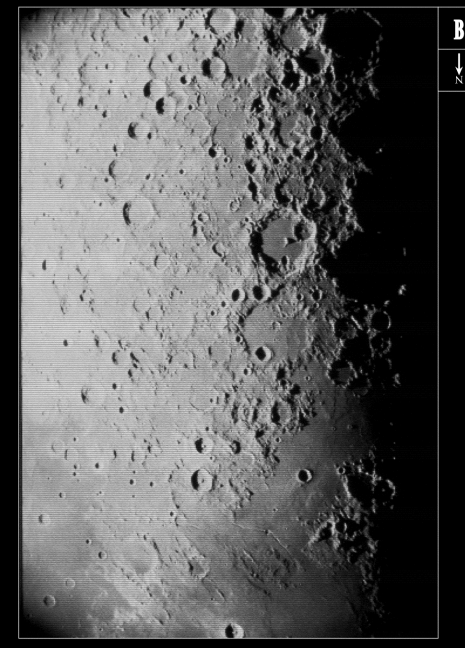
Taking our leave of Sinus Medii, we re-enter the southern highlands. This whole region contains many more grooves distributed radially with respect to Mare Imbrium. Ruined Rhaeticus lies on the lunar equator south of Triesnecker. Huge, much-eroded Hipparchus is next on our itinerary. A shower of craterlets has replaced its south wall, while Horrocks mutilates the northeast aspect of its floor. Halley separates Hipparchus from Albategnius, whose southwest aspect is spoilt by the intrusion of Klein. In turn, Albategnius squashes Parrot to the south. From Albategnius, a curious chain of small craters arc south – the chain starts at tri-lobed Vogel, and continues with Argelander, Airy, Donati, Faye, Delaunay and La Caille. From La Caille, another chain of three craters points southeast, first is ruined Blanchinus and then young Werner and Aliacensis. Larger, diamond-shaped Walter is still mostly in shadow southwest of Werner. Nonius presses on Walter's southeast wall.

South of Nonius is Fernelius whose northeastern rim is tangent to Kaiser. Recognise again gigantic, complicated Stöfler, despoiled by Faraday on its eastern aspect. It forms an interesting pair with its eastern neighbour Maurolycus. Note the crater fields that run south from Stöfler and Maurolycus to the pole and pause to consider that the Earth too must have been similarly pulverised early in its history. South of Stöfler, Licetus, Cuvier and Heraclitus form a prominent propeller-shaped trio. The central ridge with a southern apical craterlet renders Heraclitus instantly recognisable. The triangle of Jacobi, Lilius and Zach is easily identified as long as you ignore the intervening crater in the southern base of the triangle. South of Zach, the most prominent crater is Curtius, almost on the same lunar latitude as Manzinus from last night. The plethora of unnamed craters here renders navigation difficult. However, Curtius forms a triangle with Pentland and Simpelius. Once again, however, it is time to leave the compexities of the deep lunar south to a later night, when the higher Sun will reveal more.



Names of lunar formations							7.72-day-old Moon
Crater Airy Albategnius Aliacensis Aratus Archytas Argelander Aristillus Autolycus Barrow Blagg Blanchinus Bruce	Byrd Cassini Challis Chladni Conon Curtius Cuvier Delaunay Donati Faraday Faye Fernelius	Galen Halley Heraclitus Hipparchus Horrocks Hyginus Jacobi Kaiser Klein La Caille Licetus Lilius	Main Manzinus Maurolycus Menelaus Meton Murchison Nonius Parrot Pentland Petavius Proclus Protagoras	Rhaeticus Scoresby Simpelius Stöfler Taruntius Theaetetus Triesnecker Vogel W. Bond Walter (Walther) Werner Zach	**Mare – sea** Mare Frigoris Mare Imbrium Mare Nectaris Mare Serenitatis Mare Vaporum **Mons and montes – mountain(s)** Mons Blanc Mons Piton Montes Alpes Montes Apenninus Montes Caucasus Montes Haemus	**Promontorium – promontory** Prom. Agassiz Prom. Fresnel **Rima and rimae – rille(s)** Rima Ariadaeus Rima Hyginus Rimae Triesnecker	**Sinus – bay** Sinus Medii **Vallis – valley** Vallis Alpes (Alpine Valley)





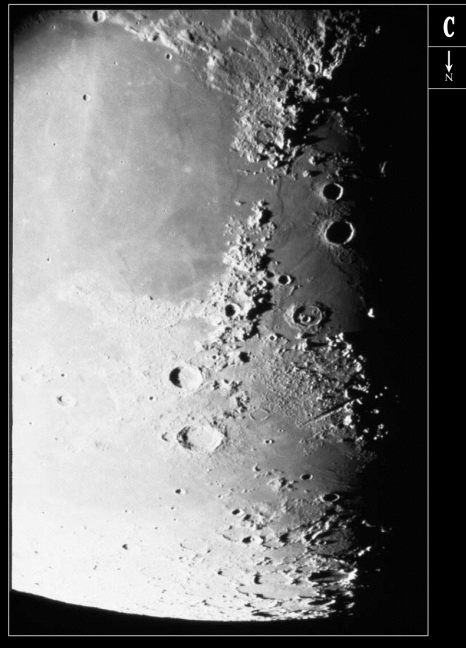


Photo A: The southern crater-fields
The field shown extends from the south pole to Arzachel in the lower right corner. The shadow of Walter's central peak forms a sharp spike. Maurolycus and Stöfler and the easily recognised Cuvier and Heraclitus complex are prominent in the centre.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/2 s (Nikon F3)
Nikon 2× Converter yielding f/26 Sky condition: 7/10
Date: 2nd Jun. 1998 Film: Kodak Ektachrome 400

Photo B: The central highlands
Manilius, on the edge of Mare Vaporum is at the centre of the lower margin while Apianus occupies the same position in the upper margin. Hipparchus and Albategnius are prominent just right of centre.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/2 s (Nikon F3)
Nikon 2× Converter yielding f/26 Sky condition: 7/10
Date: 2nd Jun. 1998 Film: Kodak Ektachrome 400

Photo C: Montes Apenninus and Montes Carpatus
These two mountain chains separate eastern Mare Serentiatis and western Mare Imbrium. Linne is a bright spot on Mare Serenitatis east of the confluence between the maria.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/2 s (Nikon F3)
Nikon 2× Converter yielding f/26 Sky condition: 7/10
Date: 2nd Jun. 1998 Film: Kodak Ektachrome 400

Lunar data

DTG (Local)	:	2 Jun. 98 (Tue.) 2043 hrs
DTG (UT)	:	2 Jun. 98 (Tue.) 1243 hrs
Lunation	:	No. 933
Age	:	7.72-day-old Moon
Illumination	:	54.5%
Diameter/dist.	:	30′13″/401,335 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/4 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	7/10 (10/10 being perfect)
Moon altitude	:	71°59′ from N horizon

The 9th-day Moon

Ninth day and the Moon is clearly gibbous. Ask anyone which looks more pleasing – the crescent, or the gibbous Moon – and you will find that they always favour the crescent. Could this be because the gibbous Moon is perceived to have a progressive hunching deformity of the terminator as the Moon swells from half to full? After all, a hunchback deformity of the spine is described by the same word, 'gibbous'.

Much more of Mare Imbrium is on display tonight. Looking first at the Alps, Alpine Valley has lost some of its allure but this is easily compensated for by the appearance of large dark-floored Plato. Watch the shadows change on the floor of Plato as the Sun rises over the crater ramparts. See how many craterlets you can count in the floor as the illumination slowly increases. The Apennines are at their grandest tonight, with the Sun still bright on the gradually rising eastern slopes and the steep western slopes still in deep shadow. Towards their eastern end, Mons Hadley casts a sharp triangular shadow. A splendid young crater just emerging into the sunlight, Eratosthenes, marks their western end.

Plato serves as a convenient place to begin our explorations. To its north, familiar Mare Frigoris continues its slow exposure – it is clearly a very elongated structure that is distinctly different from the other maria. Notice again Protagoras, despoiling the surface of the mare, and the very similar craters, Archytas and Timaeus, hugging its north shore. The latter impinges on huge diamond-shaped W. Bond, in which a ridge runs parallel to the northwestern wall. Epigenes lies close to the western tip of W. Bond. Large, antique Goldschmidt squeezes between W. Bond and the northern limb of the Moon.

South of Plato, arising from the surface of Mare Imbrium, are several isolated mountains similar to Piton from last night. Immediately south of the crater are Pico and Pico Beta. East of Pico are the Tenerife mountains and, just emerging from the terminator, the Straight Range (or Montes Recti). Montes Spitsbergen lie west of Aristillus. Aristillus and Autolycus have been joined by their more-illustrious counterpart, Archimedes, whose floor has also been flooded by the mare lava. Some foothills, called for obvious reasons Montes Archimedes, strike out south, almost to the Apennines. This region between Autolycus, Archimedes, Montes Archimedes and the Apennines, though apparently part of Mare Imbrium, has received the dignified name of Palus Putredinus, the Marsh of Decay. Look for the Rimae Fresnel system parallel to the Apennines near their beginning, and for Rima Bradley, also parallel to the Apennines between Conon and Archimedes. Between these two rille systems, and much more difficult to see because of its proximity to the Apennines, is sinuous Rima Hadley. Apollo 15 visited these regions in 1971 while Luna 2, the first spacecraft to reach the Moon, crashed near Aristillus, Archimedes and Autolycus in 1959.

An outcrop of rough highland territory separates Sinus Medii and Mare Vaporum from mare-like Sinus Aestuum. Note here the badly ruined elderly pair, Murchison and Pallas. They separate two young craters – Chladni to the east and Bode to the west. Also notice the horseshoes of Schröter and Sömmering, to their west and a little south. Schröter is the more northerly of the two. Southeast of Sömmering is very different Mösting, clearly a much younger crater. Mösting, Lalande and Herschel form a little right-angled triangle with the right angle at Lalande. Several other degenerate craters are present at the southern margin of Sinus Medii. Réaumur and Flammarion are the most obvious, while Oppolzer, adjacent to Réaumur, shows only parts of its rim above the lava flows. From Rhaeticus, Rima Oppolzer runs westwards across the smooth floor of the bay and continues past Flammarion as Rima Flammarion.

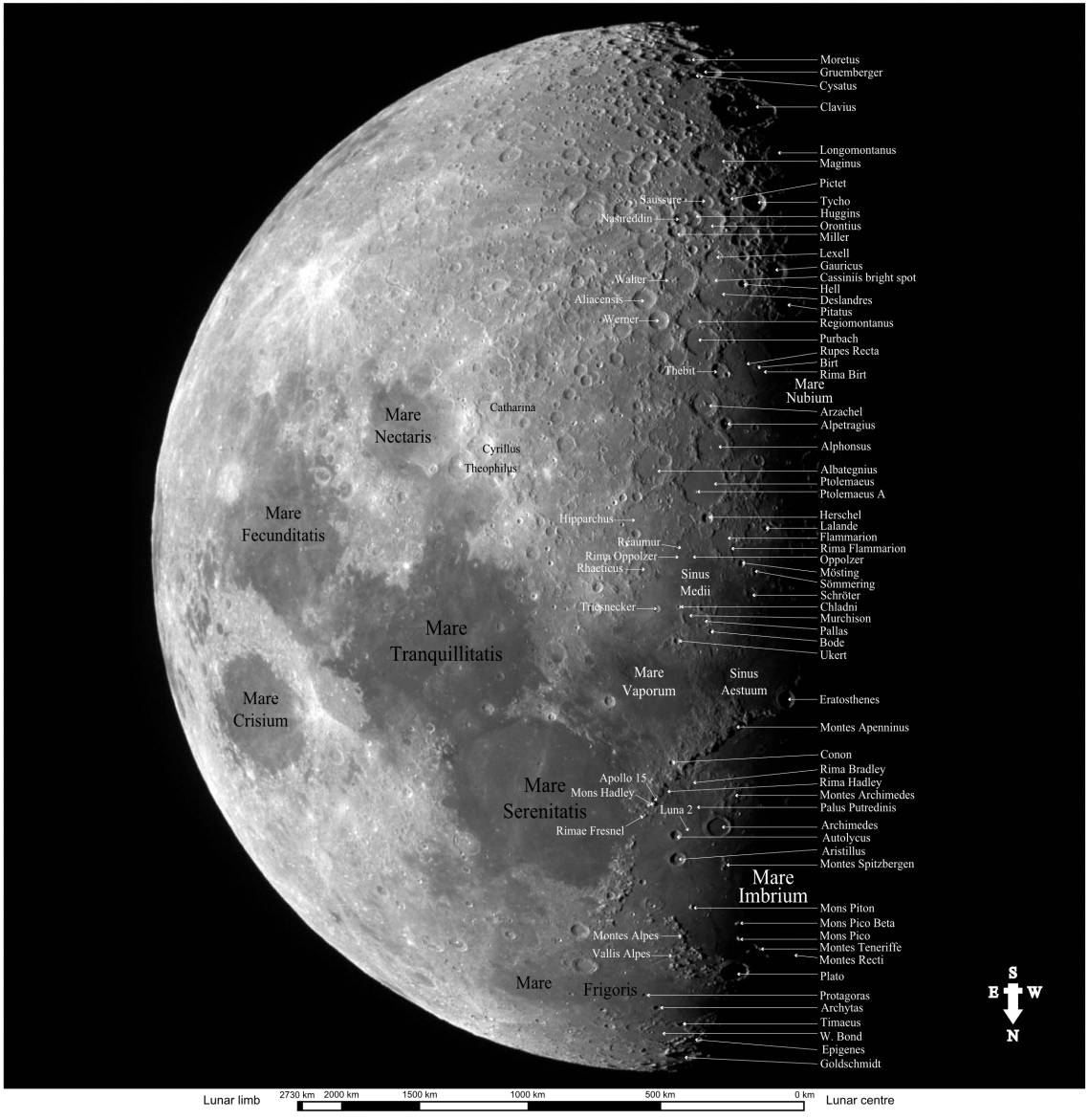
We now reach the first of tonight's two great crater chains, visible respectively west of Albategnius and Hipparchus, and of Werner and Aliacensis. This first chain comprises three huge walled plains, Ptolemaeus, Alphonsus and Arzachel, and bears some resemblance to Theophilus–Cyrillus–Catharina from three nights ago. Ptolemaeus has a very smooth floor, marred only by small Ptolemaeus A. Contrasting Alphonsus, rough floored and containing a central mountain, lies to its south. The most well-publicised report of hazes and colour-changes, so-called lunar transient phenomena, by A. Kozyrev, was from Alphonsus. The chain is completed southwards by young Arzachel, with terraced walls and a much more prominent central mountain. Both Alponsus and Arzachel contain rilles in their floors. Southwest of Alphonsus, in the crevice between it and Arzachel, is beautiful Alpetragius. A relatively large, dome-shaped mountain is located almost at the centre of its floor.

Before proceeding to the southern chain, look at Thebit, on the shores of Mare Nubium. West of Thebit, on the mare surface, is what appears tonight like a sword, with a straight dark blade and bright handle. This is Rupes Recta, the Straight Wall (not to be confused with the Straight Range mentioned earlier on Mare Imbrium). West of the Straight Wall is little Birt and still further west, running parallel to the Straight Wall is Rima Birt.

Purbach, Regiomontanus and Walter form the southern crater chain. Purbach is elliptical and encroaches on its southern neighbour, Regiomontanus. Regiomontanus, squashed between Purbach and Walter, appears even more distorted. Walter is an old crater but to its west, it intrudes upon enormous, even older, Deslandres, a crater that is so badly ruined that it was only given a name this century. Paradoxically, however, it may have been the first lunar crater ever to have been drawn, by Galileo early in the seventeenth century. Only two other nearside craters, Clavius and Bailly, are of comparable size. Within Deslandres are Lexell and Hell, the latter lying near the west edge. Adjacent to Lexell on the south wall is a bright area known as Cassini's bright spot. West of Deslandres is Pitatus, on the shores of Mare Nubium. South of Pitatus is Gauricus. Both of these are just beginning to emerge into the sunlight. If you catch it just right, the central peak in Pitatus shows as a point of light surrounded by the still-dark crater floor.

South of Deslandres and Lexell is a reversed comma-shaped chain of craters. Starting with the largest, these are Orontius, Huggins, Nasireddin and Miller. Adjacent to Orontius on the south and of similar size is Saussure. Pictet, smaller than either, separates Saussure from Tycho. Tycho doesn't look like much tonight but wait and see what happens as the lunation proceeds until Full Moon. Then, Tycho will be the centre of the most extensive bright ray system on the visible hemisphere. As a foretaste, remember that single orphan ray on Mare Nectaris; well, tonight you can see that its parent is Tycho.

Southeast of Tycho is larger Maginus and southwest of that, immense Clavius, tonight still enshrouded in shadow, but with its craterlets glowing like fiery rings. These three prominent objects, together with Longomontanus, which waits offstage tonight, form a conspicuous and unmistakable diamond-shape here in the southern half of the Moon. And finally for tonight, take note of Cysatus, Gruemberger and Moretus, all markedly foreshortened southeast of Clavius.



Names of lunar formations							8.75-day-old Moon
Crater					**Mons and montes – mountain(s)**	**Palus – marsh**	**Rupes – scarp**
Albategnius	Clavius	Huggins	Pitatus	Timaeus	Mons Hadley	Palus Putredinis	Rupes Recta (Straight Wall)
Aliacensis	Conon	Lalande	Plato	Tycho	Mons Pico		
Alpetragius	Cyrillus	Lexell	Protagoras	W. Bond	Mons Pico Beta	**Rima and rimae – rille(s)**	**Sinus – bay**
Alphonsus	Cysatus	Longomontanus	Ptolemaeus	Walter (Walther)	Mons Piton	Rima Birt	Sinus Aestuum
Archimedes	Deslandres	Maginus	Ptolemaeus A	Werner	Montes Alpes	Rima Bradley	Sinus Medii
Archytas	Epigenes	Miller	Purbach		Montes Apenninus	Rima Flammarion	
Aristillus	Eratosthenes	Moretus	Réumur	**Mare – sea**	Montes Archimedes	Rima Hadley	**Vallis – valley**
Arzachel	Flammarion	Mösting	Regiomontanus	Mare Frigoris	Montes Recti (Straight Range)	Rima Oppolzer	Vallis Alpes (Alpine Valley)
Autolycus	Gauricus	Murchison	Rhaeticus	Mare Imbrium	Montes Spitzbergen	Rimae Fresnel	
Bailly	Goldschmidt	Nasireddin	Saussure	Mare Nectaris	Montes Teneriffe		**Probe and others**
Birt	Gruemberger	Oppolzer	Schröter	Mare Nubium			Apollo 15
Bode	Hell	Orontius	Sömmering	Mare Vaporum			Luna 2
Catharina	Herschel	Pallas	Thebit				Cassini's bright spot
Chladni	Hipparchus	Pictet	Theophilus				

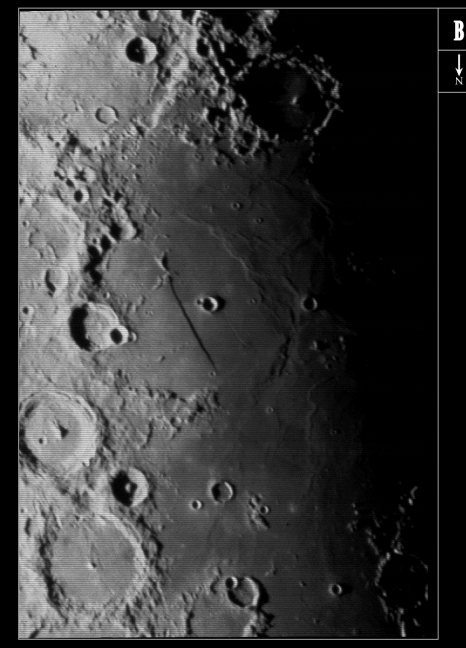


Photo A: Clavius, Maginus and Tycho
Craterlets in Clavius show bright rims. Tycho's central peak just catches the light.

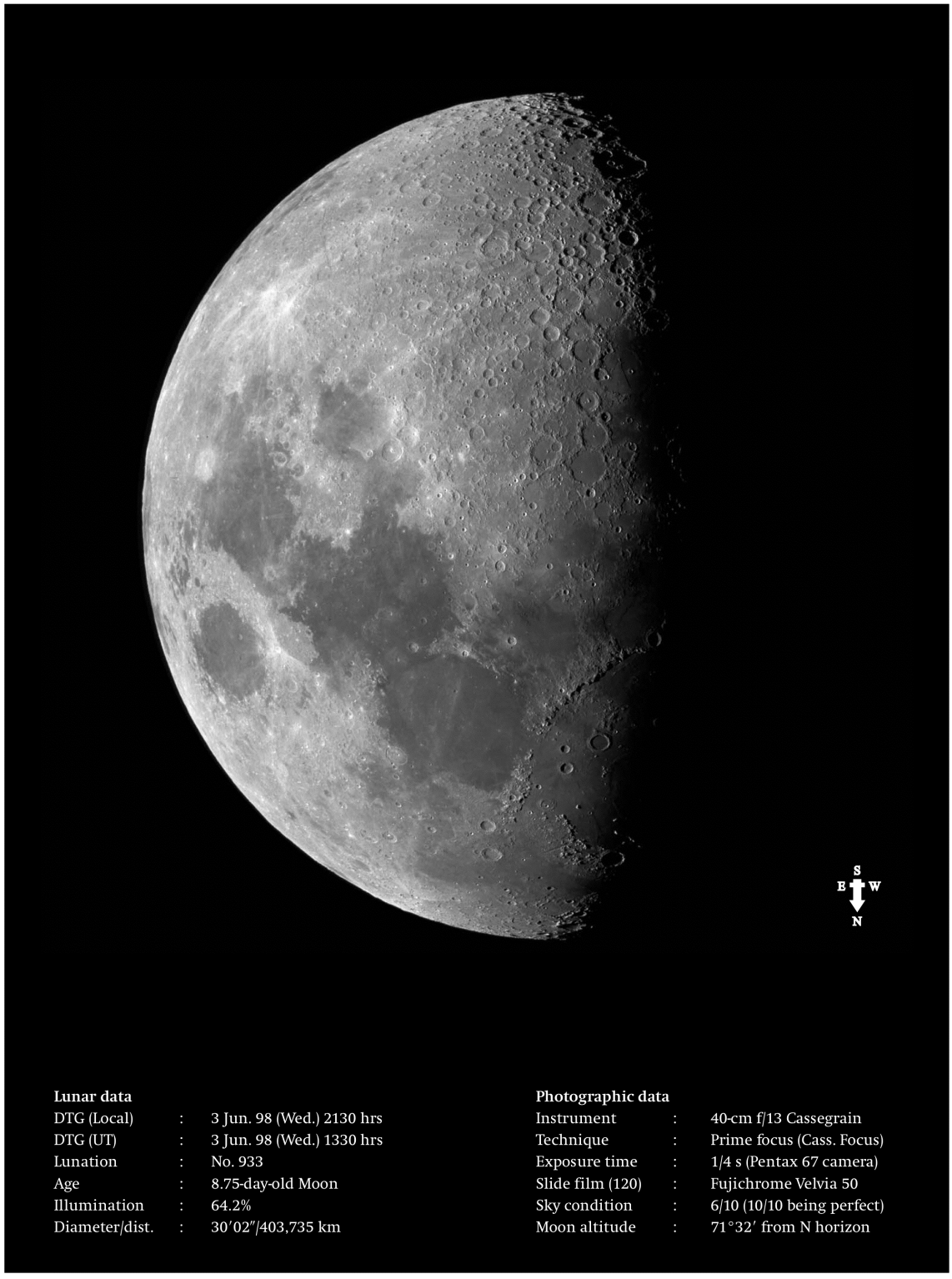
Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 5/10
Date: 3rd Jun. 1998 Film: Kodak Ektachrome 400

Photo B: Rupes Recta – the Straight Wall
The unofficially named Stags Horn mountains form a handle for the sword blade created by the Straight Wall. Rima Birt parallels the wall. Black and white Alpetragius contains a central peak with colours reversed.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 2 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 5/10
Date: 3rd Jun. 1998 Film: Kodak Ektachrome 400

Photo C: Mare Imbrium, Plato and Mare Frigoris
Bright mountains on the mare surface rise to catch the Sun. Plato broods in darkness, except for its bright west rim.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 2 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 5/10
Date: 3rd Jun. 1998 Film: Kodak Ektachrome 400



Lunar data

DTG (Local)	:	3 Jun. 98 (Wed.) 2130 hrs
DTG (UT)	:	3 Jun. 98 (Wed.) 1330 hrs
Lunation	:	No. 933
Age	:	8.75-day-old Moon
Illumination	:	64.2%
Diameter/dist.	:	30′02″/403,735 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/4 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	6/10 (10/10 being perfect)
Moon altitude	:	71°32′ from N horizon

The 10th-day Moon

Mare Imbrium is so large that it is still not completely revealed on this 10th night of the lunation. More of its boundaries are, however, apparent. A chunk is bitten out of the Alps – the Jura mountains here form the southern boundary of Sinus Iridum, the Bay of Rainbows. For a few hours tonight, as the Sun rises, they stand out of the darkness like a jewelled scimitar. This is one of the most dramatic sights of any lunation. At the southern boundary of the mare, the line of the Appenines is continued by the Carpathian mountains. They draw the eye to stunning Copernicus, most magnificent of all craters on this nearside of the Moon.

Once again, we shall begin our wanderings at the north pole. Here, severely foreshortened but still obvious, we start with the unequal pair Goldschmidt and Anaxagoras. The former is larger and much older. The latter, as befitting a young crater, will at Full Moon be a prominent bright ray centre. To their south, on the northern shore of Mare Frigoris, small bright Fontenelle catches the eye. Plato remains very prominent and its very dark, smooth floor is now clearly seen, with hardly any shadow of the crater rim still present. Try again to count the number of craterlets in the floor.

South of Plato, the scattered mountains that rise from the surface of Mare Imbrium can now be seen to be part of an inner ring concentric with the mare boundary. Towards the terminator, Le Verrier and Helicon form an almost identical pair; while further south Timocharis and Lambert are just as eye-catching. Between Lambert and Copernicus is bright-rimmed Pytheas.

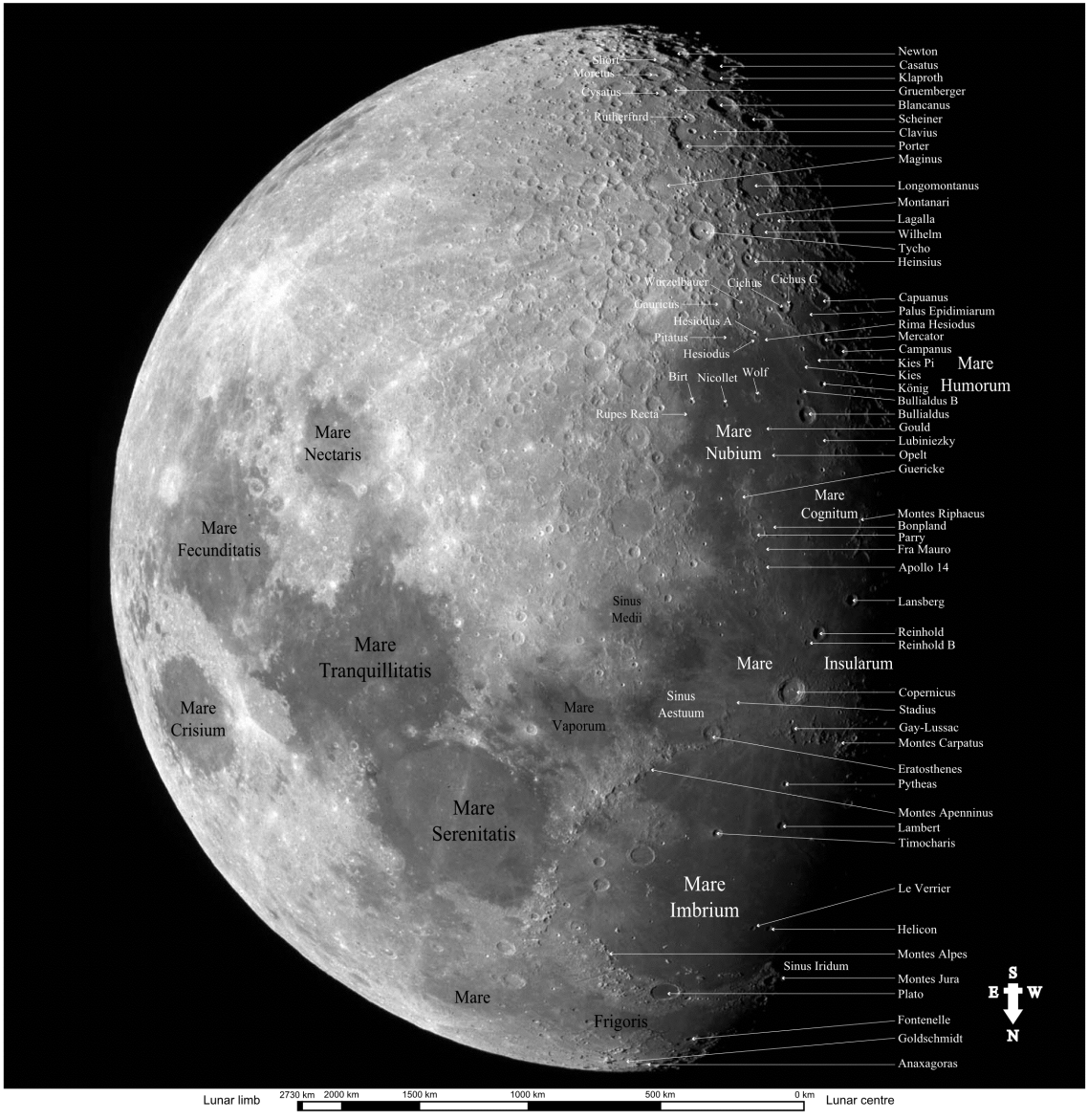
If you have not yet looked at Copernicus, it's time to do so. It's difficult to believe that you haven't, for its terraced walls, central mountain complex and surrounding striated terrain compulsively draw one's attention to the exclusion of almost everything else. A good example of this neglect is nearby and very similar Eratosthenes, at the western end of the Appenines. By all standards, Eratosthenes is an impressive young crater. Unfortunately, because of its proximity to Copernicus, it will always remain merely a poor cousin. To complete our tour of this region, Gay-Lussac lies north of Copernicus, in the Carpathian mountains, while to the south are Reinhold and smaller Reinhold B. Also, can you make out the very faint ring, Stadius, between Copernicus and Eratosthenes?

Continuing south of Copernicus, notice the triple structure formed by large Fra Mauro and its southern neighbours Bonpland and Parry. From the way in which the craters lie on one another, it's easy to tell that Parry is the youngest and Fra Mauro the oldest of the three. Apollo 14 visited Fra Mauro in 1970. Almost as ghostly as Fra Mauro is Guericke to its south. In the same latitude as the Fra Mauro complex, notice the bright arc of Montes Riphaeus emerging from the terminator.

On now to Mare Nubium, the Sea of Clouds. The Straight Wall (Rupes Recta), which was so prominent last night, is disappearing. Running westward across the mare is a string of craters – Birt, Nicollet, odd-shaped Wolf and Bullialdus B – that lead to another Copernicus look-alike, Bullialdus. König, northwest of Bullialdus, converts this running quartet into a quintet. Directly south of Bullialdus is flooded Kies. Look to its west for a very prominent dome, Kies Pi. Similarly flooded Lubiniezky is situated north of Bullialdus. A highland arc runs north and then east from Lubiniezky to complete the southern boundary of Mare Nubium, separating it from Mare Cognitum. East and southeast of Bullialdus, Gould and Opelt have been almost completely obliterated by the mare lava. Bullialdus and the Straight Wall form an isosceles triangle with large Pitatus. Tangent to Pitaus on its west is Hesiodus, with a central craterlet. Little Hesiodus A, on the southern aspect of Hesiodus, has concentric double walls. A very prominent straight rille, Rima Hesiodus, runs westwards from Hesiodus to the terminator.

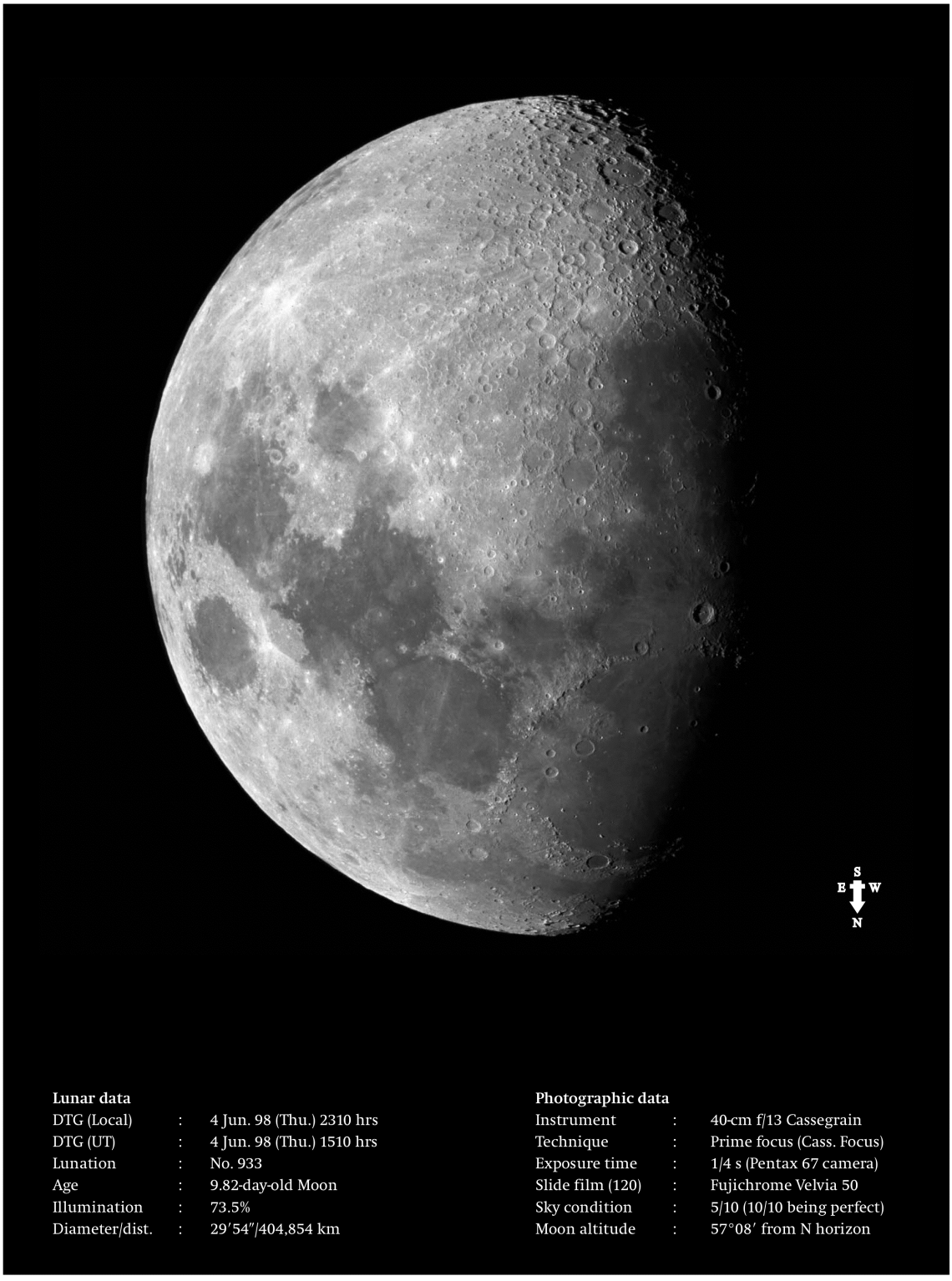
So far, it's been plain sailing south on the surfaces of the maria. Now as we move off the shores of Mare Nubium, we meet the southern crater fields again. Gauricus has an equal-sized western neighbour, Wurzelbauer, and these two craters point west towards smaller Cichus, with Cichus C perched on the crest of its southwest rim. West of Cichus, across the smooth surface of Palus Epidimiarum, the Marsh of Epidemics, is Capuanus. Cichus and Capuanus form a right-angled triangle with Mercator, with the right angle at Capuanus.

Forming another right-angled triangle but with Gauricus and Wurzelbauer is peculiar-shaped Heinsius. South of Heinsius is the battered, elderly trio Wilhelm, Montanari and Lagalla, the last markedly degraded. Longomontanus, with a name as magnificent as the crater itself, completes the diamond-shape mentioned last night. While Maginus is disappearing, youthful Tycho has become more impressive and Clavius, now fully revealed, is even more so. The arc of five craters in its floor culminates in Rutherfurd on the southern rim of the giant crater. Diametrically opposite Rutherfurd, on the northern rim, is Porter. Two pairs of twins lie south of Clavius but they are better seen tomorrow night. Blancanus and Scheiner, separated by a ridge, form the first pair. The second kissing pair is Klaproth and Casatus. To their east, Moretus shows its terraced walls and central mountain. Cysatus and Gruemberger lie on its north. South of Moretus are Short and Newton. The multitude of craters here and the severe foreshortening render navigation extremely difficult and this south pole region was very poorly mapped and Luna Incognita until recently.

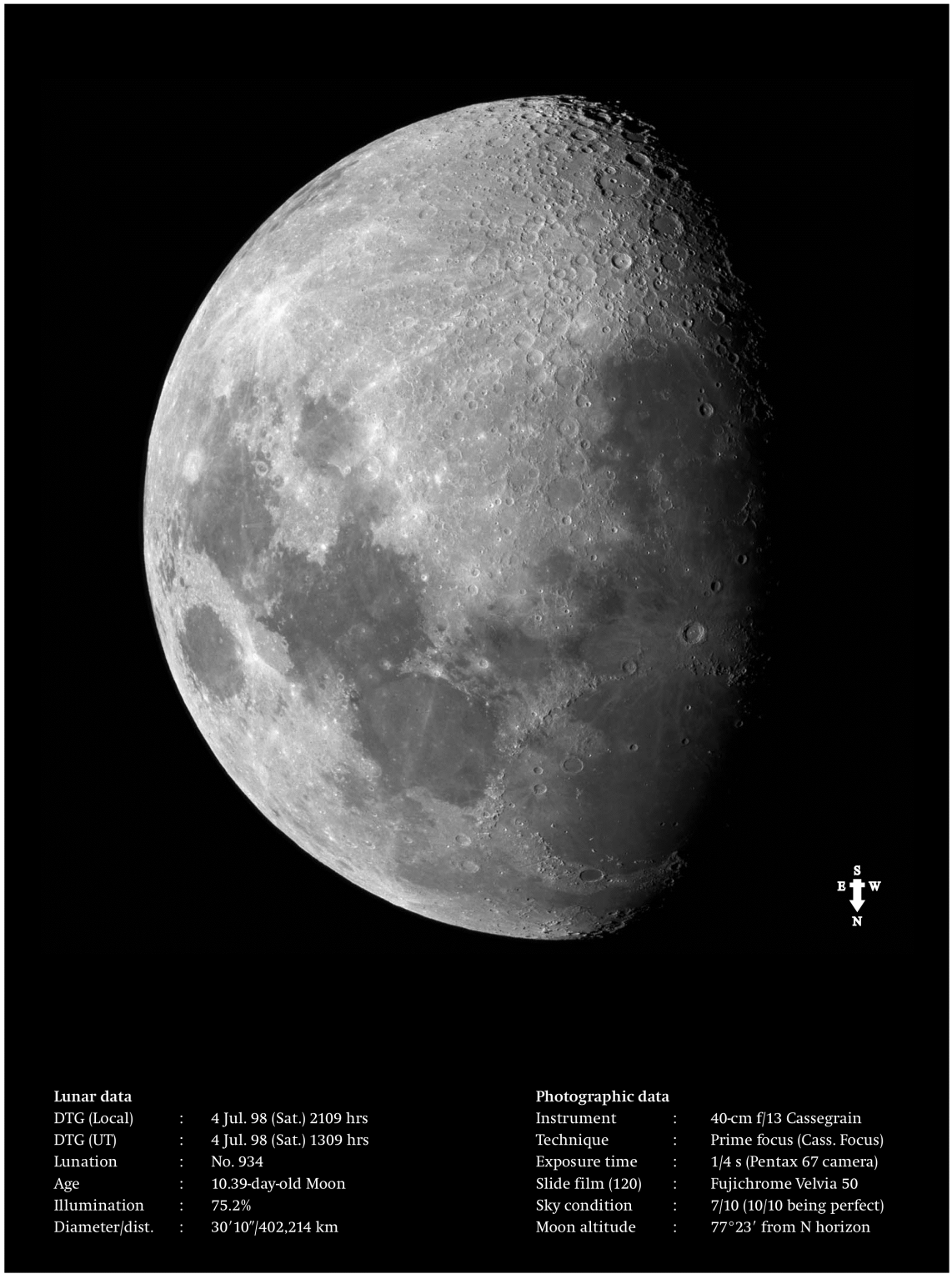


Names of lunar formations							10.39-day-old Moon
Crater					**Mare – sea**	**Palus – marsh**	**Sinus – bay**
Anaxagoras	Cysatus	Hesiodus	Montanari	Rutherfurd	Mare Cognitum	Palus Epidimiarum	Sinus Iridum
Birt	Eratosthenes	Hesiodus A	Moretus	Scheiner	Mare Frigoris		
Blancanus	Fontenelle	Kies	Newton	Short	Mare Imbrium		
Bonpland	Fra Mauro	Klaproth	Nicollet	Stadius	Mare Nubium	**Rima and rimae**	**Probe and others**
Bullialdus	Gauricus	König	Opelt	Timocharis		Rima Hesiodus	Apollo 14
Bullialdus B	Gay-Lussac	Lagalla	Parry	Tycho	**Mons and montes**		
Capuanus	Goldschmidt	Lambert	Pitatus	Wilhelm	**– mountain(s)**		
Casatus	Gould	Le Verrier	Plato	Wolf	Kies Pi (dome)	**Rupes – scarp**	
Cichus	Gruemberger	Longomontanus	Porter	Wurzelbauer	Montes Riphaeus	Rupes Recta	
Cichus C	Guericke	Lubiniezky	Pytheas		Montes Alpes	(Straight Wall)	
Clavius	Heinsius	Maginus	Reinhold		Montes Apenninus		
Copernicus	Helicon	Mercator	Reinhold B		Montes Carpatus		
					Montes Jura		

DAY 10



Lunar data			**Photographic data**		
DTG (Local)	:	4 Jun. 98 (Thu.) 2310 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	4 Jun. 98 (Thu.) 1510 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/4 s (Pentax 67 camera)
Age	:	9.82-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	73.5%	Sky condition	:	5/10 (10/10 being perfect)
Diameter/dist.	:	29′54″/404,854 km	Moon altitude	:	57°08′ from N horizon



Lunar data			**Photographic data**		
DTG (Local)	:	4 Jul. 98 (Sat.) 2109 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	4 Jul. 98 (Sat.) 1309 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 934	Exposure time	:	1/4 s (Pentax 67 camera)
Age	:	10.39-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	75.2%	Sky condition	:	7/10 (10/10 being perfect)
Diameter/dist.	:	30′10″/402,214 km	Moon altitude	:	77°23′ from N horizon

The 11th-day Moon

This 11th day sees Sinus Iridum completely revealed. Of all locations on the Moon, this Bay of Rainbows is one of the most beautiful and certainly has the most romantic name. Although called a bay, it is obviously a small basin whose southern wall has been completely flooded by lava flows. Its northern border, formed by the Jura Mountains, begins at Promontorium Laplace in the east and ends at Promontorium Heraclides in the west. Given the correct angle of illumination, one can see in the latter, the Moon-Maiden, the head and neck of a long-haired girl in profile.

Immediately north of Sinus Iridum are Maupertuis, on the east, Bianchini, in the middle of the crest of the Jura mountains, and Sharp on the west. Immediately north of Maupertuis, on the southern shore of Mare Frigoris, is La Condamine. Further north, on the opposite shore, look for large, ruined J. Herschel. To its east, Philolaus is very prominently situated on a line from Plato through Fontenelle.

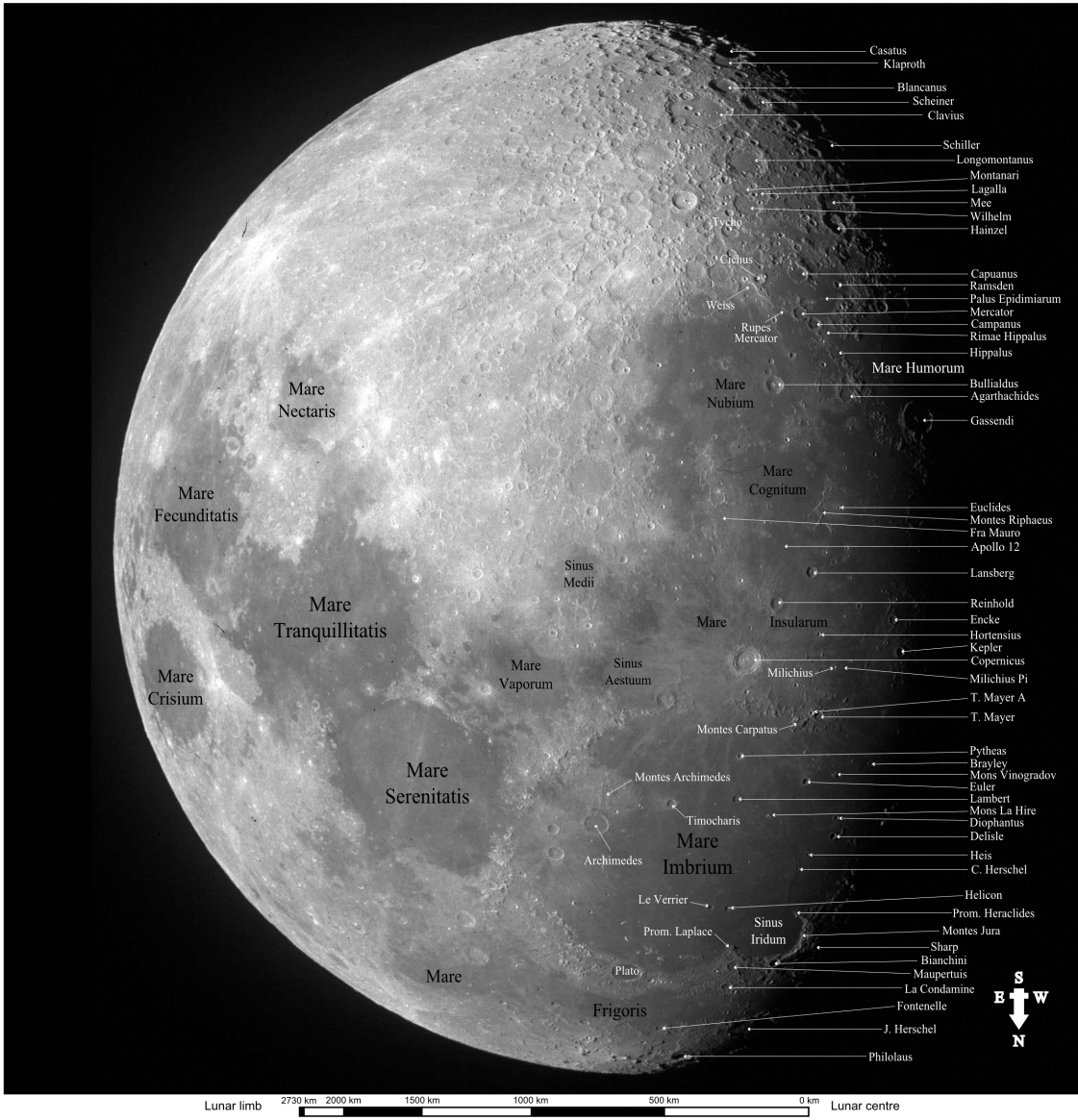
On Mare Imbrium, south of Promontorium Laplace, acquaint yourself again with the twins le Verrier and Helicon. Slightly further south, Timocharis, Lambert and Euler form a triplet in a line that runs westwards from Archimedes. The same line continued further west brings us to isolated Mons Vinogradov and then to little Brayley. Another isolated mountain, bright Mons La Hire, lies northwest of Lambert. South of Lambert, identify again bright-rimmed Pytheas. Delisle, Diophantus, Heis and C. Herschel form a little parallelogram near the terminator.

Copernicus remains magnificent tonight and serves as an important signpost, in the midst of a modern mare, Mare Insularum, whose boundaries are Sinus Aestuum in the east and Encke and Kepler in the west. Northwest of Copernicus, the Carpathians end at T. Mayer. Its smaller neighbour T. Mayer A may appear more prominent in this lighting. A southwest line from Copernicus through Reinhold and Lansberg leads to the stick-figure formed by Montes Riphaeus. Between them and the bright central highlands, the Fra Mauro complex is fading under the high Sun. Little Euclides shines brightly west of the Riphaeans. The Riphaeans, the Fra Mauro complex and some low hills running east–west form the rough boundaries of Mare Cognitum, another twentieth-century mare. Apollo 12 landed in Mare Insuralum between the crater Lansberg and the Fra Mauro complex.

West of Copernicus, Kepler and Encke are starting to arise from their slumbers. A fine field of domes can be found here between Copernicus and Kepler. First identify the two small, sharp-rimmed craters, southern Hortensius and northern Milichius, that form a rough parallelogram with Kepler and Encke. Just west of Milichius is an isolated but prominent dome, Milichius Pi. You might even be able to see its summit crater. Now look north of Hortensius for three pairs of domes. They are less prominent than Milichius Pi but shouldn't be too difficult to find. Cruising on to Mare Nubium and Bullialdus, identify Mercator and Campanus, which separate Mare Nubium from Palus Epidimiarum. The two craters, together with the central ridge that connects them, resemble an old-fashioned pair of spectacles. Rupes Mercator runs southeast from Mercator to partially ruined Weiss, adjacent to Cichus. The same line produced in the opposite direction points to ruined Hippalus. Here, between Campanus and Hippalus, at the junction between Mare Nubium and Mare Humorum, look for three parallel grooves running approximately south–north to ruined Agarthachides. They form part of the Hippalus rille complex. West of Agarthachides, large, old Gassendi is trying to cast off the shadows. Before proceeding to the southern highlands, look in Palus Epidimiarun for Capuanus (not to be confused with similar-sounding Campanus) which looks tonight like the bottom half of a pot-bellied figure with two stick-like legs. West of the two legs is bright-rimmed Ramsden.

In the rugged southern highlands, Tycho is beginning to show its far-flung ray system. Clavius and Longomontanus, both of whose floors contain multiple craterlets and relatively inconspicuous central peaks, form a stupendous pair. West of the Wilhelm–Montanari–Lagalla complex, peculiar Hainzel, actually a triple crater, stands out on the terminator. It intrudes on larger Mee to its south. The interior of elongated Schiller still remains in deep shadow south of Mee.

South of Clavius, Blancanus and Scheiner form a nice contrasting pair. Both have terraced walls but their floors look rather different. Another pair, Klaproth and Casatus, the latter probably still in shadow, lie south of Blancanus.



Names of lunar formations — **10.95-day-old Moon**

Crater
Archimedes
Agarthachides
Bianchini
Blancanus
Brayley
Bullialdus
C. Herschel
Campanus
Capuanus
Casatus
Cichus
Clavius
Copernicus
Delisle
Diophantus
Encke
Euclides
Euler
Fontenelle
Fra Mauro
Gassendi
Hainzel
Heis
Helicon
Hippalus
Hortensius
J. Herschel
Kepler
Klaproth
La Condamine
Lagalla
Lambert
Lansberg
Le Verrier
Longomontanus
Maupertuis
Mee
Mercator
Milichius
Montanari
Philolaus
Plato
Pytheas
Ramsden
Reinhold
Scheiner
Schiller
Sharp
T. Mayer
T. Mayer A
Timocharis
Tycho
Weiss
Wilhelm

Mare – sea
Mare Cognitum
Mare Frigoris
Mare Humorum
Mare Imbrium
Mare Insularum
Mare Nubium

Mons and montes – mountain(s)
Milichius Pi (dome)
Mons La Hire
Mons Vinogradov
Montes Archimedes
Montes Carpatus
Montes Jura
Montes Riphaeus (Ural Mountains)

Palus – marsh
Palus Epidimiarum

Promontorium –promontory
Prom. Heraclides
Prom. Laplace

Rima and rimae –rille(s)
Rimae Hippalus

Rupes – scarp
Rupes Mercator

Sinus – bay
Sinus Aestuum
Sinus Iridum

Probe
Apollo 12

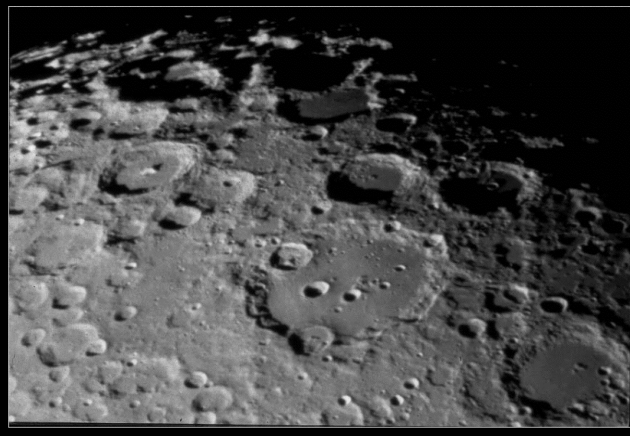


Photo A: Clavius
Commencing with Rutherfurd, an arc of craterlets of decreasing size decorates the interior of Clavius. Blancanus and Scheiner form a matched pair of craters south of Clavius.

Photographic data
Instr: 40-cm f/13 Cassegrain
14 mm XP eyepiece projection yielding f/112
Date: 4th Jul. 1998
Exp: 2 s (Nikon F3)
Sky: 6/10
Film: Kodak Elite II - 400

Photo B: Mare Imbrium, Plato and Mare Frigoris
Compare this picture with the earlier one (day 9) showing the same region to see the effects of increasing angle of illumination as the Sun rises.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 4th Jun. 1998
Exp: 1/2 s (Nikon F3)
Sky condition: 2/10
Film: Kodak Ektachrome 400

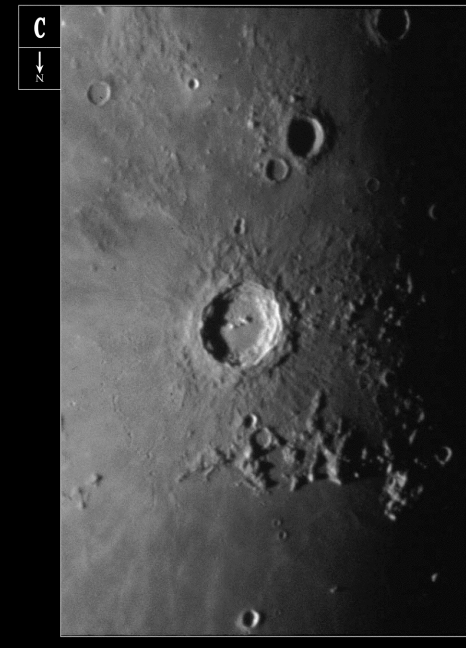
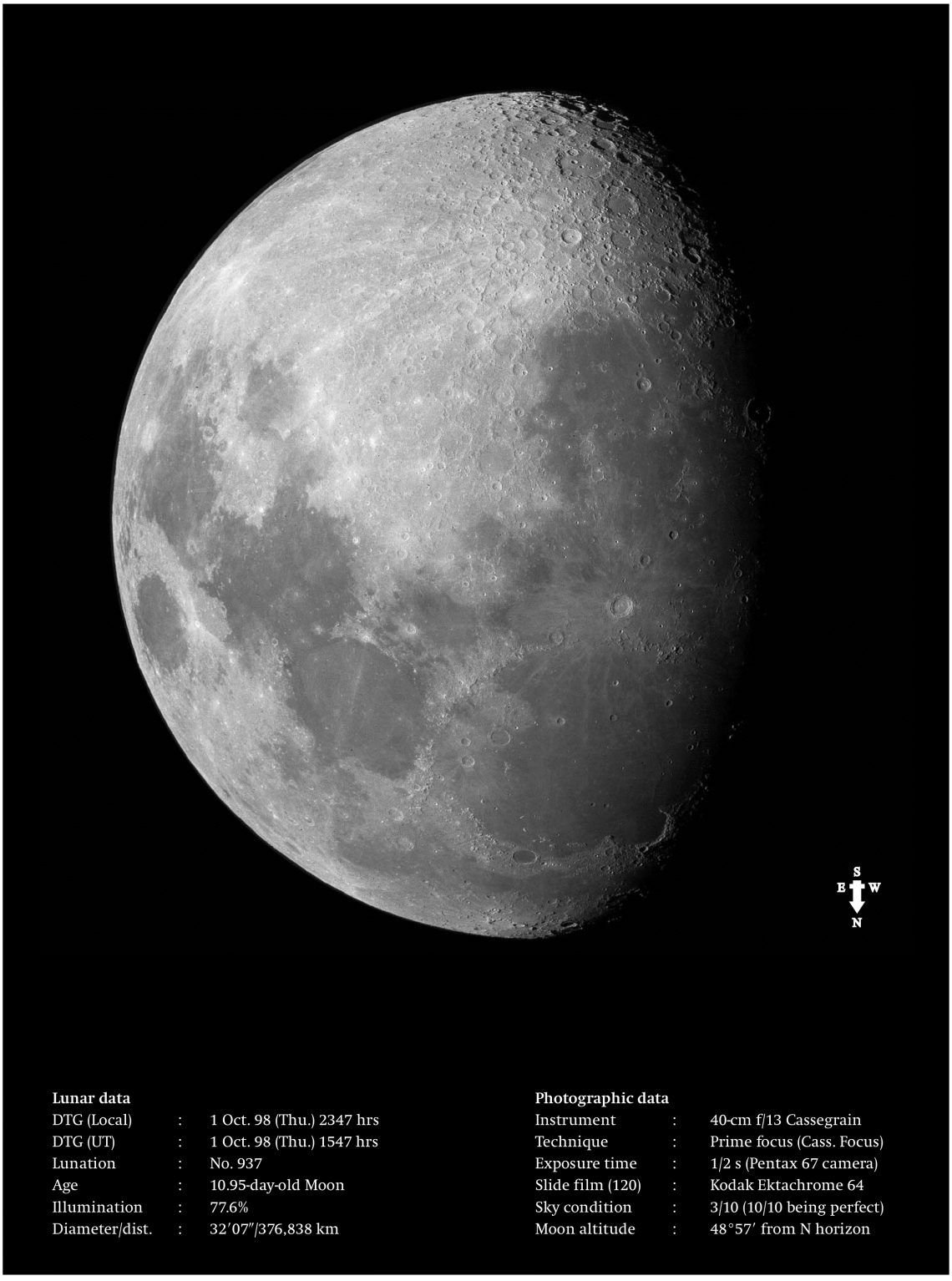


Photo C: Copernicus
Seen face on, Copernicus is a stupendous sight south of Montes Carpatus.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 4th Jun. 1998
Exp: 1 s (Nikon F3)
Sky condition: 2/10
Film: Kodak Ektachrome 400



Lunar data			**Photographic data**		
DTG (Local)	:	1 Oct. 98 (Thu.) 2347 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	1 Oct. 98 (Thu.) 1547 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 937	Exposure time	:	1/2 s (Pentax 67 camera)
Age	:	10.95-day-old Moon	Slide film (120)	:	Kodak Ektachrome 64
Illumination	:	77.6%	Sky condition	:	3/10 (10/10 being perfect)
Diameter/dist.	:	32′07″/376,838 km	Moon altitude	:	48°57′ from N horizon

The 12th-day Moon

Three more nights to Full Moon and the Moon is already so bright that there isn't much point looking at anything else in the sky. The southern half of the terminator is once again studded with craters while the northern half, with the exception of the extreme north, is occupied by the vast grey expanse of Oceanus Procellarum, the Ocean of Storms.

Mare Imbrium, with Sinus Iridum a prominent bulge on its northern aspect, is finally completely revealed. The mountainous region north and west of Sinus Iridum contains two small, bright-rimmed craters, Sharp and Mairan. They form a nice quartet with Maupertuis and Bianchini. At the southwest tip of the mountains, look for two smoothly convex hills, Gruithuisen Gamma and Gruithuisen Delta, both named after the nearby but undistinguished little Gruithuisen. Gruithuisen Gamma has a little craterlet at its summit and resembles an upturned kitchen-sink, complete with outlet. Luna 17, a lunar rover, cruised the mare surface near Promontorium Heraclides.

A string of three craters lines the south shore of Mare Frigoris. La Condamine, the easternmost, is already beginning to fade although its small sibling, La Condamine A, still retains bright rims. Its western neighbours, Bouguer and Foucault, still remain prominent. Notice the mountain ridge immediately west of Foucault. The smooth mare surface itself is disturbed by striking Harpalus.

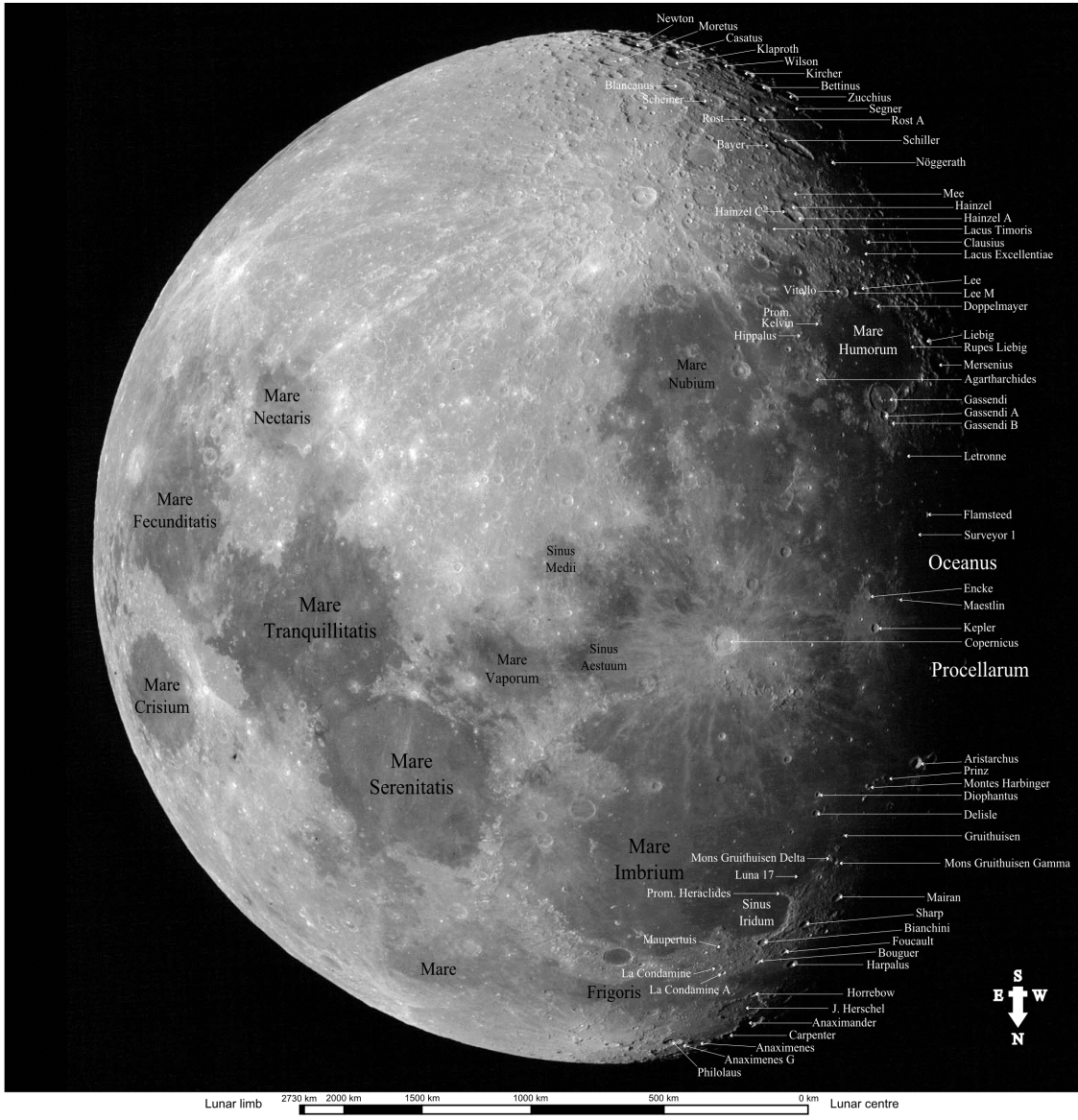
North of Mare Frigoris, large J. Herschel has its northwest wall further desecrated by Horrebow. A bright ridge formed by the eastern rims of Anaximander and Carpenter runs north from J. Herschel to Anaximenes and Anaximenes G, both markedly foreshortened. Their compatriot here, Philolaus, is a convenient terminus for our northern excursion tonight.

And now, it's time to venture south onto the mighty Ocean of Storms. First stop here, where Mare Imbrium merges into Oceanus Procellarum, is Delisle; and then Diophantus. To their west, the scattered Harbinger mountains, ending at the half-ring of Prinz, are well-named as they lead us irresistibly to Aristarchus. It doesn't look like much tonight; but in a few nights, Aristarchus will become the brightest spot on the Moon's surface and will remain conspicuous until the Sun sets on it in 2 weeks' time. Directly south of Aristarchus, and west of Copernicus, is Kepler, now very different from last night. Notice its surrounding corona of lighter material. As the lunation proceeds, this will become another system of bright rays. South of Kepler is Encke, already losing its individuality. The flooded partial ring, Maestlin, lies west of Encke.

As we continue our voyage south, little Flamsteed marks a historic spot. The nameless ghostly ring to its north is the site where Surveyor 1 soft-landed on the Moon in 1967. Continuing south, we reach Letronne, another partially flooded crater. Finally, we reach landfall at Gassendi, who with his assistants Gassendi A and Gassendi B, serve as guardians of the northern entrance to Mare Humorum. Gassendi is also partially ruined and flooded but the central mountain complex still protrudes from the flooded floor. A mountainous spike protrudes from the southwest wall on to the floor of Mare Humorum. This is continued further south by Rupes Liebig, named after little Liebig in the mountains to the west. Far more prominent here, north of Liebig, is Mersenius. Look carefully at its floor – it is distinctly convex. The rille continues south, parallel to the mare boundary, to a system of partially flooded craters at the southern apex of the mare. Here, Doppelmayer has its central peak still visible, but its northeastern wall is completely flooded over. South of Doppelmayer are Lee and Lee M, the latter also almost completely flooded. East of these is much better preserved Vitello. North of Vitello, look for the isolated mountain massif, Promontorium Kelvin, rising from the floor of the mare. Recall ruined Hippalus and Agartharchides and their associated rille systems here north of Promontorium Kelvin where Mare Humorum opens into Mare Nubium.

Clausius, though small, stands out in mare-like Lacus Excellentiae south of Mare Humorum. Two unusual elongated structures lie in the badlands here. The less obvious, more northern structure, first encountered last night, is actually a triple crater made up of Hainzel, Hainzel A and Hainzel C. To its north is a smooth dark strip, Lacus Timoris, while to its south is large Mee, so badly ruined as to be almost indiscernible. The southern, more elongated and more striking object is Schiller. Its unusual shape makes it an excellent landmark in this difficult region. A mountain ridge in its northern floor runs parallel to the crater rim. Schiller points north to Nöggerath, which seems to lie within a ghost ring, and south to Rost and Rost A. East of Schiller is Bayer, while to its south and west, a chain of five very similar-sized craters is prominent. From north to south, these are Segner, Zucchius, Bettinus, Kircher and Wilson. Do you think Schiller marks the northern boundary of a mare-like region centred just north of Segner?

Schiller points out Scheiner and Blancanus, the former easily recognised by its trio of craterlets, and Moretus, containing a central mountain. Directly south of Blancanus, recognise Klaproth and Casatus, which contains a prominent craterlet. Adjacent to them on the east, and south of Moretus, is excavated Newton.



Names of lunar formations							11.99-day-old Moon
Crater					**Lacus – lake**	**Promontorium – promontory**	**Rupes – scarp**
Agartharchides	Clausius	Hainzel	Lee	Philolaus	Lacus Excellentiae	Prom. Kelvin	Rupes Liebig
Anaximander	Copernicus	Hainzel A	Lee M	Prinz	Lacus Timoris		
Anaximenes	Delisle	Hainzel C	Letronne	Rost		**Mons and montes – mountain(s)**	**Sinus – bay**
Anaximenes G	Diophantus	Harpalus	Liebig	Rost A	**Mare – sea**	Mons Gruithuisen Delta	Sinus Iridum
Aristarchus	Doppelmayer	Hippalus	Maestlin	Scheiner	Mare Frigoris	Mons Gruithuisen Gamma	
Bayer	Encke	Horrebow	Mairan	Schiller	Mare Humorum	Montes Harbinger	**Probe**
Bettinus	Flamsteed	J. Herschel	Maupertuis	Segner	Mare Imbrium		Luna 17 (Lunokhod 1)
Bianchini	Foucault	Kepler	Mee	Sharp	Mare Nubium		Surveyor 1
Blancanus	Gassendi	Kircher	Mersenius	Vitello			
Bouguer	Gassendi A	Klaproth	Moretus	Wilson	**Oceanus – ocean**		
Carpenter	Gassendi B	La Condamine	Newton	Zucchius	Oceanus Procellarum		
Casatus	Gruithuisen	La Condamine A	Nöggerath				

Lunar data			**Photographic data**		
DTG (Local)	:	6 Jun. 98 (Sat.) 2145 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	6 Jun. 98 (Sat.) 1345 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/4 s (Pentax 67 camera)
Age	:	11.76-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	87.8%	Sky condition	:	2/10 (10/10 being perfect)
Diameter/dist.	:	30′03″/403,608 km	Moon altitude	:	75°06′ from N horizon

Lunar data

DTG (Local)	:	3 Oct. 98 (Sat.) 0048 hrs
DTG (UT)	:	2 Oct. 98 (Fri.) 1648 hrs
Lunation	:	No. 937
Age	:	11.99-day-old Moon
Illumination	:	86.5%
Diameter/dist.	:	32′40″/370,448 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/8 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	5/10 (10/10 being perfect)
Moon altitude	:	48°25′ from N horizon

The 13th-day Moon

Although the terminator is dominated by the somewhat dull expanse of Oceanus Procellarum, interesting objects remain to be found in both northern and southern hemispheres. Outstanding in the south is Tycho, while Aristarchus dazzles in the northwest.

Sinus Iridum is a convenient starting point in the north. Running northwest across Mare Frigoris through Harpalus, we reach three large kissing craters. Northernmost of these is incongruously named South, so ruined as to be almost invisible in this lighting, except for its north-eastern rim, which looks like a ridge of hills. Immediately north of South is Babbage, containing smaller Babbage A in its floor. Adjacent to the northern aspect of Babbage, but reduced to a dark slit, is large Pythagoras. But for extreme foreshortening, Pythagoras would be much more striking. A suitable libration will, however, show it to advantage. Smaller Oenopides lies on the terminator southwest of Babbage. Still further along the terminator is Markov. The peculiar, very foreshortened and apparently trilobed object east of Pythagoras is actually composed of Anaximander, Anaximander B and Carpenter.

Mare Frigoris flows into Sinus Roris, the Bay of Dew, and this in turn empties into Oceanus Procellarum. Here, take careful note of isolated Mons Rümker, a low complex of domes rising from the surface of Oceanus Procellarum. It is only visible when close to the terminator. If you have lost your bearings because of the vastness of Oceanus Procellarum, remember that Rümker is north of Aristarchus and west of Promontorium Heraclides.

Aristarchus is brilliant tonight. Note the central mountain before it disappears into the glare. West of Aristarchus is Herodotus. Just north of Herodotus, the sinuous rille, Vallis Schröteri, issues from a tiny crater, often referred to as the Cobra Head. Immediately north of Aristarchus is a diamond-shaped area, the Aristarchus uplift, that is worthy of close scrutiny. Worth noting also is that it is from Aristarchus that the most reports of transient lunar phenomena have been made.

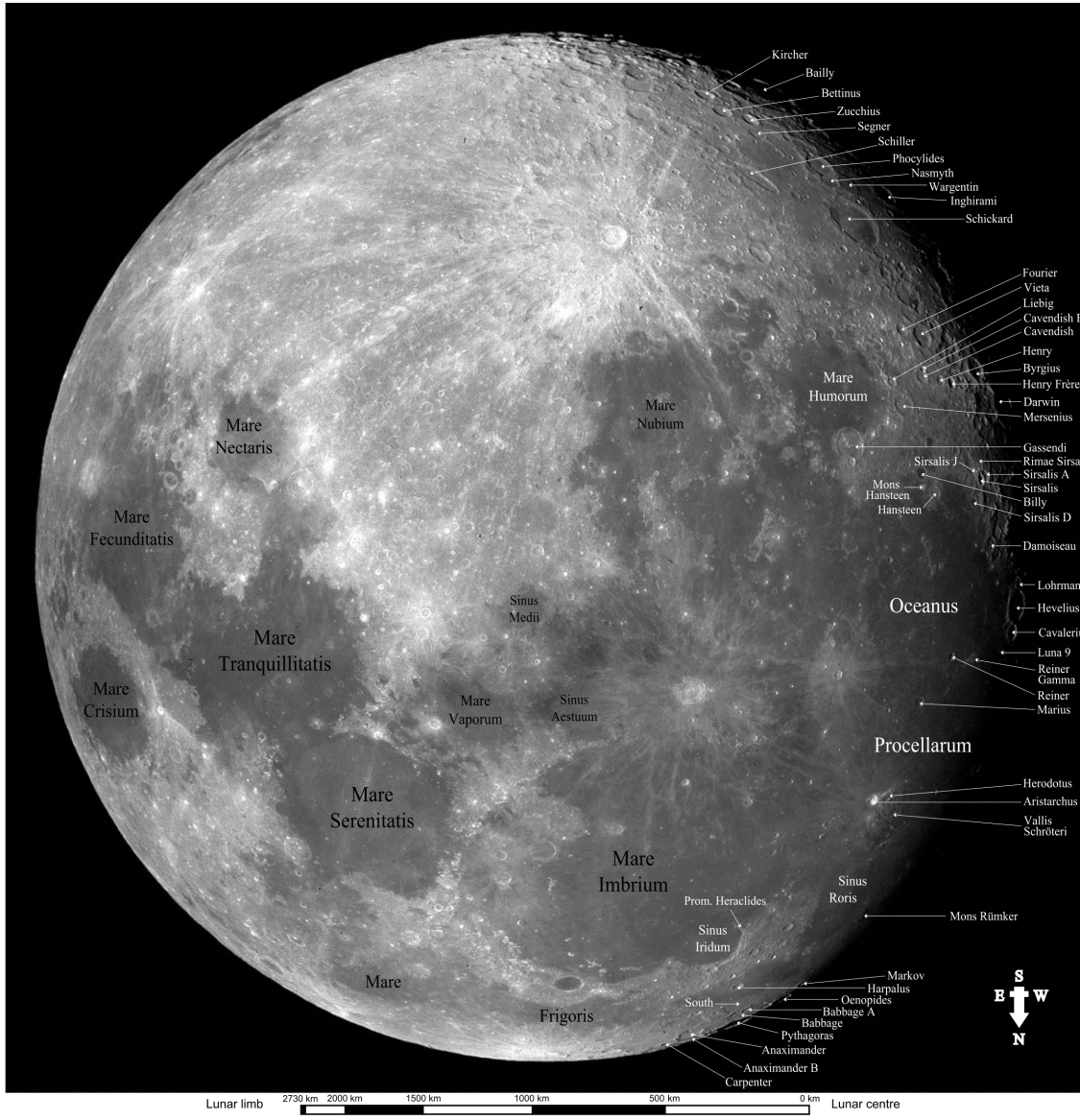
Continuing south through Oceanus Procellarum, look for Marius, with low walls and a central peak. To its west is an interesting region containing multiple low hills. Some little way southwest of Marius is another undistinguished crater, Reiner. Unique pale diamond-shaped Reiner Gamma lies to its east. Even the best photographs of this area show no vertical relief – Reiner Gamma is believed to be just an unusually pale area on the surface.

On the western shore of Oceanus Procellarum are Cavalerius, near which Luna 9 accomplishged the first lunar soft-landing, and Hevelius. From Hevelius, moving along the shore of Oceanus, notice Damoiseau, a crater within another older crater. Moving the same distance further south, we reach the kissing pair of Sirsalis and Sirsalis A. East of Sirsalis, look for the long Sirsalis rille that runs north. How much of it can you see tonight? Unlike other rilles, which run through maria, this rille runs through the highlands. It starts at the edge of Oceanus Procellarum, near Sirsalis D, courses north–south, east of Sirsalis and then is interrupted by little Sirsalis J. Resuming its southward journey, it finally ends up in Darwin.

Midway between the Sirsalis pair and Gassendi is smooth, dark-floored Billy. Its northern neighbour, Hansteen, is of similar size but very dissimilar appearance. Between them is isolated bright Mons Hansteen.

Now, the southward journey becomes more difficult again as the terrain becomes more rugged. Fortunately, there are landmarks from the previous night to help. Identify Mersenius and its southern neighbour, Liebig. West of Liebig is Cavendish, scarred on its southwestern rim by little Cavendish E. Two very similar craters with very similar names are situated west of Cavendish. The eastern crater is Henry (named after the great physicist, Joseph Henry) and the western one Henry Frères (named after the Henry brothers, who were among the earliest pioneers of astrophotography). Further west, almost at the terminator, is Byrgius.

Southeast of Byrgius, across a mess of unnamed structures, are Vieta and smaller Fourier to its east. South of these is large Schickard, which has a dark and flooded floor. Elongated Schiller, from last night, points at it. West of Schickard, on the terminator, is Inghirami. The most interesting object here, Wargentin, lies southwest of Schickard. Originally a crater, Wargentin is now a plateau as the crater basin has been filled with lava up to the elevated rim. Immediately south of Wargentin lies the shoeprint made up of Phocylides and the smaller Nasmyth. The string of Segner, Zucchius, Bettinus and Kircher now catches the eye. Brooding on the terminator to their west is Bailly, largest of all named craters on this visible surface of the Moon. Unfortunately, Bailly is not usually well seen unless there is a favourable libration.



Names of lunar formations							13.35-day-old Moon
Crater Anaximander Anaximander B Aristarchus Babbage Babbage A Bailly Bettinus Billy Byrgius	Carpenter Cavalerius Cavendish Cavendish E Damoiseau Darwin Fourier Gassendi Hansteen Harpalus	Henry Henry Frères Herodotus Hevelius Inghirami Kircher Liebig Marius Markov	Mersenius Nasmyth Oenopides Phocylides Pythagoras Reiner Schickard Schiller Segner	Sirsalis Sirsalis A Sirsalis D Sirsalis J South Tycho Vieta Wargentin Zucchius	**Mare – sea** Mare Frigoris **Oceanus – ocean** Oceanus Procellarum **Mons and montes – mountain(s)** Mons Hansteen Mons Rümker	**Promontorium – promontory** Prom. Heraclides **Rima and rimae – rille(s)** Rimae Sirsalis	**Sinus – bay** Sinus Iridum Sinus Roris **Vallis – valley** Vallis Schröteri **Probe and others** Luna 9 Reiner Gamma (swirl)

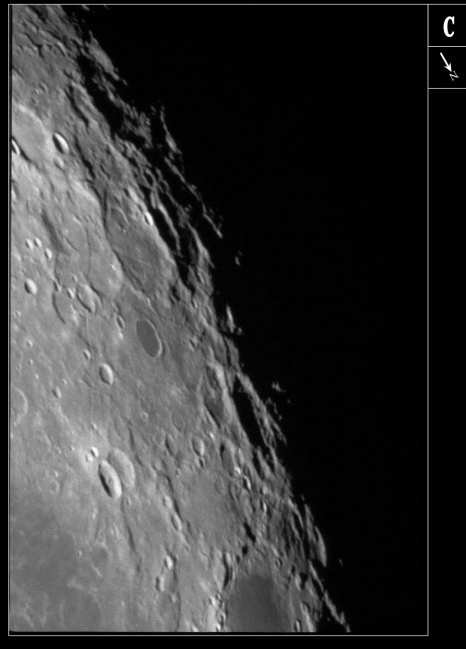


Photo A: Schickard and Wargentin
Contrast vast Schickard with neighbouring Wargentin – the latter has been filled with lava to the rim so that it is now a plateau. Phocylides and Nasmyth form a footprint adjacent to Wargentin. Vallis Inghirami extends northwards from Inghirami.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/4 s (Nikon F3)
14 mm XP eyepiece projection yielding f/112 Sky condition: 5/10
Date: 4th Oct. 1998 Film: Kodak Elite II - 400

Photo B: Hevelius and Cavalerius
Hevelius contains a crisscrossing complex of clefts. Dark-floored Grimaldi is partially seen south of Hevelius. Somewhat more west is massive Riccioli.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/4 s (Nikon F3)
14 mm XP eyepiece projection yielding f/112 Sky condition: 5/10
Date: 4th Oct. 1998 Film: Kodak Elite II - 400

Photo C: Rima Sirsalis
Longest of all rilles, Rima Sirsalis begins at the edge of Oceanus Procellarum, runs past Sirsalis and Sirsalis A, and then dark-floored Cruger, and finally ends in an anonymous ruined crater east of large ruined Darwin. Rima Darwin emerges from Darwin to cross Rima Sirsalis.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/4 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 4/10
Date: 8th Jun. 1998 Film: Kodak Elite II - 400

Lunar data

DTG (Local)	:	7 Jul. 98 (Tue.) 2011 hrs
DTG (UT)	:	7 Jul. 98 (Tue.) 1211 hrs
Lunation	:	No. 934
Age	:	13.35-day-old Moon
Illumination	:	94.8%
Diameter/dist.	:	30′46″/392,397 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/8 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	3/10 (10/10 being perfect)
Moon altitude	:	39°22′ from N horizon

The 14th-day Moon

It takes a good eye to discern that the Moon isn't completely full tonight if you're using the naked eye. The clue lies in the fact that the sunrise terminator, and its associated craters, is still visible on the western limb.

Starting in the northwest, Pythagoras, with its central double mountain, is extremely prominent. Babbage, to its south, has almost disappeared but Oenopides and Markov are still discernible. Look further west for the rim of Repsold.

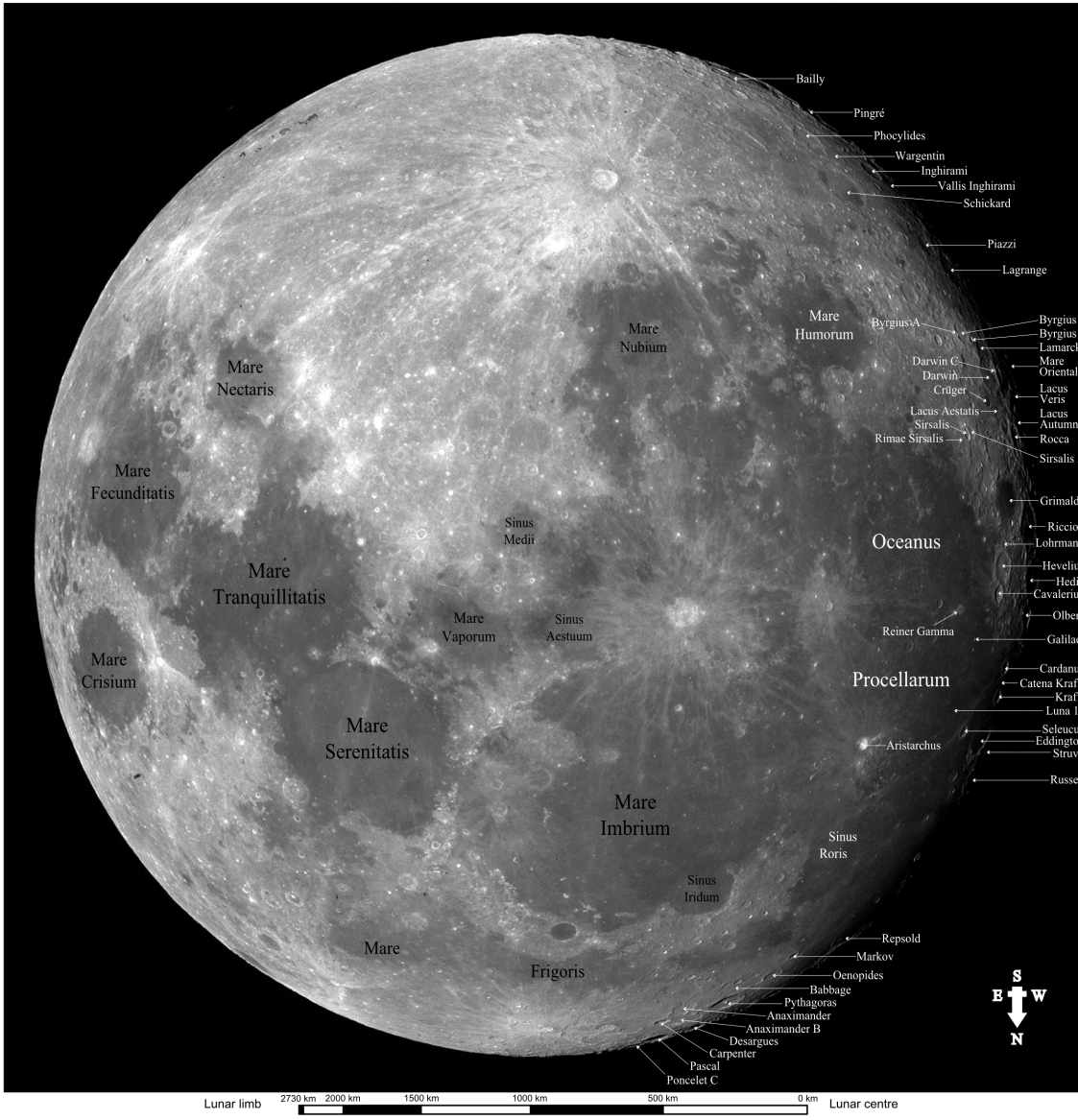
Aristarchus is unmistakably bright but its surroundings have lost all detail. Lying west is sharp-margined Seleucus, near which Luna 13 soft-landed. Still further west, on the terminator, is the complex of Struve, Russell and Eddington. Struve looks very much like a wishbone. South of the complex is the almost identical pair Kraft and Cardanus, connected by a crater chain, Catena Kraft. Minute Galilaei (surely Galileo Galilei deserved a more prominent crater) lies midway between Cardanus and Reiner Gamma. You should look for Olbers northwest of Hevelius – by tomorrow, this region will be so bright that you will not be able to find craters at all.

We now reach the rugged area in which lie Cavalerius and Hevelius. To their west, the rim of Hedin is just visible. Lohrmann separates Hevelius from dark-floored Grimaldi to its south. Don't you think Grimaldi looks very much like a little mare? Northwest of Grimaldi is Riccioli, still in partial shadow. Riccioli is almost as large as Grimaldi but because its dark-floored portion is the most conspicuous part, one always gets the impression that it is much smaller.

About one Grimaldi-length further south is Rocca, easily identified by its eastern neighbours, Sirsalis A and Sirsalis. If you didn't manage to see it last night, look again for the Sirsalis Rille. Adjacent to Rocca is dark Lacus Aestatis (formerly dignified as Mare Aestatis) and in the same direction southeast is the prominent dark floor of flooded Crüger. West of these objects tomorrow night and subsequently will be the two dark parallel strips of Lacus Autumni and Lacus Veris. These form part of bullseye-shaped Mare Orientale, unfortunately only visible as such from spacecraft orbiting the Moon.

Large, complicated Darwin is south of Crüger. It is easily recognised because its west wall is interrupted by bright Darwin C. Darwin merges imperceptibly southwards into Lamarck. Southeast of Lamarck, identify Byrgius, with Byrgius D on its west rim and Byrgius A on its east rim.

Shallow Lagrange and Piazzi lie between Lamarck and sharp-rimmed Inghirami, easily recognised west of immense Schickard. Try to identify Vallis Inghirami, a groove that runs along the terminator northwards from Inghirami. Unique Wargentin should be used as a landmark if you have difficulty in this region. West of Phocylides is an excavation from the terminator – the darkest southern portion of this is Pingré. Finally, look again at gigantic Bailly. It is easily distinguished by the two side by side craters on its southeast aspect.



Names of lunar formations							13.95-day-old Moon
Crater						**Lacus – lake**	**Rima and rimae – rille(s)**
Aristarchus	Cavalerius	Hedin	Markov	Repsold	Sirsalis A	Lacus Aestatis	Rimae Sirsalis
Babbage	Crüger	Hevelius	Oenopides	Riccioli	Struve	Lacus Autumni	
Bailly	Darwin	Inghirami	Olbers	Rocca	Wargentin	Lacus Veris	**Vallis – valley**
Byrgius	Darwin C	Krafft	Phocylides	Russell			Vallis Inghirami
Byrgius A	Eddington	Lagrange	Piazzi	Schickard			
Byrgius D	Galilaei	Lamarck	Pingré	Seleucus	**Catena**	**Mare – sea**	**Probe and others**
Cardanus	Grimaldi	Lohrmann	Pythagoras	Sirsalis	Catena Krafft	Mare Orientale	Luna 13
							Reiner Gamma (swirl)

Lunar data			**Photographic data**		
DTG (Local)	:	8 Jun. 98 (Mon.) 2155 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	8 Jun. 98 (Mon.) 1355 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/8 s (Pentax 67 camera)
Age	:	13.72-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	97.3%	Sky condition	:	4/10 (10/10 being perfect)
Diameter/dist.	:	30′21″/398,942 km	Moon altitude	:	56°44′ from N horizon

Lunar data			**Photographic data**		
DTG (Local)	:	4 Oct. 98 (Sun.) 2345 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	4 Oct. 98 (Sun.) 1545 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 937	Exposure time	:	1/15 s (Pentax 67 camera)
Age	:	13.95-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	97.9%	Sky condition	:	6/10 (10/10 being perfect)
Diameter/dist.	:	33′41″/361,017 km	Moon altitude	:	83°57′ from N horizon

The 15th-day Moon

Tonight the Moon is full (or at Second Quarter, if you wish to be pedantic). It rises at sunset and sets at sunrise next morning. And it appears quite enormous when rising, looking much larger than when at the zenith. This is an illusion, but no one quite knows the reason. Current thinking suggests that the Moon on the horizon is perceived to be at a vast distance while the Moon at the zenith is perceived to be nearer. This results in the horizon Moon being perceived to be twice as large as the elevated Moon.

Several other illusory statements about the Moon should also be debunked at this stage. First, the Moon is so bright when full that one is tempted to think that its surface is highly reflective, like that of a mirror. In fact, the Full Moon is so bright only because the night sky is so dark. In truth, the Moon only reflects 7% of the light incident on it, its reflectivity being somewhat less than that of a tarred road!

The second illusion is that the Full Moon is completely round and the visible surface therefore completely illuminated – in other words, there is no terminator. But, there usually is a terminator, and you should look for it at one of the poles. Because of the inclination of the Moon's orbit, the Full Moon is usually either just above or just below the ecliptic plane; hence, the opposite pole will not be illuminated by the Sun – the same explanation accounts for terrestrial seasons. Also, Full Moon is an instant, not a period of time, and therefore, anybody viewing the 'Full' Moon for an extended period, sees the Moon either just before or just after Full.

We've already dealt with the main features on the face of the Full Moon. So let's concentrate on those on the west and east limbs, starting first with some unfinished business on the west limb.

Return first to Pythagoras in the extreme northwest. To its west, identify Boole and Cleostratus, the former on the limb and the latter somewhat off. A complex of unnamed craters separates them. From Cleostratus, identify large Xenophanes and then Volta, Langley and Galvani between Repsold and the limb. Can you also see Regnault and Stokes squeezed between Volta and the limb? Then, two nameless craters, one with a very bright western rim help to identify Bunsen. The two craters point south, first, toward ruined Lavoisier and then, to dark Ulugh Beigh.

The rough outline of the Struve–Eddington–Russell complex is still discernible, especially when one realises that Seleucus forms a bright ring at to its east. Look for Balboa, Dalton and Vasco da Gama slightly southwest of the complex. Even further west of these three craters, a good libration will reveal Einstein, a magnificent, but much foreshortened, crater containing an almost concentric central crater. Somewhat south of Einstein is his illustrious contemporary, Bohr. Jumping to the region west of Grimaldi and Riccioli, identify Schlüter. It lies at the northern tip of Mare Orientale whose ring mountains, the outer Montes Cordillera and the inner Montes Rook, can sometimes be identified at a good libration.

In contrast to the south pole, the north pole lies in a less rugged region that is much easier to explore, although foreshortening will always contribute some difficulty to crater identification. Here, the bright ray-crater, Anaxagoras, springs to attention north of Plato and we use it as a suitable starting-point. To its west, identify the pale outlines of Philolaus, Carpenter and Pythagoras, the last recognised by its terraced walls and double central peak. Look for Cremona, right on the limb, adjacent to Pythagoras. Working northwards, along the limb, identify Desargues, which has a westward extension resembling the teat on a baby's milk bottle. Pascal and Brianchon are both situated immediately north of Carpenter while Hermite lies north of Anaxagoras. Northeast of Anaxagoras, Scoresby contains a central craterlet, while north of Scoresby's western tip are Challis, Main and Gioja. Squeezed between Gioja and the limb are Byrd and Peary, the pole being at the centre of the northern rim of Peary. East of the pole, look first for Hayn on the limb northwest of Mare Humboldtianum and then for Nansen, also on the limb northwest of Cusanus and Petermann.

If you observe just after Full Moon, you might find that the terminator is beginning to appear in the east. Humboldt and Hecataeus, east of Petavius, should then be coming into view. Abel, south of Humboldt, is prominent. As you move further south, identify Marinus and Oken, the latter lying on the fringe of Mare Australe. Immense Lyot lies within Mare Australe. Look for Hanno and its larger neighbour, Pontécoulant, on the southern shores of the mare.

A good libration on a Full Moon night will allow identification of the craters in either of the polar regions. On the southwest terminator, look for Hausen and Drygalski, both containing central peaks. Hausen is the more westerly of the two. If you lose your bearings, first look for Bailly, easily identified by prominent Bailly B towards its southern apex. Hausen lies on the limb beyond Bailly and slightly to its southwest. Similarly, to get your bearings on the southeast, first identify the trio of, from east to west, Helmholtz, Boussingault with its terraced walls and Boguslawsky. Neumayer occupies the space between Helmholtz and Boussingault and the limb. Demonax lies in a similar position between Boguslawsky and the limb. Adjacent to Demonax and containing an interior ridge is Scott. Even further south than Scott is Amundsen. North of Scott, identify Schomberger and Schomberger A. Notice how mountainous the whole region is – do you get the impression that the region around the pole has a rim wall of mountains around it while the pole itself seems to be in a somewhat depressed region?

Full Moon is another occasion when the Moon arrives at one of the nodes in its orbit round the Sun. This means that circumstances are once again ripe for an eclipse to occur, except that in this case, it is an eclipse of the Moon (see Figure 4). Solar eclipses therefore occur at New Moon, while lunar eclipses occur at Full Moon. Once again, however, they don't occur every month and are perhaps even less common than total solar eclipses. To compensate, a lunar eclipse is a much more leisurely affair than a solar eclipse – this is because the Earth's shadow is so much larger than the Moon's shadow. Now, you might think you can't see the Moon when it is eclipsed, but in fact, you can. Although direct sunlight doesn't reach the eclipsed Moon's surface, reflected light from the Earth does. This Earthshine can cause the Moon to assume different colourations, sometimes even a blood-red hue. What exactly is seen then – how dark the Moon is and what colour it will be – depends therefore on the state of the Earth's atmosphere.

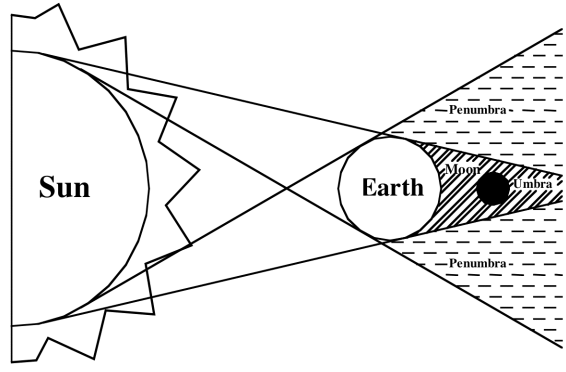
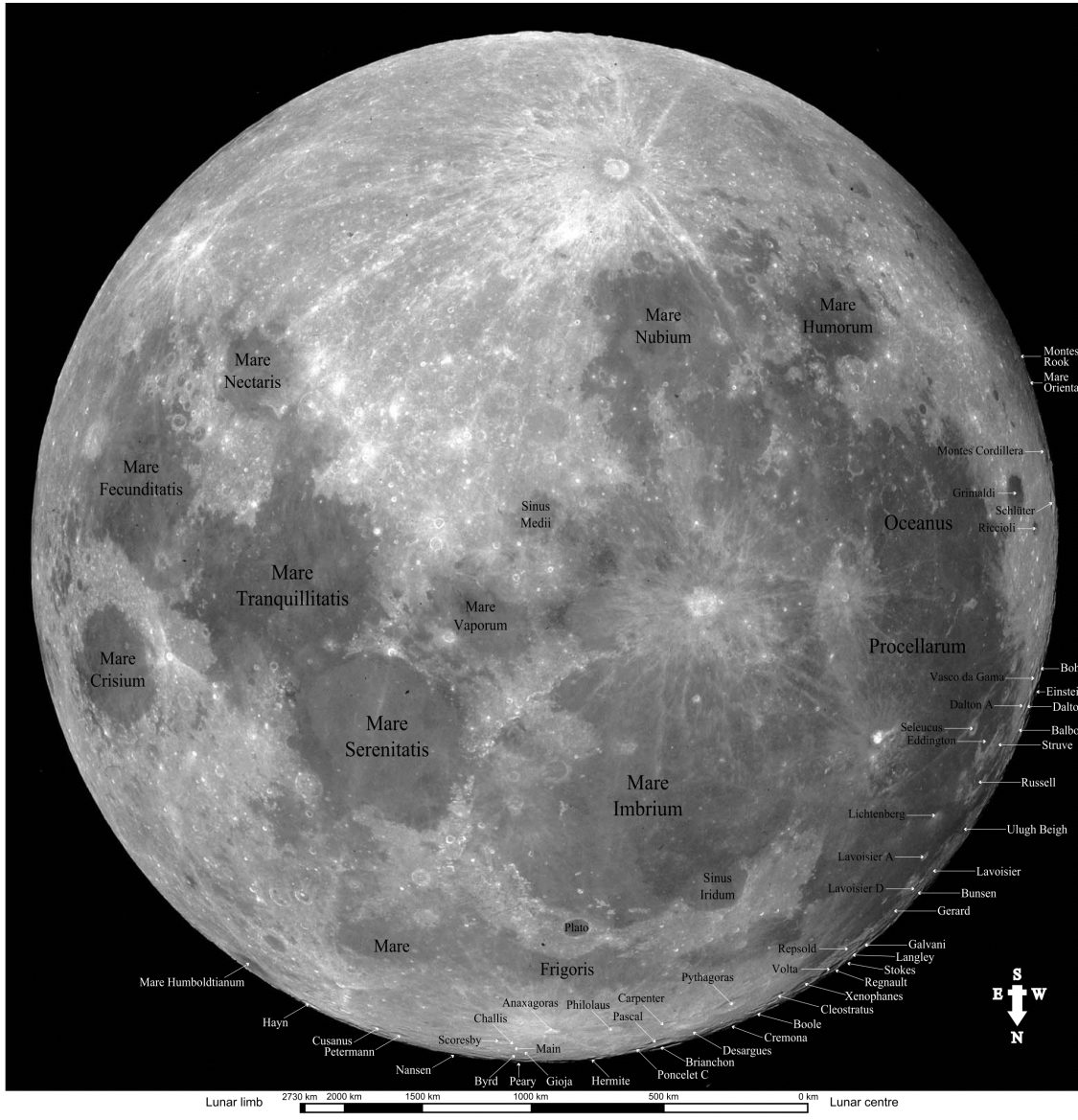


Figure 4 Lunar eclipse



Names of lunar formations							14.94-day-old Moon
Crater Anaxagoras Balboa Bohr Boole Brianchon Bunsen Byrd Carpenter	Challis Cleostratus Cremona Cusanus Dalton Desargues Eddington Einstein	Galvani Gioja Grimaldi Hayn Hermite Langley Lavoisier	Main Nansen Pascal Peary Petermann Philolaus Plato	Pythagoras Regnault Repsold Riccioli Russell Schlüter Scoresby	Seleucus Stokes Struve Ulugh Beigh Vasco da Gama Volta Xenophanes	**Mare – sea** Mare Humboldtianum Mare Orientale	**Mons and montes** – mountain(s) Montes Cordillera Montes Rook

Photo A: The south polar region
This is a very rugged region and was not well observed for many years. Some of the crater floors here never sees sunlight and may contain ice. Drygalski on the west limb (right) contains a central mountain complex.

Photographic data
Instr: 15cm F15 Apo refractor
24 mm XP eyepiece projection yielding f/65
Date: 12th May 1998
Exp:1/15 s (Nikon F3)
Sky: 4/10
Film: Kodak Elite II - 100

Photo B: The north polar region
The north polar region contains many old craters and is much less rugged than the south polar region. Anaxagoras, emitting bright rays, Philolaus, Anaximenes and Pythagoras, containing a central peak, form an easily recognised string of craters.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 6th Oct. 1998
Exp: 1/60 s (Nikon F3)
Sky: 7/10
Film: Kodak Elite II - 400

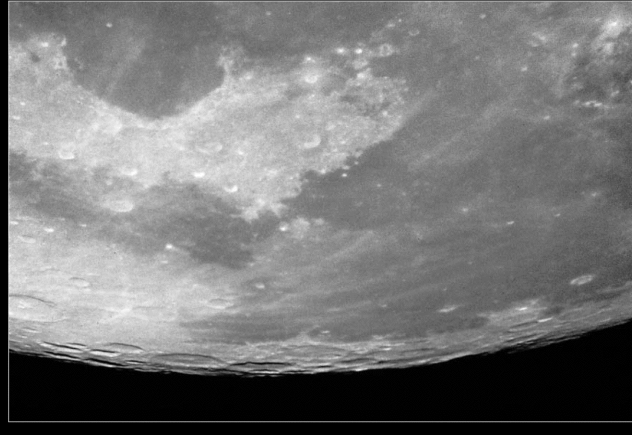
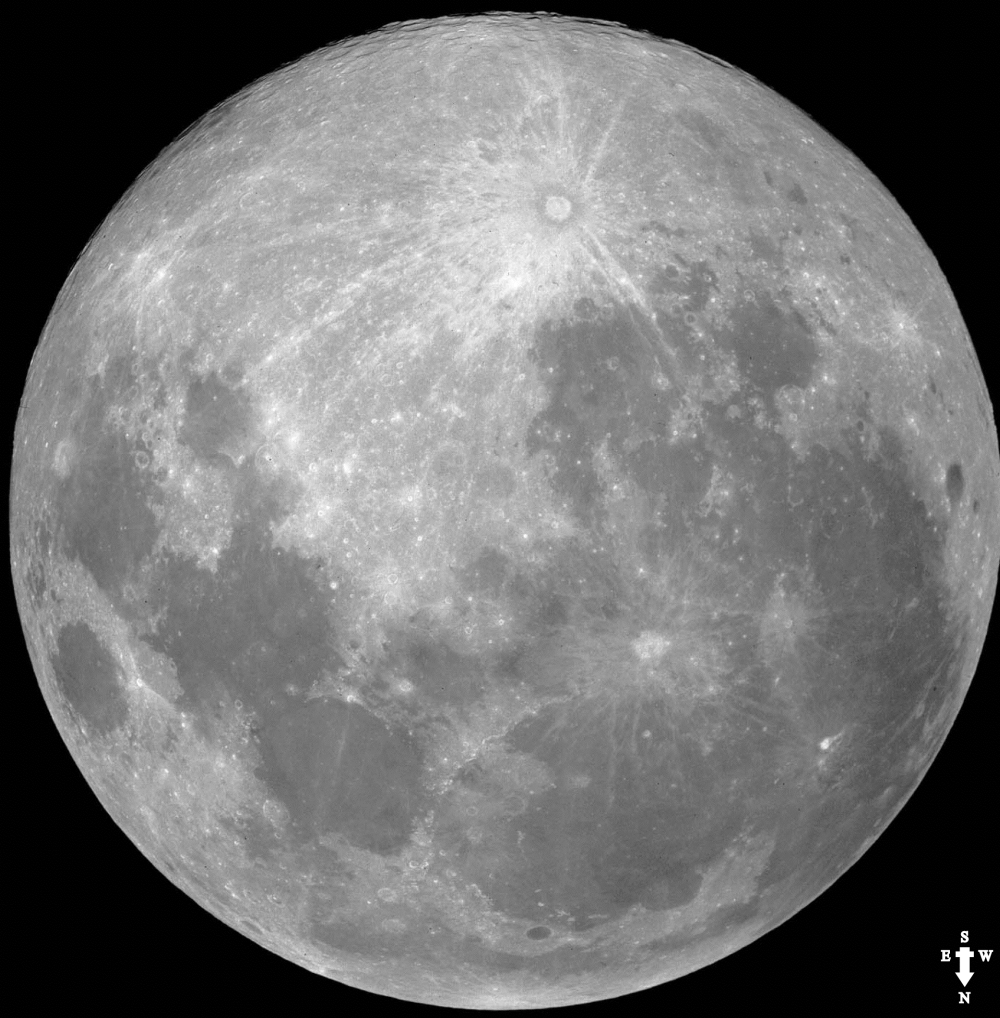


Photo C: Sinus Roris and the northwest limb
Pythagoras is partially shown at the left. The small bright crater on the right in Oceanus Procellarum is Harding.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 6th Oct. 1998
Exp: 1/60 s (Nikon F3)
Sky: 7/10
Film: Kodak Elite II - 400

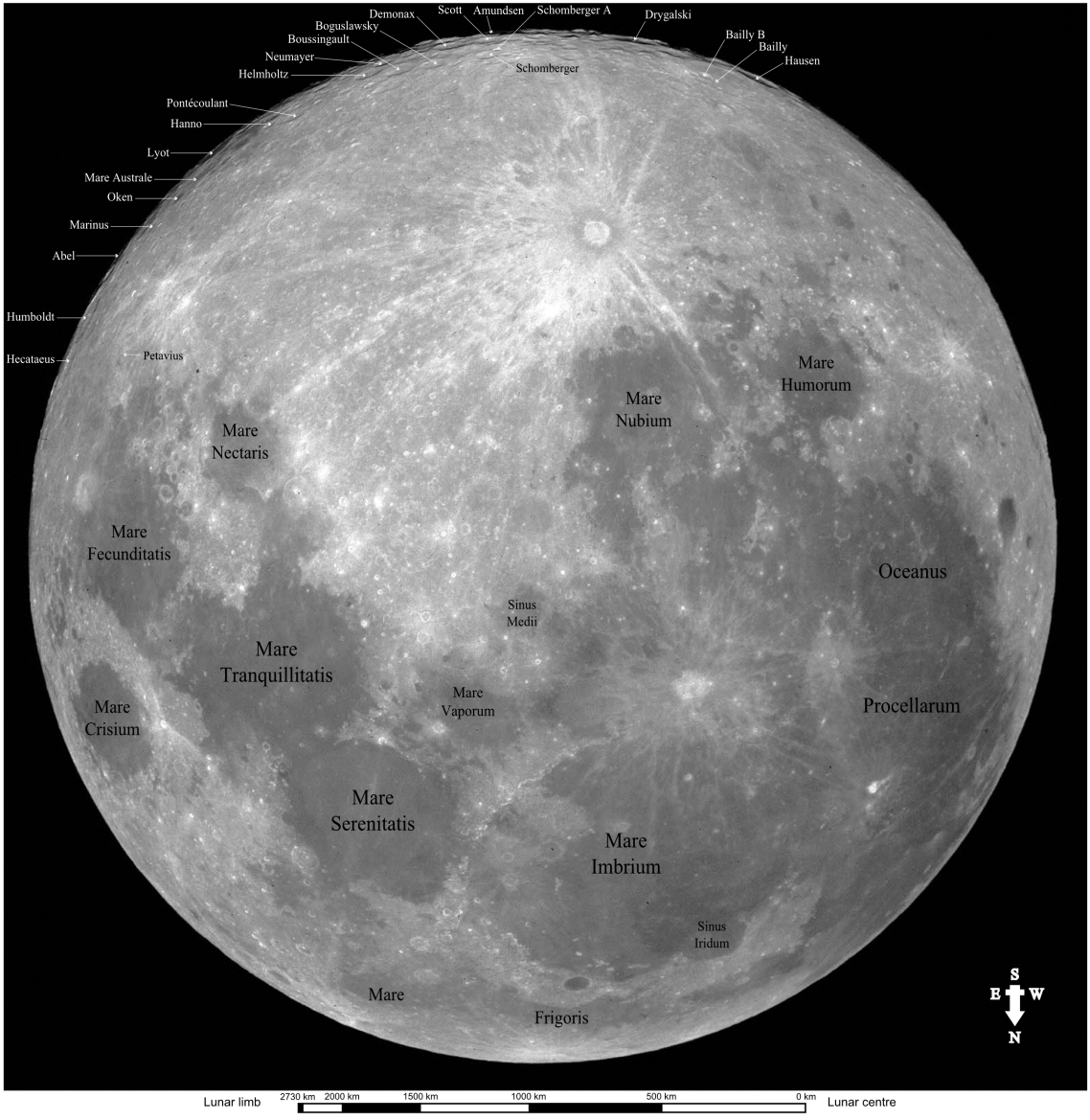
Lunar data			**Photographic data**		
DTG (Local)	:	5 Oct. 98 (Mon.) 2330 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	5 Oct. 98 (Mon.) 1530 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 937	Exposure time	:	1/30 s (Pentax 67 camera)
Age	:	14.94-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	99.9%	Sky condition	:	7/10 (10/10 being perfect)
Diameter/dist.	:	33′54″/358,414 km	Moon altitude	:	70°12′ from N horizon

DAY 15



Lunar data		
DTG (Local)	:	11 May 98 (Mon.) 2318 hrs
DTG (UT)	:	11 May 98 (Mon.) 1518 hrs
Lunation	:	No. 932
Age	:	15.15-day-old Moon
Illumination	:	99.9%
Diameter/dist.	:	30′08″/401,896 km

Photographic data		
Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/15 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	4/10 (10/10 being perfect)
Moon altitude	:	58°39′ from N horizon



Names of lunar formations							15.15-day-old Moon
Crater Abel Amundsen Bailly Bailly B	Boguslawsky Boussingault Demonax Drygalski	Hanno Hausen Hecataeus	Helmholtz Humboldt Lyot	Marinus Neumayer Oken	Petavius Plato Pontécoulant	Schomberger Schomberger A Scott	**Mare – sea** Mare Australe

Lunar data (total lunar eclipse)

DTG (Local)	:	16 Jul. 2000 (Sun.) 2245 hrs
DTG (UT)	:	16 Jul. 2000 (Sun.) 1445 hrs
Lunation	:	No. 959
Age	:	14.80-day-old Moon
Illumination	:	100.0%
Diameter/dist.	:	29′46″/405,879 km
Location	:	Singapore

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	3 min (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	6/10 (10/10 being perfect)
Moon altitude	:	46°51′ from N horizon

Lunar data (partial phase of total lunar eclipse)

DTG (Local)	:	16 Jul. 2000 (Sun.) 2331 hrs
DTG (UT)	:	16 Jul. 2000 (Sun.) 1531 hrs
Lunation	:	No. 959
Age	:	14.84-day-old Moon
Illumination	:	100.0%
Diameter/dist.	:	29′49″/405,858 km
Location	:	Singapore

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	6/10 (10/10 being perfect)
Moon altitude	:	55°42′ from N horizon

The 16th-day Moon

One day after full, and from now on, the Moon will rise later and later every night (or, after third quarter, earlier and earlier every morning). This waning phase of the Moon is the test that differentiates the true 'lunatic' from the dilettante, as observing it means staying up until the wee hours. In compensation, you get to see the Moon as few have. Everything is reversed as we now see the sunset terminator moving west. Contour irregularities that were bright during the waxing phase are now dark and vice versa. The relation between the waxing and waning Moons is very similar to that between *Alice in Wonderland* and its sequel *Through the Looking Glass* – less well known, but with the same characters, slightly altered.

And so, as we turn our eyes from the glaring west to the terminator in the east, what do we see? Well, what exactly you see will depend on precisely when you are observing after Full Moon. And also, as we are looking at the limb region again, libration will play an important part.

Recall the eastern margin of Mare Fecunditatis and the three great craters – Langrenus, Vendelinus and Petavius – there. Look east of Petavius for Humboldt and southeast of Vendelinus for Hecataeus. Depending on when exactly Full Moon was, however, the terminator may already have engulfed them. Humboldt's west wall, coincident with the east wall of its neighbour, Phillips, may be all that's left. Southeast of Petavius, the bright east wall of little Adams B catches the eye and draws attention to its darkening neighbours, Adams and Adams D. Immediately north of these two is similarly darkening Legendre.

As you move south along the terminator from Humboldt, identify Marinus, by a complex of five craters along its western aspect. Still further south, at the northern apex of Mare Australe, is Oken. Within, the mare Lyot occupies a prominent position. Hanno and its larger neighbour Pontécoulant lie west of the southern end of the mare. The foreshortened dark ellipse of Gill lies further south, between Pontecaulant and Helmholtz. If you haven't yet succeeded in sorting out the south polar regions, try again tonight. The constantly changing illumination can only make it more and more difficult. Helmholtz, Boussingault and Boguslawsky will appear prominent here if libration permits.

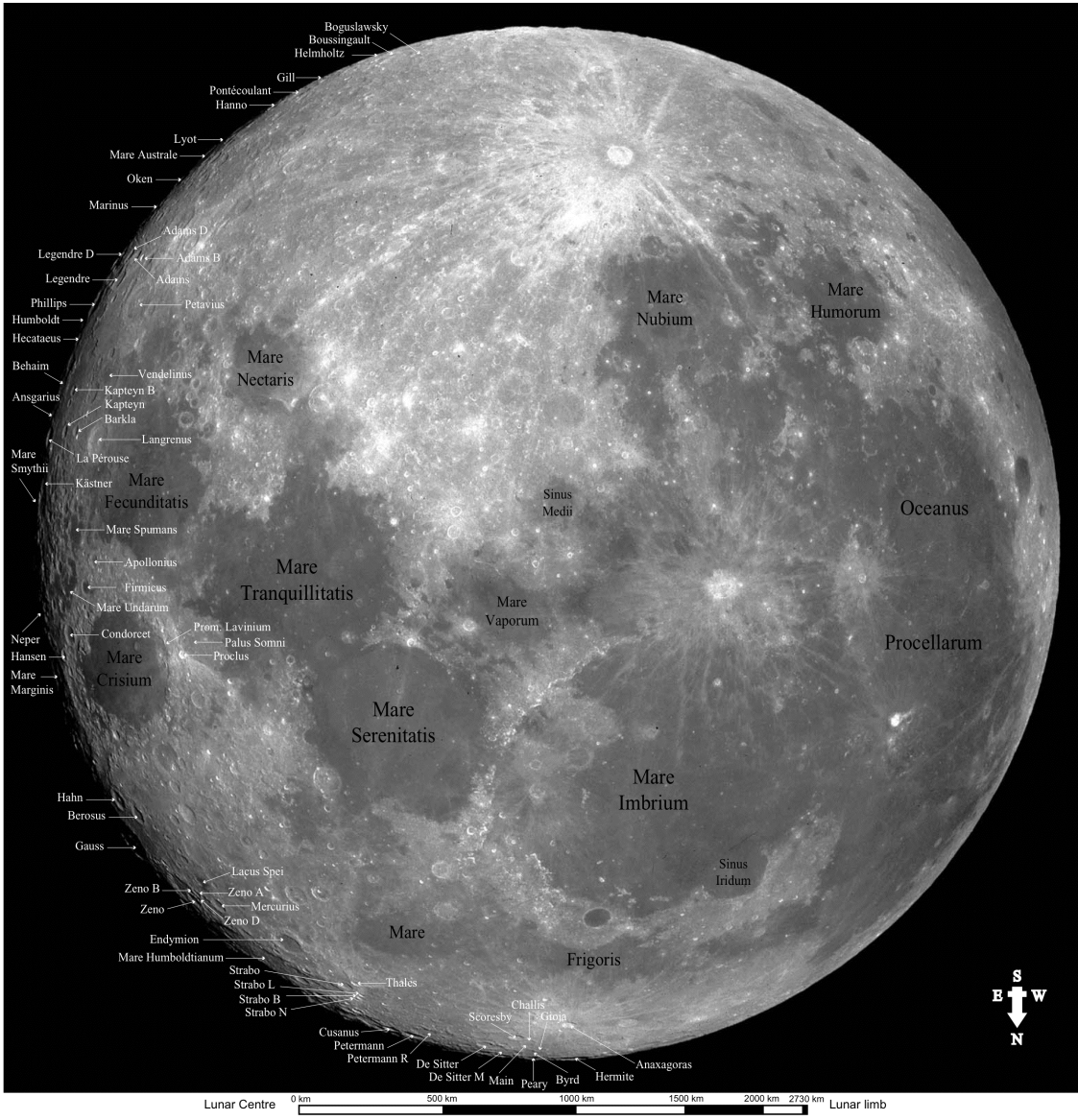
Let's move north now from Hecataeus. Behaim, Ansgarius, La Pérouse, Kästner – do they sound familiar from a brief encounter two weeks ago? Unfortunately, encounters with them will always have to be brief. By now you are east of Langrenus and it is best to pause here for a breath and to regain bearings.

Time to move on. If libration again allows, however, tarry a while over Mare Smythii, Neper and Mare Marginis – you won't see them again for another two weeks. If you're lost again, use Apollonius, Firmicus, Condorcet and Hansen as landmarks. All four have dark floors that render them easily recognisable. If you still have a problem, Mare Crisium, Mare Spumans and Mare Undarum are more prominent landmarks. Take a good look at Mare Crisium and see if you can identify its double-ringed nature. To its west, on the edge of pale Palus Somni, the eastern wall of Proclus appears as a bright 'C'.

Hahn and Berosus are reappearing under the oblique lighting conditions. To their east, say farewell to Gauss as it slips into the night. There's a large, old and anonymous crater south of Gauss. Paradoxically, the crater that has obliterated its south apex has a name – Zeno – and the three smaller adjacent craters are Zeno B, A and D from south to north. The adjacent mare-like area has a twentieth-century name, Lacus Spei, the Lake of Hope. Mercurius is located immediately to its south.

Endymion, with its dark floor, is easily identified. What could that huge gouge in the terminator immediately east be? Well, that's Mare Humboldtianum and it's easy to see then that maria, like craters, must be impact structures, only on a much larger scale. Does it have a surrounding outer ring? Nobody ever mentions the possibility but look, and then make up your own mind. A complicated much-cratered region lies north of Endymion. The landmark here is a chain of three small craters that run east–west. Unfortunately, they do not have proper names, merely being designated as Strabo N, B and L, from east to west respectively. Their parent, Strabo, lies immediately south. Its western neighbour, Thales, is easily recognised as a ray centre.

Moving north along the terminator, Cusanus and Petermann form a prominent elongated pair. Old Petermann R lies adjacent to the latter. The next prominent feature is the distorted figure-eight formed by De Sitter and De Sitter M. To their west is the road to the north pole, the crater chain of Scoresby, Challis, Main and Gioja. North of Gioja is Byrd and north of that, Peary. The pole itself lies on the north wall of Peary. As an aid, huge Hermite lies right on the limb west of Peary (that direction should really be south as all directions are south from the north pole but that might be confusing here). The bright ray-crater, Anaxagoras, is also a useful landmark here and Hermite lies due north of it.



Names of lunar formations — **15.94-day-old Moon**

Crater
Adams
Adams B
Adams D
Anaxagoras
Ansgarius
Apollonius
Behaim
Berosus
Boguslawsky
Boussingault
Byrd
Challis
Condorcet
Cusanus
De Sitter
De Sitter M
Endymion
Firmicus
Gauss
Gill
Gioja
Hahn
Hansen
Hecataeus
Helmholtz
Hermite
Humboldt
Kästner
La Pérouse
Langrenus
Legendre
Lyot
Main
Marinus
Mercurius
Neper
Oken
Peary
Petavius
Petermann
Petermann R
Phillips
Pontécoulant
Proclus
Scoresby
Strabo
Strabo B
Strabo L
Strabo N
Thales
Vendelinus
Zeno
Zeno A
Zeno B
Zeno D

Lacus – lake
Lacus Spei

Mare – sea
Mare Australe
Mare Crisium
Mare Fecunditatis
Mare Humboldtianum
Mare Marginis
Mare Smythii
Mare Spumans
Mare Undarum

Palus – marsh
Palus Somni

DAY 16

Lunar data		
DTG (Local)	:	10 Jul. 98 (Fri.) 2231 hrs
DTG (UT)	:	10 Jul. 98 (Fri.) 1431 hrs
Lunation	:	No. 934
Age	:	16.44-day-old Moon
Illumination	:	98.9%
Diameter/dist.	:	31′45″/379,985 km

Photographic data		
Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/15 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	3/10 (10/10 being perfect)
Moon altitude	:	35°12′ from N horizon

Lunar data			**Photographic data**		
DTG (Local)	:	6 Oct. 98 (Tue.) 2331 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	6 Oct. 98 (Tue.) 1531 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 937	Exposure time	:	1/15 s (Pentax 67 camera)
Age	:	15.94-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	98.9%	Sky condition	:	4/10 (10/10 being perfect)
Diameter/dist.	:	33′55″/357,643 km	Moon altitude	:	56°34′ from N horizon

The 17th-day Moon

On the 17th day the terminator is closing in on Mare Crisium. There isn't much to its north and we can run through that area very quickly. The region immediately adjacent to the north pole is devoid of structure and the first easily identifiable object is Thales, recognisable by the persistence of its bright rays. Strabo, immediately east, might still be identifiable.

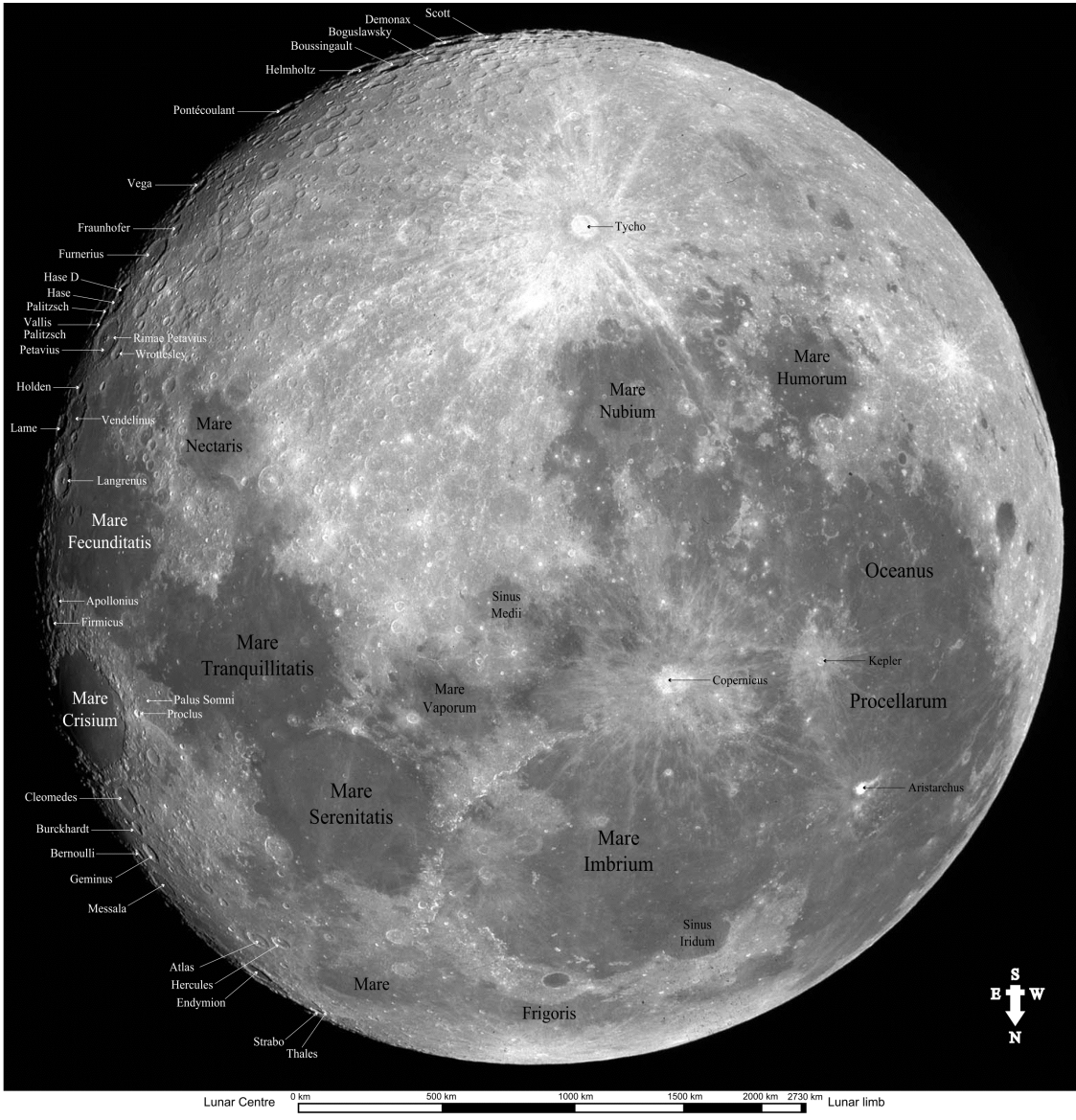
Moving south along the terminator, we reach Endymion, easily recognised again by its floor, and nearby Atlas and Hercules. Next is low-walled Messala, closely followed by Geminus and its smaller eastern neighbour, Bernoulli. A little rille emerges from the group of craterlets at the southeastern aspect of Geminus. Burckhardt and its two flanking neighbours look like a foreshortened letter 'X'.

And, of course, the last large crater north of Mare Crisium is Cleomedes. There's not much to see on the mare but Proclus, on the edge of Palus Somni, is as eye-catching as ever.

As we go south, we have another opportunity to view those four magnificent craters, Langrenus, Vendelinus, Petavius and Furnerius, on the eastern margin of Mare Fecunditatis. Once again, consider the similarities between Langrenus and Petavius and between Vendelinus and Furnerius respectively and see how the two pairs illustrate the differences between young and old craters. Look at the rille in Petavius – it's now bright, rather than dark – an example of the reversal that occurs during the waxing Moon. Don't forget to take a good look at the Palitzsch complex just to the east of Petavius.

What are those three huge craters that stretch along the terminator to the south pole? The clue lies in identifying Boussingault by its concentric structure. Then, Helmholtz is the crater to its east and the large crater along the terminator north of Helmholtz is Pontécoulant. West of Boussingault is Boguslawsky and the dark ellipse to its south is Demonax. Adjacent to Demonax is Scott, adjacent to the south pole.

Before you pack up, compare the ray systems of Tycho, Copernicus and Kepler. The latter two systems resemble cobwebs more than anything else, while that of Tycho is more reminiscent of an octopus. How do you account for the skew ray that runs southwest? Could it be that it is not part of the Tycho system but of another ray centre?



Names of lunar formations						16.82-day-old Moon	
Crater Atlas Bernoulli Boguslawsky Boussingault	Burckhardt Cleomedes Copernicus Demonax	Endymion Furnerius Geminus Helmholtz	Hercules Kepler Langrenus Messala	Palitzsch Petavius Pontécoulant Proclus	Scott Strabo Thales Tycho Vendelinus	**Mare – sea** Mare Crisium Mare Crisium Mare Fecunditatis	**Palus – marsh** Palus Somni

Photo A: Vallis Rheita, Watt and Steinheil
Watt and Steinheil form a matched pair east of Janssen. Vallis Rheita stretches east from Rheita.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 12th Jun. 1998
Exp: 1/8 s (Nikon F3)
Sky: 7/10
Film: Kodak Ektachrome 400

Photo B: Petavius, Vendelinus and Langrenus
Low-walled, old Vendelinus is barely discernible at sunset. Younger Petavius and Langrenus lie respectively south and north.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 12th Jun. 1998
Exp: 1/8 s (Nikon F3)
Sky condition: 7/10
Film: Kodak Ektachrome 400

Photo C: Sunset on Mare Crisium
Proclus forms a bright C as the Sun sets on Mare Crisium.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 12th Jun. 1998
Exp: 1/4 s (Nikon F3)
Sky Condition: 7/10
Film: Kodak Ektachrome 400

Lunar data			**Photographic data**		
DTG (Local)	:	12 Jun. 98 (Fri.) 0119 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	11 Jun. 98 (Thu.) 1719 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/8 s (Pentax 67 camera)
Age	:	16.82-day-old Moon	Slide film (120)	:	Fujichrome Velvia 50
Illumination	:	97.4%	Sky condition	:	7/10 (10/10 being perfect)
Diameter/dist.	:	31′13″/388,519 km	Moon altitude	:	63°59′ from N horizon

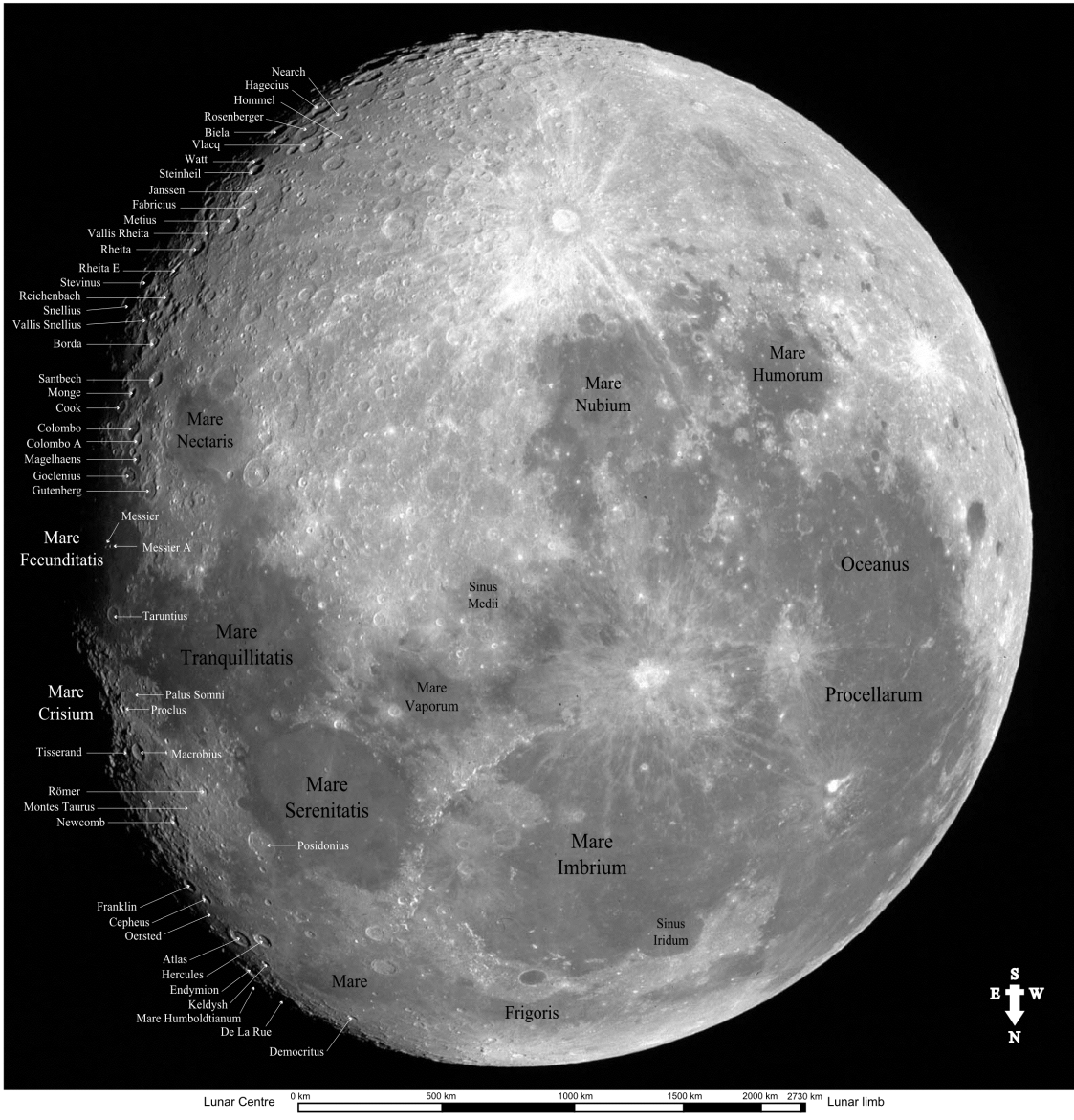
The 18th-day Moon

First out in the Sun, first back into the dark – that's the theme of the waning Moon. And so, like Mare Humboldtianum two nights ago, Mare Crisium produces a bulge in the terminator tonight. Also departing is Mare Fecunditatis.

The north is rather nondescript again. Small Democritus should be noted – it's one of the deepest of craters. Atlas and Hercules are also prominent again. To their northeast, two rather interesting indentations in the terminator are visible – the nearer one is what's left of Endymion and the other the remnant of De La Rue. Partially obscured Oersted, and more obvious Cepheus and Franklin, lie to their southeast. Passing over a rugged area, in which Newcomb is located, we reach Macrobius and Tisserand adjacent to Mare Crisium. You might not even realise you're there – that's how disconcerting and confusing its absence is. Palus Somni is, however, still a useful landmark. Look for Proclus – instead of the customary glare, you can see its true shape tonight. A short trip northwest brings us to Römer, also in the Taurus mountains, halfway between Macrobius and Posidonius.

As we pass onto Mare Fecunditatis, recall first Taruntius, guarding the narrow passage connecting to Mare Tranquillitatis, and then the cometlike pair, Messier and Messier A. To the west, the cratered peninsula that separates Mare Fecunditatis from Mare Nectaris is very obvious. As we enter the southern highlands, Gutenberg and Goclenius are easily identified. Less obvious is the complex of rilles that runs from Goclenius to the north of Gutenberg. Magelhaens (better known as Magellan), Colombo (better known as Columbus) and Cook are located here in this region devoted to intrepid explorers. And thus we reach Monge and Santbech. Time to pause for breath again before the really difficult part.

Snellius and Stevinus are entering the terminator and Vallis Snellius is difficult to discern. Look for it north of Reichenbach's two subsidiary craters. Much more prominent is Vallis Rheita. Remember that the rolling-pin crater, otherwise known as Rheita E, points south toward Rheita if you have difficulties. Enormous Janssen starts to show its complicated interior. Beside it, Watt and Steinheil are largely dark, as is Biela, but Vlacq, Rosenberger and owlish Hommel show well. Last stop tonight, Nearch and Hagecius. From here to the pole, the complexities of light and shade are almost insuperable.



Names of lunar formations							17.83-day-old Moon
Crater					**Mare – sea**	**Mons and montes – mountain(s)**	**Vallis – valley**
Atlas	Franklin	Magelhaens	Proclus	Steinheil	Mare Crisium	Montes Taurus	Vallis Rheita
Biela	Goclenius	Messier	Reichenbach	Stevinus	Mare Fecunditatis		Vallis Snellius
Cepheus	Gutenberg	Messier A	Rheita	Taruntius	Mare Humboldtianum	**Palus – marsh**	
Colombo	Hagecius	Monge	Rheita E	Tisserand	Mare Nectaris	Palus Somni	
Cook	Hercules	Nearch	Römer	Vlacq	Mare Tranquillitatis		
De La Rue	Hommel	Newcomb	Rosenberger	Watt			
Democritus	Janssen	Oersted	Santbech				
Endymion	Macrobius	Posidonius	Snellius				

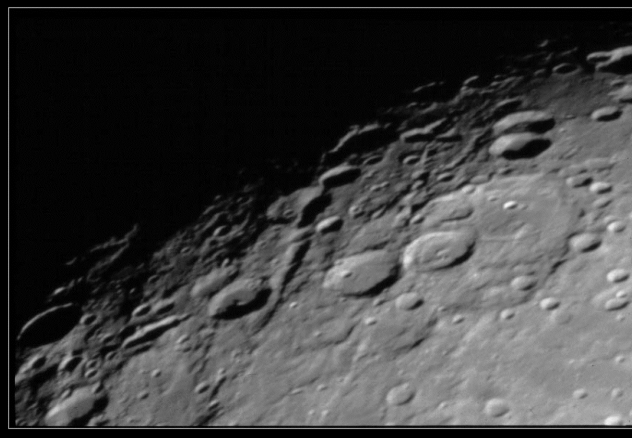


Photo A: Janssen and Vallis Rheita
Vallis Rheita cuts a dark groove at sunset. Note the cross partly formed by a curvilinear rille in huge ruined Janssen.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 13th Jun. 1998
Exp: 1/4 s (Nikon F3)
Sky: 4/10
Film: Kodak Ektachrome 400

Photo B: Cleomedes, Burckhardt, Geminus and Messala
Old Messala contrasts with young Geminus at sunset, while Burckhardt and Cleomedes look on.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 12th Jun. 1998
Exp: 1/4 s (Nikon F3)
Sky condition: 7/10
Film: Kodak Ektachrome 400

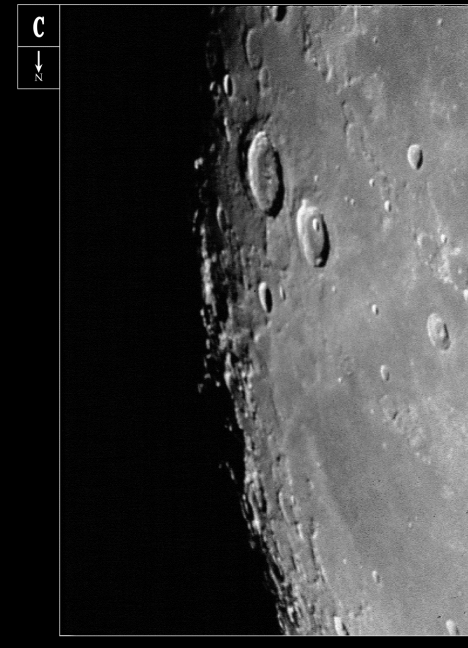
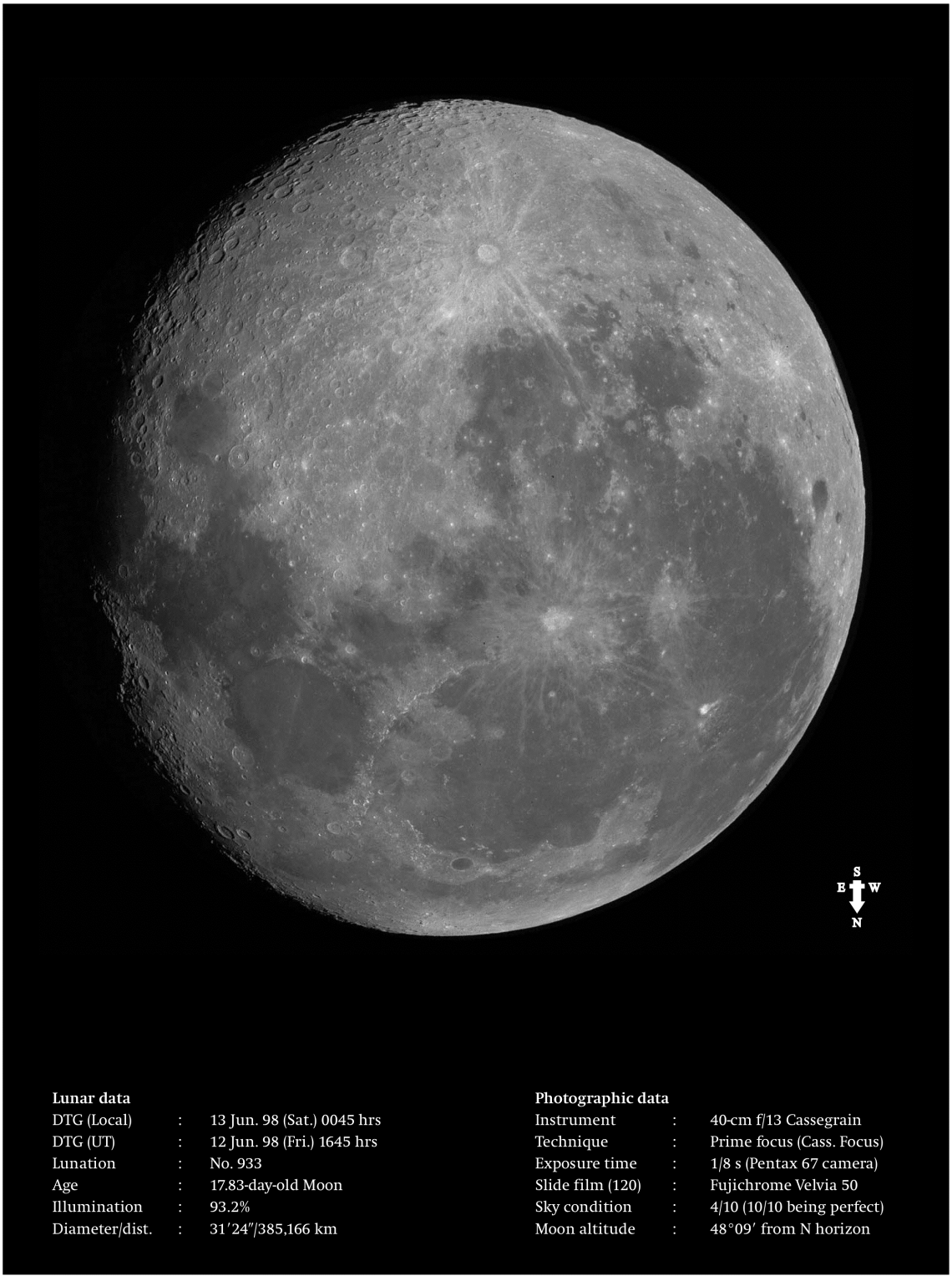


Photo C: Atlas and Hercules
Hercules contains a flooded floor and a craterlet. Atlas shows a system of central peaks. Burg lies within pentagonal Lacus Mortis.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 13th Jun. 1998
Exp: 1/4 s (Nikon F3)
Sky Condition: 4/10
Film: Kodak Ektachrome 400



Lunar data

DTG (Local)	:	13 Jun. 98 (Sat.) 0045 hrs
DTG (UT)	:	12 Jun. 98 (Fri.) 1645 hrs
Lunation	:	No. 933
Age	:	17.83-day-old Moon
Illumination	:	93.2%
Diameter/dist.	:	31′24″/385,166 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/8 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	4/10 (10/10 being perfect)
Moon altitude	:	48°09′ from N horizon

The 19th-day Moon

Tonight the terminator eats into Mare Nectaris. Interesting sights abound in both northern and southern halves of the Moon and the theme is identifying rilles (rimae) and scarps (rupes).

In the north, the number of old craters present may cause confusion; they all look very similar. Meton, distinguished by its three lobes, is a useful marker. To its east, contrast large old Arnold with neighbouring young Democritus. Even more ancient than Arnold, and partially covered by the lavas of Mare Frigoris, is Gärtner, south of Democritus.

Southeast of Democritus, Bürg, located in Lacus Mortis, is nicely highlighted. Eudoxus and Aristoteles, however, are still sun-drenched and may show very little detail in their interiors.

Crossing over Lacus Somniorum brings us to Posidonius, a magnificent sight tonight. An interior mountain ridge parallels its east wall and numerous intersecting rilles may be visible on the crater floor. Adjacent Chacornac contains a similar interior system of rilles. In the Taurus mountains, the most prominent crater remaining is Römer. To its north is an unnamed crater of similar size. Still further north, look for small G. Bond and larger, partially flooded Hall. Both lie east of Posidonius. You should now be able to identify the north–south rille, Rima G. Bond, west of Hall. Can you see that it continues southwards west of Römer as Rima Römer? Littrow, with a smooth dark floor, stands out amongst the mountains southwest of Römer. Try to identify long, curving Rima Littrow running in the valley west of the crater. Also, look for the rilles of Rimae Plinius that cross the narrows between Mare Serenitatis and Mare Tranquillitatis in an east–west direction. Notice also the numerous wrinkle ridges on Mare Serenitatis – the longest, Dorsa Smirnov, needs no introduction while Dorsa Aldrovandi, running from Le Monnier, south of Posidonius, to Mons Argaeus, is also very prominent.

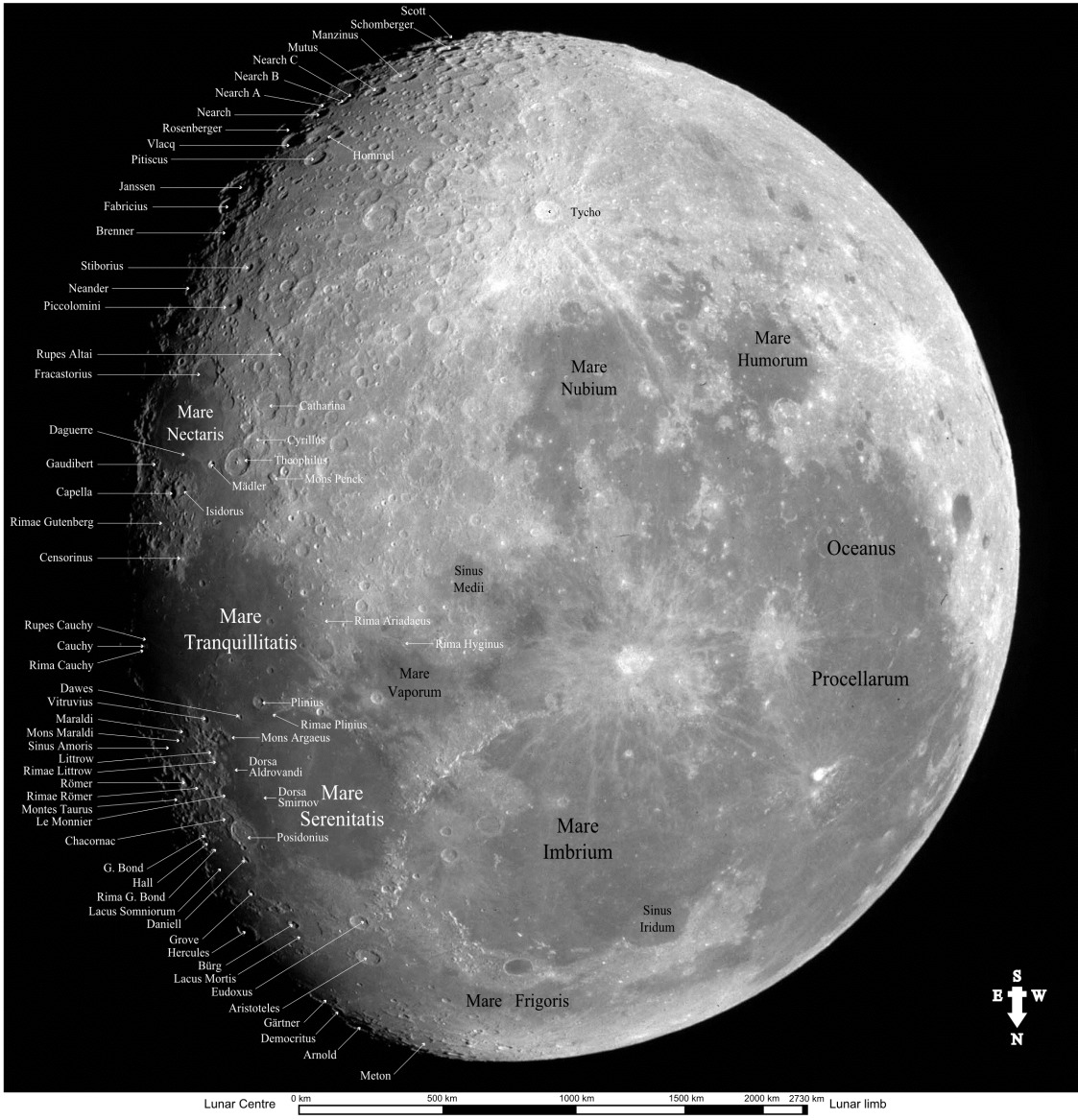
Continuing south into Sinus Amoris, Maraldi, another crater with a dark floor, is easily identified. An isolated mountain, Mons Maraldi is immediately adjacent to the northeast. The crescent formed by the east wall of Vitruvius is also conspicuous here.

As we enter Mare Tranquillitatis, look for little Cauchy and its two companions Rima Cauchy, a dark line to its north, and Rupes Cauchy, a bright line to its south. Both run east–west. And in the central highlands, across Mare Tranquillitatis, the Ariadaeus and Hyginus rilles are visible as bright streaks.

The rectangular highland block separating Mare Fecunditatis from Mare Nectaris and Mare Tranquillitatis is well-placed for observation tonight. Here, once again, Capella is skewered while his western companion, Isidorus, looks on helplessly. North of Capella, tonight's theme recurs – look for Rima Gutenberg as it crosses the highlands. In the northwestern corner of the block, Censorinus is striking – the nimbus around it is still bright, but what a minute crater it is! At the opposite southeast corner, identify Gaudibert.

Look at the dark wrinkle of Rupes Altai fringing Mare Nectaris. Like Mare Serentiatis, Mare Nectaris also contains numerous wrinkle ridges. The faint outline of Daguerre can just be discerned east of Mädler. Theophilus, Cyrillus and Catharina will be better seen tomorrow. Fracastorius is to Mare Nectaris what Sinus Iridum is to Mare Imbrium, a large crater that has been partially flooded by the mare lavas. In this case, however, because the relative difference in size is much less, Fracastorius appears much more conspicuous. Notice the bright ray that extends from Tycho to its west wall. South of Fracastorius, Piccolomini marks the end of Rupes Altai while Stiborius rests comfortably in an old anonymous crater. To their east, Neander, mostly in darkness, and kitelike Brenner with its tail of craterlets radial to Mare Nectaris, lie along a parallel line.

One last rille for tonight – it's in Janssen, which is a magnificent spectacle tonight. The intricate interior structure makes for a fascinating shadow-play. To its south, Vlacq will soon join its neighbour, Rosenberger, in the dark. The two eyes of Hommel, however, show well. The eastern eye contains a central peak for a pupil while the western eye, without a peak, is blind. Pitiscus, north of Hommel, also shows a central peak. Do not confuse the large figure-eight formed by Nearch and Nearch A with the smaller one of Nearch B and Nearch C. A little chain of three small craterlets, together with Nearch B and C, renders the area immediately east of the small figure-eight very crater-like. You can recognise that it isn't by the fact that its apparent floor is well-lit while the surrounding true crater floors are all dark. Adjacent to the three small craters, Mutus looks like a miniature Hommel. Manzinus, its immediate southern neighbour, has a very different appearance. The last two prominent craters before the pole are Schomberger, showing a terrace on its lip, and Scott, essentially only a defect on the limb.



Names of lunar formations — **18.98-day-old Moon**

Crater
Aristoteles
Arnold
Brenner
Bürg
Capella
Catharina
Cauchy
Censorinus
Chacornac
Cyrillus
Daguerre
Democritus
Eudoxus
Fracastorius
G. Bond
Gärtner
Gaudibert
Hall
Hommel
Isidorus
Janssen
Le Monnier
Littrow
Mädler
Manzinus
Maraldi
Meton
Mutus
Neander
Nearch
Nearch A
Nearch B
Nearch C
Piccolomini
Pitiscus
Posidonius
Römer
Rosenberger
Schomberger
Scott
Stiborius
Theophilus
Tycho
Vitruvius
Vlacq

Dorsa – wrinkle ridges
Dorsa Aldrovandi
Dorsa Smirnov

Lacus – lake
Lacus Mortis
Lacus Somniorum

Mare – sea
Mare Fecunditatis
Mare Frigoris
Mare Imbrium
Mare Nectaris
Mare Serenitatis
Mare Tranquillitatis

Mons and montes – mountain(s)
Mons Argaeus
Mons Maraldi
Montes Taurus

Rima and rimae – rille(s)
Rima Ariadaeus
Rima Cauchy
Rima G. Bond
Rima Hyginus
Rimae Gutenberg
Rimae Littrow
Rimae Plinius
Rimae Römer

Rupes – scarp
Rupes Altai
Rupes Cauchy

Sinus – bay
Sinus Amoris
Sinus Iridum

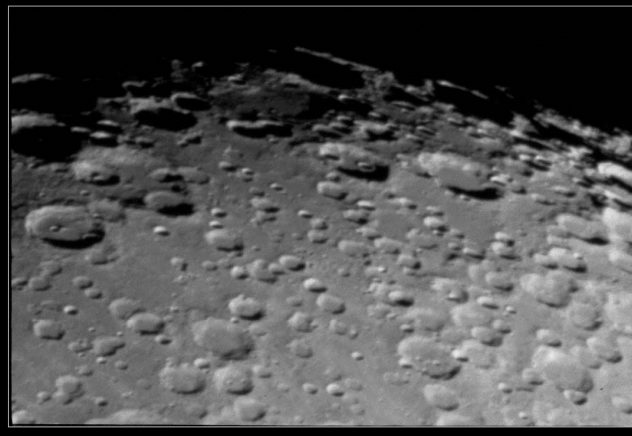


Photo A: Pitiscus, Hommel, Mutus and Manzinus
Much battered and owlish Hommel lies adjacent to Pitiscus. Mutus and Manzinus form a contrasting pair in this southeastern portion of the Moon.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 14th Jun. 1998
Exp: 1 s (Nikon F3)
Sky: 5/10
Film: Kodak Elite II - 400

Photo B: Janssen as night falls
Janssen is hardly visible as night falls but the cross aids in identification, as does the bright rim of Fabricius. Stiborius, Riccius and Nicolai are prominent west of Janssen.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky: 5/10
Date: 14th Jun. 1998 Film: Kodak Elite II - 400

Photo C: Mare Nectaris
Fracastorius gouges out the southern apex of Mare Nectaris. Theophilus and Cyrillus guard its western margin. In the highlands north of the mare, a crater chain pierces Capella.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 5/10
Date: 14th Jun. 1998 Film: Kodak Elite II - 400

Lunar data			**Photographic data**		
DTG (Local)	:	14 Jun. 98 (Sun.) 0307 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	13 Jun. 98 (Sat.) 1907 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/4 s (Pentax 67 camera)
Age	:	18.98-day-old Moon	Slide film (120)	:	Kodak Ektachrome 64
Illumination	:	86.3%	Sky condition	:	6/10 (10/10 being perfect)
Diameter/dist.	:	31′48″/381,511 km	Moon altitude	:	66°15′ from N horizon

The 20th-day Moon

Even the most casual of glances tonight will tell you that there are more craters in the south of the Moon than the north. Or, to put it another way, there is more mare surface area in the north than in the south. The reason for this asymmetry is not understood.

Although the north pole is less of a mess than the south, the problems of crater identification here remain considerable. Hexagonal W. Bond and the trilobed Meton complex should be recognisable if not by shape, then by size. Sunset on the latter, however, may make it difficult to identify tonight. A dark gash, Meton E, at its western apex may help in identification. West of Meton are Barrow, Goldschmidt and Anaxagoras, the last easily recognised as a young crater, unlike the other ancients here.

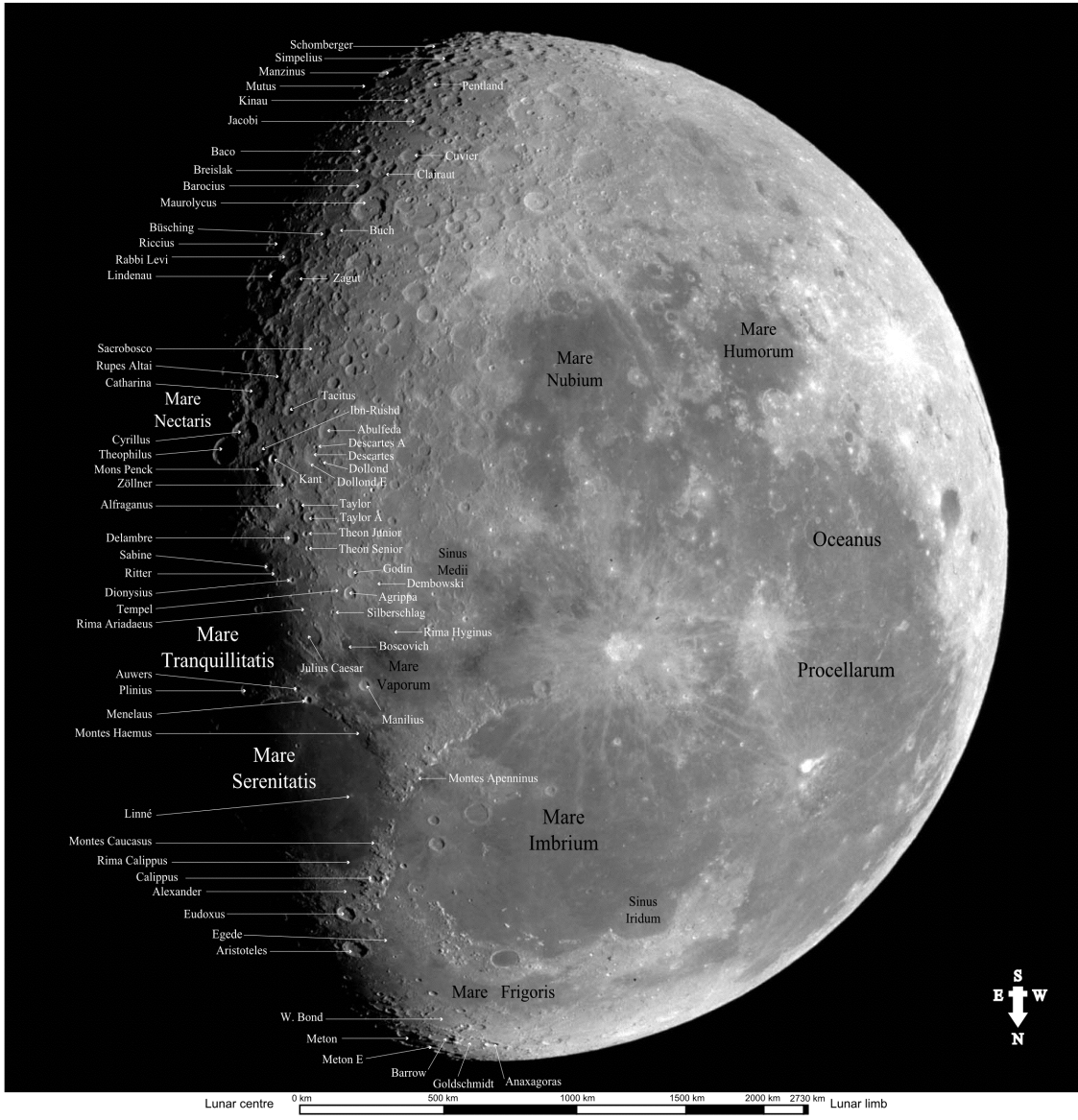
Aristoteles and Eudoxus are wonderfully placed for observation tonight at the terminator. Low-walled Egede, west of Aristoteles is, however, easily missed. Ancient Alexander south of Eudoxus contrasts well with its neighbour Calippus situated in the spine formed by the Caucasus mountains. To return to last night's theme, try and identify the short rille, Rima Calippus, that cuts off a little inlet from the main body of Mare Serenitatis. While in the neighbourhood, recall Linné, east of the gap between Mare Serenitatis and Mare Imbrium.

Contrast the bright western slopes of the Apennines fringing Mare Imbrium with the dark eastern counterparts of the Haemus mountains bounding Mare Serenitatis. Here, amidst the Haemus mountains, Menelaus lies midway between rapidly darkening Plinius in the east and Manilius in the west. South of Menelaus, the horseshoe of Julius Caesar and the dark ruin that is Boscovich serve as useful guides to Rima Ariadaeus, immediately south, and the more westerly Rima Hyginus. Agrippa and Godin, south of the two rilles, are easily identified; less so is Agrippa's eastern neighbour Tempel. Incomplete Dembowski at the western apex of a triangle formed with Agrippa and Godin is also easily glossed over.

Recall the twins Sabine and Ritter in western Mare Tranquillitatis. They point west to Dionysius, whose bright east rim brings cheer amidst the gathering gloom. Jumping over Delambre and the very similar Theon siblings, we reach Alfraganus as it presents its east margin to the setting Sun in the rugged terrain south of Mare Tranquillitatis. To its west, identify Taylor and its neighbour Taylor A. Zöllner, south of Alfraganus, shows two central peaks. Kant, on the crest of a highland ridge, defies the dark shadows.

Ibn-Rushd and Mons Penck, the latter casting a triangular shadow eastward, are both situated between Kant and Theophilus. Most of Theophilus is already pitch black but Cyrillus and Catharina still show detail in their interiors and are well worth scrutinising. West of these three great craters, Dolland E, another little crater with a nimbus, draws attention to its neighbour, Descartes. To their south, crinkled and much darkened Rupes Altai is now difficult to discern but eternally surprised Sacrobosco is still easily identified. To its southeast is the complex of Zagut, Lindenau and Rabbi Levi. Much of their southeast neighbour, Riccius, is already dark. Büsching and Buch form a twin pair that points towards Maurolycus. The complicated region that lies west of Maurolycus and Sacrobosco, we leave for tomorrow night.

South of Maurolycus, two-eyed Clairaut is easily recognised. There are so many small craters in this region that many of them do not have individual proper names and only bear letter appellations. However, Breislak and Baco, east of Clairaut, should be noted, as should its southwest neighbour, Cuvier. Jacobi, further south, is easily recognised by the little chain of craterlets in its interior. Southeast of Jacobi, Mutus, Manzinus and Schomberger are merely dark ellipses. Between Jacobi and Schomberger, only Kinau, Pentland and Simpelius have been dignified with individual names.



Names of lunar formations							20.05-day-old Moon
Crater						**Mare – sea**	**Rima and rimae – rille(s)**
Agrippa	Büsching	Dollond E	Lindenau	Plinius	Tempel	Mare Imbrium	Rima Ariadaeus
Alexander	Calippus	Egede	Linné	Rabbi Levi	Theon Junior	Mare Serenitatis	Rima Calippus
Alfraganus	Catharina	Eudoxus	Manilius	Riccius	Theon Senior	Mare Tranquillitatis	Rima Hyginus
Anaxagoras	Clairaut	Godin	Manzinus	Ritter	Theophilus		
Aristoteles	Cuvier	Goldschmidt	Maurolycus	Sabine	W. Bond	**Mons and montes – mountain(s)**	
Baco	Cyrillus	Ibn-Rushd	Menelaus	Sacrobosco	Zagut	Mons Penck	**Rupes – scarp**
Barrow	Delambre	Jacobi	Meton	Schomberger	Zöllner	Montes Apenninus	Rupes Altai
Boscovich	Dembowski	Julius Caesar	Meton E	Simpelius		Montes Caucasus	
Breislak	Descartes	Kant	Mutus	Taylor		Montes Haemus	
Buch	Dionysius	Kinau	Pentland	Taylor A			

Photo A: Theophilus, Catharina and Cyrillus at sunset
Sacrobosco looks on in surprise. Ibn Rushd presents a bright east rim.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 15th Jun. 1998
Exp: 2 s (Nikon F3)
Sky condition: 3/10
Film: Kodak Ektachrome 400

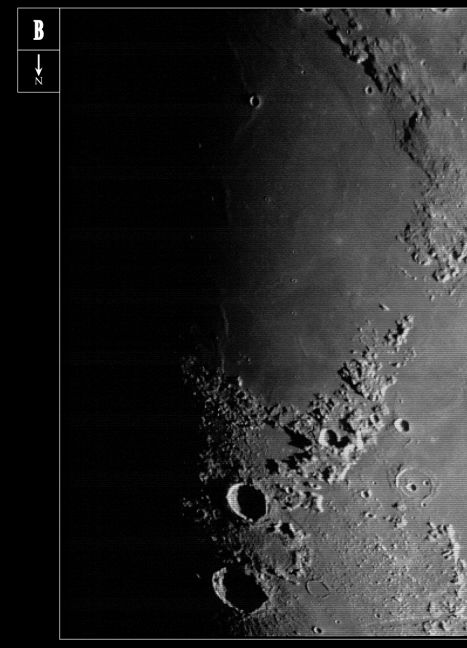


Photo B: Montes Caucasus and Cassini
Montes Caucasus form a highland finger separating Mare Serenitatis and Mare Imbrium. To their west, ruined Cassini, containing two craterlets, is easily recognised.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/4 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65
Date: 15th Jul. 1998 Sky condition: 7/10
Film: Kodak Ektachrome 400

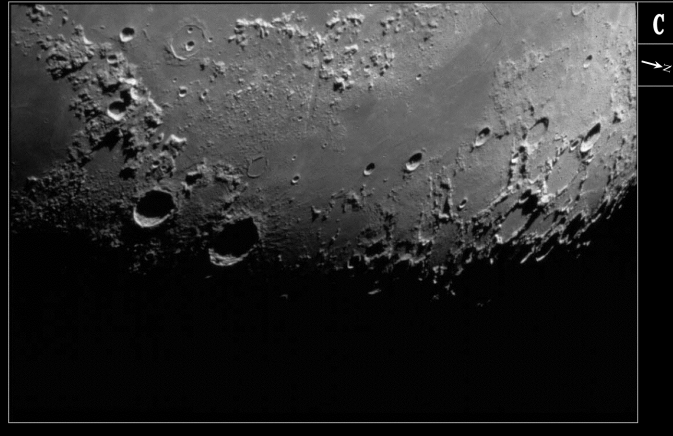
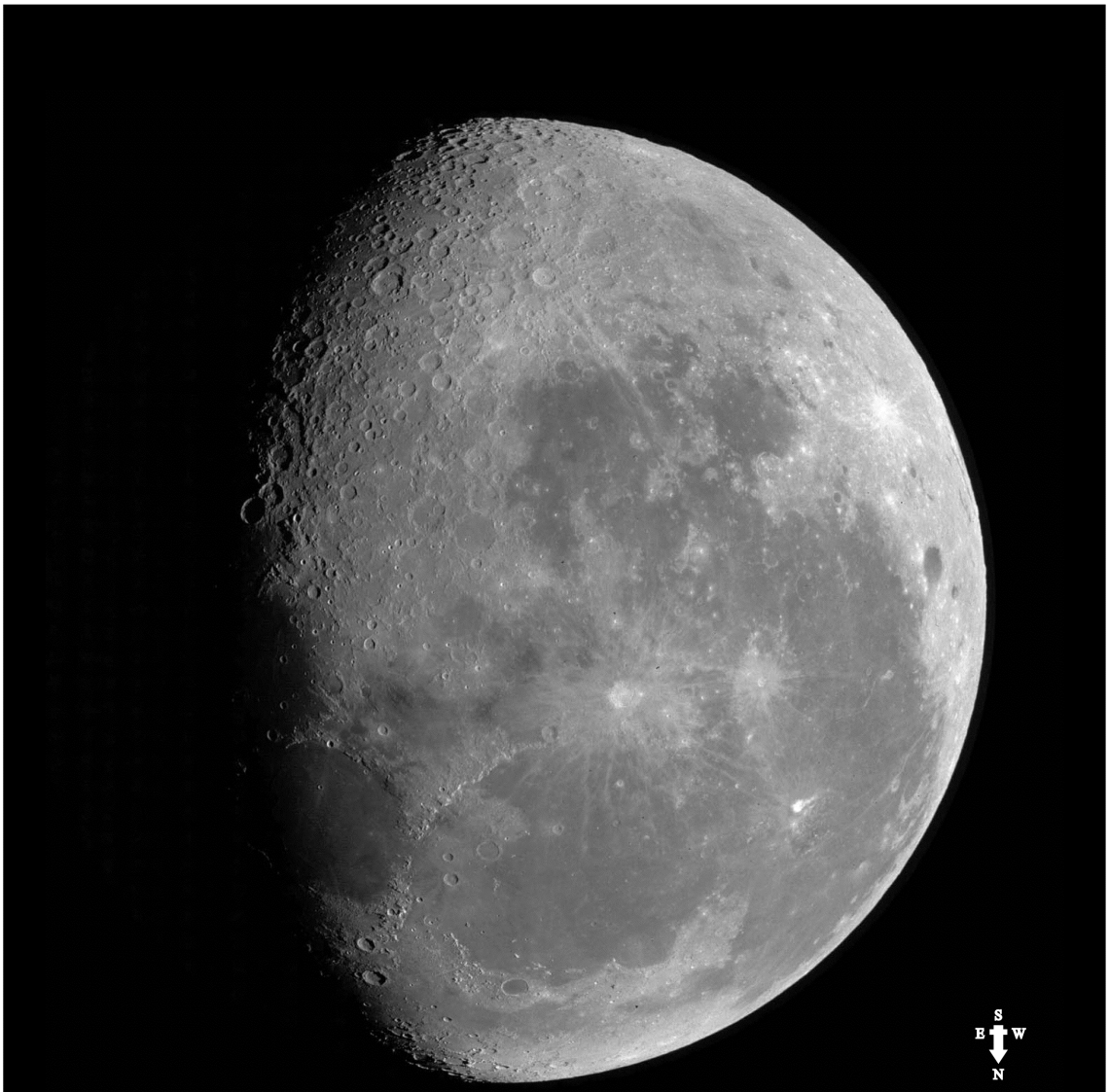


Photo C: Vallis Alpes
Vallis Alpes forms a gash in the Alps. Eudoxus and Aristoteles in the Caucasus are about to disappear into the night. W.Bond stands out among the old northern craters.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 15th Jul. 1998
Exp: 1/4 s (Nikon F3)
Sky: 7/10
Film: Kodak Ektachrome 400



Lunar data			**Photographic data**		
DTG (Local)	:	15 Jun. 98 (Mon.) 0438 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	14 Jun. 98 (Sun.) 2038 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 933	Exposure time	:	1/4 s (Pentax 67 camera)
Age	:	20.05-day-old Moon	Slide film (120)	:	Kodak Ektachrome 64
Illumination	:	77.4%	Sky condition	:	5/10 (10/10 being perfect)
Diameter/dist.	:	32′07″/378,144 km	Moon altitude	:	73°41′ from N horizon

The 21st-day Moon

Let's take a good look at Mare Imbium before it starts to disappear. To recap, the arc of the Carpathians, the Apennines and the Caucasus forms the south and east boundaries and the Alps the northern boundary. That northern boundary, however, seems to distort the shape of the mare, compressing it in a north–south direction. For a clue to the real nature of things, notice that the Straight Range (Montes Recti), Teneriffe mountains, Pico, Piton, Spitzbergen mountains and La Hire lie on an arc more or less concentric with the bounding mountain ranges. These mountains on the mare surface are the relicts of the almost-completely submerged innermost ring of the multi-ringed Imbrium basin. A large wrinkle ridge continues this arc northwards from Diophantus and Delisle through C. Herschel to Sinus Iridum. It is better seen a few nights later though. The mountainous mare boundary formed by the Montes Carpatus, Apenninus and Caucasus forms the outermost ring and this is continued along the northern boundary of Mare Frigoris. It should then be clear that the Alps represent the middle ring.

Return now to the terminator. In the extreme north, Peary, Byrd and Gioja have gouged out the north polar region. Immediately to their south, the overlapping pair of Main and Challis are very prominent. Scoresby, slightly larger than either, impinges on the southeast border of Challis. Continuing south, Meton is almost completely enveloped in darkness but Barrow is prominent, with the shadow of the west wall producing a large bulge on the floor. Recall large, old W. Bond and its young neighbour, Timaeus, perched on the shore of Mare Frigoris. On the mare itself, Archytas and Protagoras have regained prominence.

South of Mare Frigoris, Aristoteles and Eudoxus form an unusual pair of crescents. West of Aristoteles the low walls of ancient Egede are now well brought out by the oblique illumination. Similarly, the actual shapes of the ruined, low walls of Alexander are greatly exaggerated by the stark, sharp shadows they cast.

On Mare Serenitatis, a series of wrinkle ridges trace out a reasonably good approximation of the terminator line. One of them seems to pass through Bessel. Menelaus stands out in the Haemus mountains, at the southern boundary of the mare. You might be able to identify Rima Menelaus parallel to the mare boundary here. The name 'Menelaus' is so similar to 'Manilius' that it is only natural to look for that crater nearby in Mare Vaporum to the west.

The horsehoe of Julius Caesar is prominent here in the central highlands. Notice to its northeast two prominent grooves that are radial to Mare Imbrium. There are many other such here; the most conspicuous is some distance away, northeast of Herschel, easily recognised north of Ptolemaeus as it is the only crater there that shows some shadowing in its floor. Don't you think many of these grooves show a distinct resemblance to the Rheita and Snellius valleys? Both the Ariadaeus and Hyginus rilles are very well situated for study tonight. The Triesnecker rilles may be more difficult to see because of the glare but should become more easily identified towards morning.

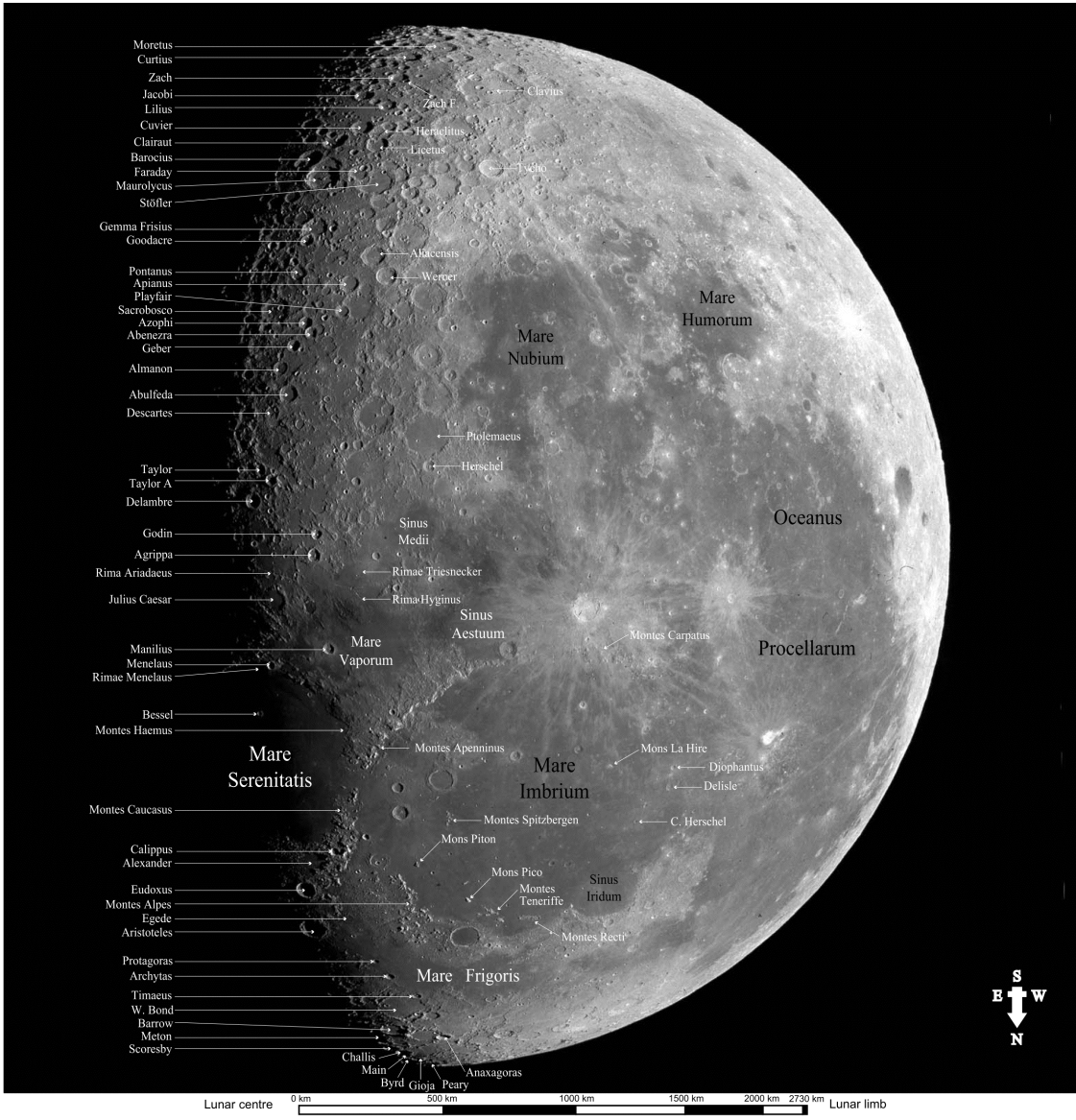
And so, once more into the southern highlands. Well, we've been here before and therefore the crater-fields should be much less difficult to sort out. Don't you believe it. There are so many craters here that this area is always a problem. It might be wise to define the visible boundaries first. The western boundary extends from Clavius through Tycho and then along the shore of Mare Nubium to Sinus Medii. There seems to be a natural division into two regions, with Maurolycus and Stöfler forming the dividing line south of which foreshortening becomes apparent.

Starting north(!) of the equator and just south of the rille complexes, Agrippa and Godin form a prominent pair of craters with central peaks. To their southeast, Delambre, Taylor and Taylor A create a prominent triangle with their bright eastern rims. A jump across ruined Descartes brings us to Abulfeda. Dark shadows from the west wall encroach on its brighter floor. The east wall contains a prominent terrace. To its south, look for Almanon and Geber. Although Geber is further from the terminator than Almanon, much more of its interior appears dark because of its greater depth and its bowl shape. Continuing south, recall the prominent pair Abenezra and its older partner Azophi. We now reach goggle-eyed and open-mouthed Sacrobosco, probably the most easily identified crater in this complex region, to their southeast.

Southwest of Abenezra–Azophi, two pairs of craters some distance from the terminator are beginning to show shadows from their western walls; the nearer pair comprises Playfair and Apianus and the further pair Werner and Aliacensis. Notice the bright ridge connecting the first pair that is formed by the conjoint wall of two old anonymous craters.

From Sacrobosco, three steps of approximately equal distance lead to old Pontanus, then Gemma Frisius and its northern interloper Goodacre, and finally, massive Maurolycus. The bright crest of Maurolycus' inner east wall is outstanding tonight. From there, the striated east wall slopes down to the crater floor with its bright central peak, soon to be engulfed by the shadow of the west wall. Much of Barocius, east of Maurolycus, is already dark but Stöfler, and its trespasser, Faraday, both west of Maurolycus, remains fully illuminated and not very conspicuous tonight.

South of Maurolycus, look for Clairaut with its two eyes. Correspondingly south of Stöfler is Licetus, and immediately south of that, Heraclitus, containing a central ridge whose west wall draws a dark line on the crater floor. Cuvier, east of Heraclitus, is already half dark. Further south, Lilius with its bright central peak is prominent. Jacobi, southeast of Lilius, has the shadows lapping at its six craterlets, while Zach, south of Lilius, has its neighbour, Zach F almost entirely in shadow except for a narrow eastern arc of brightness. The deep south is already dissolving into chaos but before calling it a night, take note of Curtius and Moretus, both large but severely foreshortened.



Names of lunar formations — **20.76-day-old Moon**

Crater
Abenezra
Abulfeda
Agrippa
Alexander
Aliacensis
Almanon
Apianus
Archytas
Aristoteles
Azophi
Barocius
Barrow
Bessel
Byrd
C. Herschel
Challis
Clairaut
Clavius
Curtius
Cuvier
Delambre
Delisle
Descartes
Diophantus
Egede
Eudoxus
Faraday
Geber
Gemma Frisius
Gioja
Godin
Goodacre
Heraclitus
Herschel
Jacobi
Julius Caesar
Licetus
Lilius
Main
Manilius
Maurolycus
Menelaus
Meton
Moretus
Peary
Playfair
Pontanus
Protagoras
Ptolemaeus
Sacrobosco
Scoresby
Stöfler
Taylor
Taylor A
Timaeus
Tycho
W. Bond
Werner
Zach
Zach F

Mare – sea
Mare Frigoris
Mare Imbrium
Mare Nubium
Mare Serenitatis
Mare Vaporum

Mons and montes – mountain(s)
Mons La Hire
Mons Pico
Mons Piton
Montes Alpes
Montes Apenninus
Montes Carpatus
Montes Caucasus
Montes Haemus
Montes Recti
(Straight Range)
Montes Spitzbergen
Montes Teneriffe

Rima and rimae – rille(s)
Rima Ariadaeus
Rima Hyginus
Rimae Menelaus
Rimae Triesnecker

Sinus – bay
Sinus Aestuum
Sinus Iridum
Sinus Medii

Vallis – valley
Vallis Rheita
Vallis Snellius

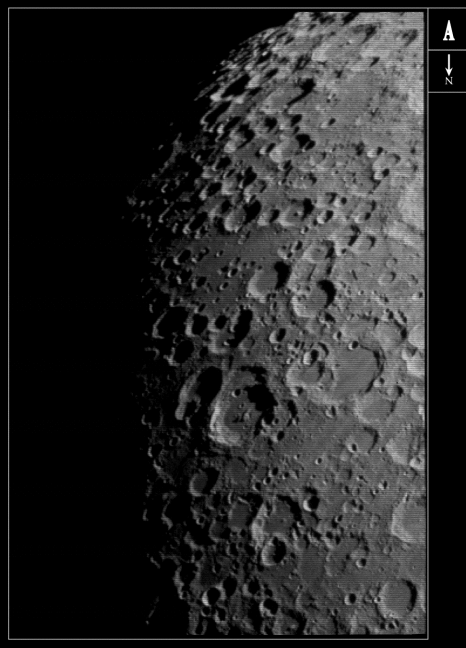


Photo A: Maurolycus and Stöfler
Amongst the southern crater fields, Maurolycus and Stöfler stand out. To their south, Licetus, Cuvier and Heraclitus D form an easily recognised triangle while Heraclitus contains an inner ridge.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/4 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65
Sky Condition: 7/10
Date: 15th Jul. 1998 Film: Kodak Ektachrome 400

Photo B: Plato and Mare Imbrium
Plato contains a dark and flooded floor, very reminiscent of the surface of adjoining Mare Imbrium. Mons Pico, Montes Teneriffe and Montes Recti (from east to west) are remnants of the inner ring formed by the Imbrium creation event.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/4 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65
Sky condition: 7/10
Date: 15th Jul. 1998 Film: Kodak Ektachrome 400

Photo C: Rima Ariadaeus, Hyginus and Triesnecker
Rima Ariadaeus and Rima Hyginus run approximatly east–west. Rima Triesnecker, in contrast, runs in a north–south direction.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 15th Jul. 1998
Exp: 1/2 s (Nikon F3)
Sky: 7/10
Film: Kodak Ektachrome 400

Lunar data

DTG (Local)	:	15 Jul. 98 (Wed.) 0611 hrs
DTG (UT)	:	14 Jul. 98 (Tue.) 2211 hrs
Lunation	:	No. 934
Age	:	20.76-day-old Moon
Illumination	:	69.3%
Diameter/dist.	:	32′48″/370,443 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/4 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	7/10 (10/10 being perfect)
Moon altitude	:	80°35′ from N horizon

The 22nd-day Moon

Third quarter Moon tonight marks the last lap, but this is the most trying part of any lunation. Moonrise occurs at midnight and that means that observations cannot begin much before 3 a.m., a truly horrible hour.

The terminator has definitely taken a bite out of Mare Imbrium and both the Apennines and Alps have been truncated, with the loss of Alpine Valley. Watching the lengthening shadows in Plato's floor reinforces the sombre mood and one can't help feeling that things are drawing slowly to a close. On the mare surface, the three Greeks, Aristillus, Autolycus and Archimedes, are also feeling the touch of the shadow. Bright Piton and Pico, however, provide some cheer. Nevertheless, it is a good time to try and identify the rilles at the edge of the mare – Rima Archimedes, in particular, standing out well. Look for the outline of Wallace east of the midpoint of a line joining Eratosthenes and Timocharis. Between Timocharis and Archimedes, Beer and Feuillée form a matched pair of small craters, while Bancroft, of similar size, lies adjacent to Archimedes.

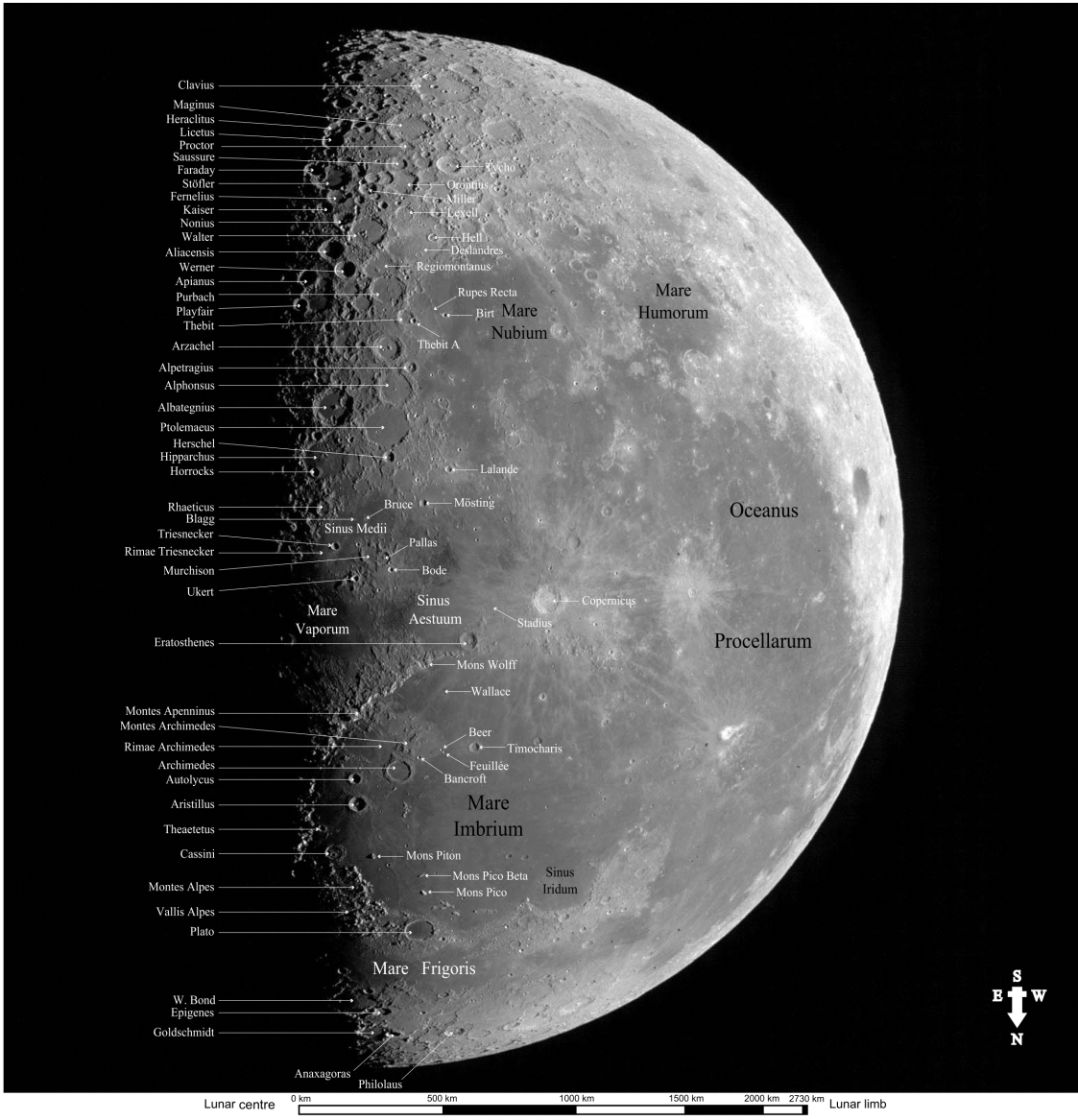
Across Mare Frigoris, W. Bond is almost completely lost except for the shared wall with Epigenes. Further north, Goldschmidt and Anaxagoras form a striking study in light and shade. Can you see the central point of light in the latter as its central peak struggles to hold on to the light? Further east, Philolaus with its central peak and terraced walls continues to show interior detail.

Follow the Apennines to Eratosthenes and Copernicus, taking note again of the many radial grooves created in the mountains by ejecta from the Imbrium impact event. Mons Wolff lies west of the nearest of the gashes to Eratosthenes. It's a good night to study Eratosthenes as it shows much more detail than Copernicus, which remains bleached by the high light. Even here, however, the bright cobwebby Copernican rays are beginning to fade. A useful landmark to remember here is the short mountain range southwest of Eratosthenes that leads to submerged Stadius.

Near mid-terminator, the Murchison–Pallas pair immediately catch the eye. Triesnecker, Ukert and Bode form a trio of bright rings that surrounds them. In Sinus Medii, little Blagg and Bruce are about to disappear into the night.

Shadows are creeping eastwards along the floors of Ptolemaeus, Alphonsus and Arzachel. This is most obvious in Arzachel where they have reached the central peak. That peak also casts an eastward shadow, but it is outclassed by the long spike caused by the central peak in Alphonsus. Look also for the double ridge running north from the central peak to the crater rim there. Before leaving this chain, look at Alpetragius – it's an interesting abstract study in black and white. The central peak and its shadow are dark and light reversed compared with the two halves of the crater floor. An interesting set of grooves runs approximately north–south in the highlands west of Ptolemaeus from the northwest rim of Alphonsus to Lalande.

Thebit and Birt straddle the sword of the Straight Wall (Rupes Recta), now bright instead of dark. It's a good night to study the innards of Purbach, Regiomontanus and Walter. Note how large Deslandres really is, although Clavius to the south is even larger. Hell and Lexell are the most prominet craterlets in Deslandres. Before you leave the Moon tonight, can you see the shadow image of Elvis inside Orontius, between Deslandres and Maginus? As a supreme insult, the setting Sun has reduced Tycho to being merely one crater among many in the southern highlands.



Names of lunar formations							21.73-day-old Moon
Crater Alpetragius Alphonsus Anaxagoras Archimedes Aristillus Arzachel Autolycus Bancroft Beer	Birt Blagg Bode Bruce Clavius Copernicus Deslandres Epigenes Eratosthenes	Feuillée Goldschmidt Hell Lalande Lexell Maginus Mösting Murchison	Orontius Pallas Philolaus Plato Ptolemaeus Purbach Regiomontanus Stadius	Timocharis Thebit Triesnecker Tycho Ukert W. Bond Wallace Walter (Walther)	**Mare – sea** Mare Frigoris Mare Imbrium **Mons and montes – mountain(s)** Mons Pico Mons Piton Mons Wolff Montes Alpes Montes Apenninus	**Promontorium – promontory** Prom. Laplace **Rima and rimae – rille(s)** Rimae Archimedes	**Rupes – scarp** Rupes Recta (Straight Wall) **Sinus – bay** Sinus Medii **Vallis – valley** Vallis Alpes (Alpine Valley)

DAY 22

Lunar data			**Photographic data**		
DTG (Local)	:	15 Aug. 98 (Sat.) 0420 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	14 Aug. 98 (Fri.) 2020 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 935	Exposure time	:	1/2 s (Pentax 67 camera)
Age	:	22.27-day-old Moon	Slide film (120)	:	Kodak Ektachrome 64
Illumination	:	49.9%	Sky condition	:	5/10 (10/10 being perfect)
Diameter/dist.	:	32′37″/371,115 km	Moon altitude	:	49°11′ from N horizon

Lunar data

DTG (Local)	:	16 Jul. 98 (Thu.) 0515 hrs
DTG (UT)	:	15 Jul. 98 (Wed.) 2115 hrs
Lunation	:	No. 934
Age	:	21.73-day-old Moon
Illumination	:	58.7%
Diameter/dist.	:	32′51″/369,826 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	6/10 (10/10 being perfect)
Moon altitude	:	72°17′ from N horizon

The 23rd-day Moon

There's no doubt about the most conspicuous object on the Moon tonight – Copernicus wins by miles. The ray pattern has vanished but the floor is completely illuminated, the multiple central peaks well-defined, the east wall bright and the west wall just starting to darken. One can easily see that the crater rim is elevated above the surroundings. Return to it regularly throughout tonight's session to see the shadows lengthening in its floor. A conspicuous string of craterlets, created by secondary impacts from Copernicus ejecta flung east of their parent, lies south of the relict west rim of Stadius. The chain ends at the gap between the Apennines and the Carpathians.

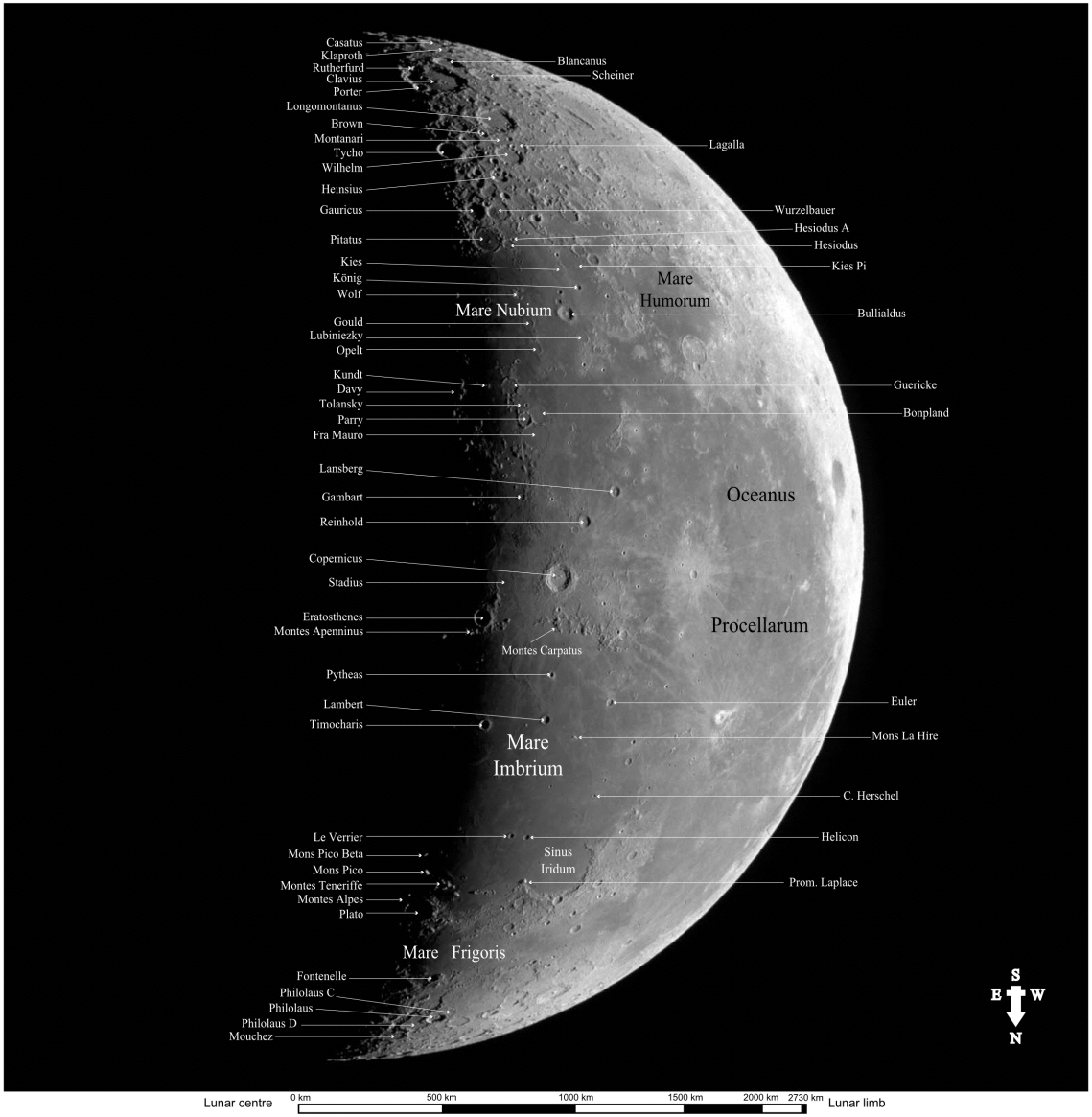
Now it's time to start our systematic observations in the north again. The many old craters in the extreme north are dissolving into bright jigsaw patterns. Most obvious still is sharp-edged Philolaus, its two central peaks casting triangular shadows eastwards. Its elderly eastern neighbour, Philolaus D, shows to advantage in this lighting. A smaller crater separates it from similarly ancient Mouchez to its north. Philolaus has also partially replaced another old crater, Philolaus C, whose remnants are visible west of Philolaus itself. Fontenelle, on the southern shore of Mare Frigoris, appears almost on the same longitude as Philolaus and yet, so much more of its interior is dark compared with Philolaus. Once again you have to remember that the Moon is a sphere so that meridians of longitude are actually arcs and not straight lines. This means that Fontenelle is actually further east than Philolaus. Before leaving this region, take note of the wrinkle ridge that runs across the mare floor into the terminator, like smoke rising from a chimney.

In the Alps, Plato is a bite in the terminator, its only vestige being part of the east rim. Also struggling to remain above the darkness are Pico and Pico Beta. A similar fate will soon befall the Teneriffe mountains. Timocharis, Lambert and Euler provide an interesting contrast in light and shade on the mare surface. Easternmost Timocharis has a dark interior and a bright east rim; Lambert is at the half-and-half stage with its central peak just beyond the shadow and westernmost Euler is only just beginning to darken at the base of its west wall. Pytheas, south of Lambert, shows as a complete bright ring with an inky interior. Between Timocharis and Lambert, another isolated bright mountain, Mons La Hire, yet another relic of the inner ring of the Imbrium basin, rises from the mare surface like its counterpart northwest of Lambert. And tonight, the completion of the inner ring by a wrinkle ridge can be easily traced from La Hire through little C. Herschel to Promontorium Laplace. Look how the west face of the promontory reflects the Sun. Before we leave the mare, take another look at Le Verrier and Helicon.

Reinhold and Lansberg remain prominent southwest of Copernicus. Both have terraced walls but while Reinhold contains a central craterlet, Lansberg has an obvious central mountain. In contrast to these two young craters, Gambart, southeast of Copernicus is old. Even older are the components of the Fra Mauro complex to its south. Notice how delicate Fra Mauro and Bonpland are compared with their compatriot, Parry. Guericke, to their southeast, is also fairly conspicuous in this lighting. It lies at the centre of a triangle formed by three little craters: Tolansky, adjacent to Parry; Kundt between Guericke and Davy, now merely a bright arc on the terminator; and an anonymous crater at the southernmost vertex of the triangle.

On Mare Nubium, the Copernicus look-alike, Bullialdus, has no equal. Of the three craters that arc southwestwards from it, only the southernmost, König, has been dignified with its own name. Many ghost rings disrupt the mare surface. Wolf, Gould and Opelt lie east of Bullialdus and show their bright west rims to advantage. Kies and Lubiniezky are separated by Bullialdus. If you haven't seen the dome Kies Pi before, tonight's a good night to try again. At the southern apex of the mare, look at the flooded floor of Pitatus. Similarly flooded Hesiodus is to its west. The really noteworthy object here, however, is little Hesiodus A, with its great resemblance to a target.

Contrast Gauricus and Wurzelbauer immediately southeast of Hesiodus. Much of the interior of Gauricus has been darkened but look at the mottled insides of Wurzelbauer. To the south, Tycho is but a bright eastern arc, its interior being completely dark. Old Wilhelm, to its west, however, is surprisingly prominent. Its neighbours, Montanari and Lagalla, although even more ancient, also show surprisingly well in this lighting. Compare Longomontanus and Clavius. The former has shadows in its west floor while the eastern portion remains well illuminated; Clavius, however, has a dark eastern floor! This can only mean that the floor of Clavius is distinctly convex, so that its eastern half is lower than the centre and therefore poorly illuminated. Blancanus and Scheiner, adjacent to Clavius, form another striking pair tonight. Finally, squeezed between Blancanus and the limb, look at the Klaproth–Casatus pair. You should just be able to see the low wall that separates them.



Names of lunar formations — **23.31-day-old Moon**

Crater
Blancanus
Bonpland
Bullialdus
C. Herschel (Caroline)
Casatus
Clavius
Copernicus
Davy
Euler
Fontenelle
Fra Mauro
Gambart
Gauricus
Gould
Guericke
Helicon
Hesiodus
Hesiodus A
Kies
Klaproth
König
Kundt
Lagalla
Lambert
Lansberg
Le Verrier
Longomontanus
Lubiniezky
Montanari
Mouchez
Opelt
Parry
Philolaus
Philolaus C
Philolaus D
Pitatus
Plato
Pytheas
Reinhold
Scheiner
Stadius
Timocharis
Tolansky
Tycho
Wilhelm
Wolf
Wurzelbauer

Mare – sea
Mare Frigoris
Mare Imbrium
Mare Nubium

Mons and montes – mountain(s)
Kies Pi (dome)
Mons La Hire
Mons Pico
Mons Pico Beta
Montes Alpes
Montes Apenninus
Montes Carpatus
Montes Teneriffe

Promontorium – promontory
Prom. Laplace

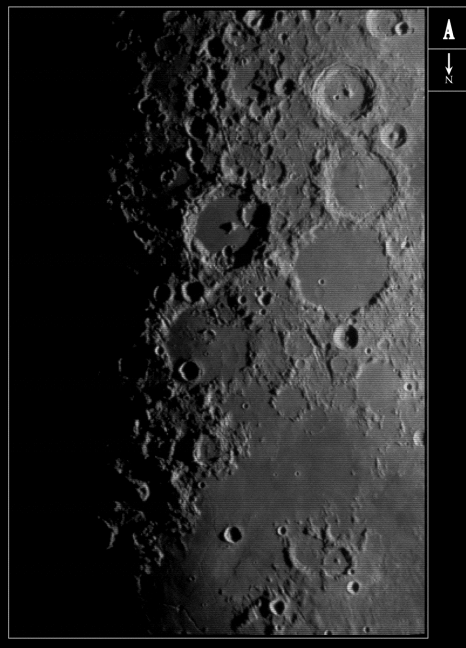


Photo A: Ptolemaeus, Alphonsus and Arzachel
From north to south, and decreasing in size, Ptolemaeus, Alphonsus and Arzachel form a prominent triad in the Moon's central regions. Hipparchus, Albategnius and Parrot are almost as conspicuous just to their east.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/2 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 5/10
Date: 16th Jul. 1998 Film: Kodak Ektachrome 400

Photo B: Mare Nubium and Pallus Epidemiarum
Bullialdus stands out on the surface of Mare Nubium. In Palus Epidemiarum, Capuanus forms a pot-bellied stick figure. Rima Hesiodus runs in a straight line from Hesiodus on Mare Nubium to Capuanus.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1/2 s (Nikon F3)
2× Barlow projection yielding f/39 Sky condition: 7/10
Date: 20th May 1998 Film: Kodak Elite II - 400

Photo C: Wrinkle ridges on Mare Imbrium
Lambert, Le Verrier and Helicon fill up with darkness as the Sun sets on Mare Imbrium. Several wrinkle ridges are prominent. The inner Imbrium ring can be traced from Mons la Hire to C. Herschel (at right edge of photograph) and then between Le Verrier and Promontorium Laplace to Montes Recti.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
2× Barlow projection yielding f/39 Sky condition: 7/10
Date: 20th May 1998 Film: Kodak Elite II - 400

Lunar data

DTG (Local)	:	16 Aug. 98 (Sun.) 0515 hrs
DTG (UT)	:	15 Aug. 98 (Sat.) 2115 hrs
Lunation	:	No. 935
Age	:	23.31-day-old Moon
Illumination	:	38.2%
Diameter/dist.	:	32′22″/373,820 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	8/10 (10/10 being perfect)
Moon altitude	:	48°33′ from N horizon

The 24th-day Moon

Copernicus remains outstanding tonight, sited as it is close to the centre of the terminator. It's at the half-and-half stage and the interior details are striking. West of Copernicus, Kepler, with its surrounding ray system, provides a contrast and illustrates how the appearance of craters varies depending on the angle of illumination.

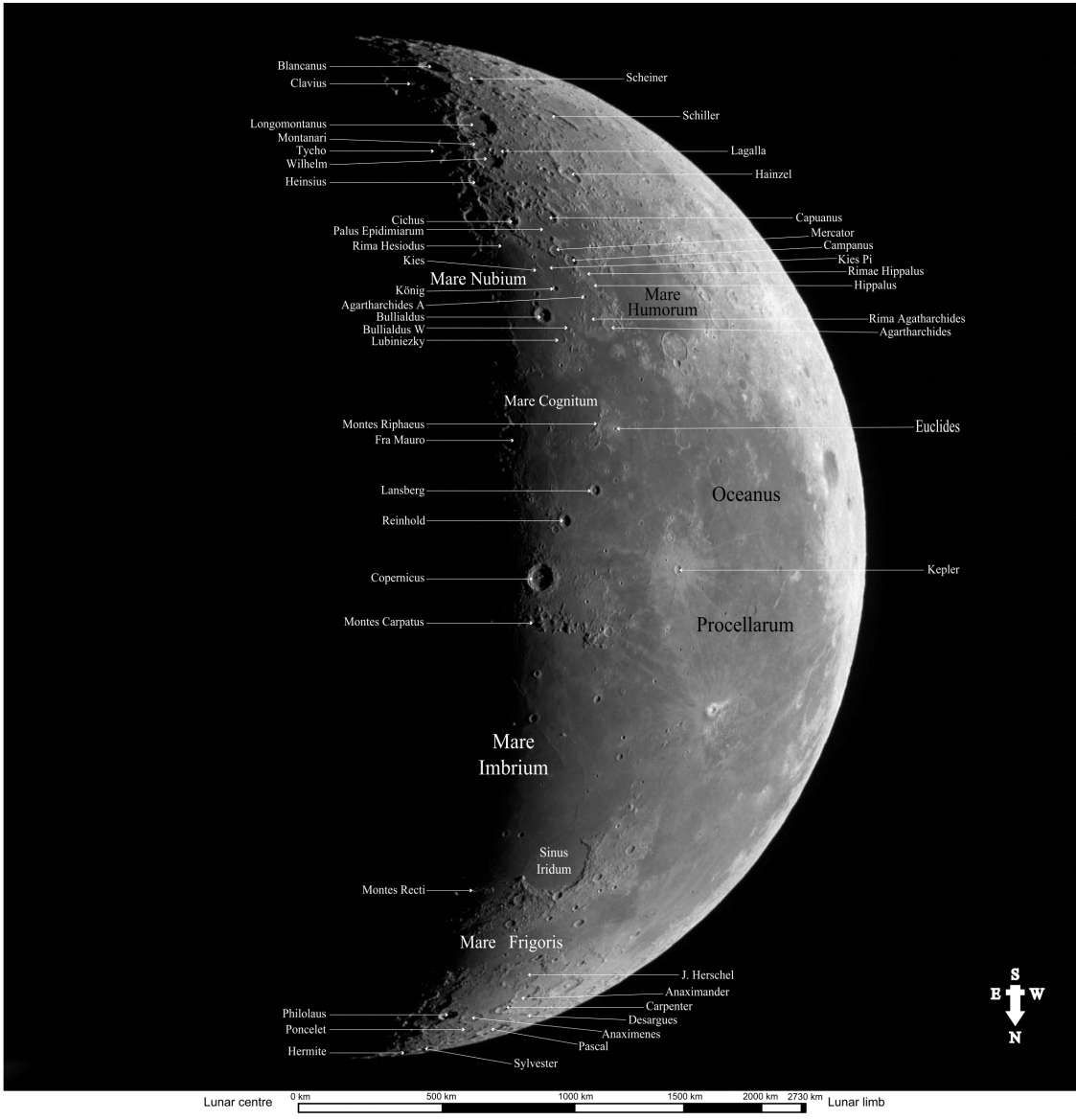
In the extreme north, Philolaus, with its double central peak, remains an apparently eternal landmark. The three craters Philolaus, Anaximenes and Carpenter form an easily recognised feature running from east to west in this limb region. Two prominent craters, Hermite and Sylvester, both unfortunately very markedly foreshortened, lurk on the limb north of Philolaus. Their proper identification will require a favourable libration. To their west, identify low-walled Poncelet, north of Anaximenes, and then look for Pascal and Desargues. Their most prominent features are the shadows lengthening in their floors. Carpenter, at the western edge of the Anaximander complex, appears as a trilobed structure with a prominent dark V formed by the shadows cast by the western walls of Anaximander itself. South of this complex is monstrous J. Herschel. Both these craters will look better tomorrow night.

A good observing night will show that the apparently smooth surface of Mare Frigoris is actually marred by numerous small craterlets and irregularities. On Mare Imbrium, many wrinkle ridges meander across the surface. Also, the mare surface is distinctly mottled with ill-defined paler foci standing out from the surrounding darker areas. Sinus Iridum is clearly just a large crater whose south wall has been overrun by the Imbrium lavas. To its east, looking like a diamond necklace carelessly strewn on the dark mare surface, glitters the Straight Range, Montes Recti.

The western Carpathians, north of Copernicus, are worth a close look tonight. Their most prominent mountain massifs are elongated roughly north–south. You might also be able to see several domes. Proceeding south from Copernicus, jumping over Reinhold and Lansberg, we reach Montes Riphaeus and Euclides, another little crater, like Linné, with a surrounding bright nimbus. East of the Riphaean mountains, extending to the Fra Mauro complex on the terminator, is Mare Cognitum. An isolated, anonymous, north–south elongated mountain catches the Sun and the eye here.

Bullialdus still stands out in Mare Nubium. It bears a resemblance to a compass, with the ridge that runs from the central peak to the south wall serving as the compass needle. An ill-defined, rather broad and shallow valley, Bullialdus W runs southwest from the crater. Just southwest of Lubiniezky, a curved wall intersects the valley and looks remarkably like a bridge across it. South of Bullialdus, identify again König, Kies and Kies Pi and then look for the goggle-eyed pair Mercator and Campanus between Mare Nubium and Palus Epidimiarum. Midway between Campanus and Kies Pi is another dome. A narrow dark rille runs from the mare through this dome and then passes between Mercator and Campanus into Palus Epidimiarum. More prominent than this is Rima Hesiodus, cutting a chord in Mare Nubium and then also proceeding into Palus Epidimiarum. Rima Hesiodus ends just north of Capuanus, a crater that bears a resemblance to a diseased, potbellied figure with stick legs. There must be some penalty for residing in Palus Epidimiarum, the Marsh of Disease. There are more rilles to see before leaving this area – the Hippalus rille complex arcs through the rough are northwest of Campanus and then through Hippalus itself. One of the rilles passes through Agatharchides A and may continue east of ruined Agatharchides as Rima Agatharchides.

Not much is left of Clavius tonight and nothing of Tycho. Longomontanus, however, still survives and can be seen to have intruded on an older crater, the remnant of which lies to its east. To its north, the Wilhelm–Montanari–Lagalla complex is conspicuous. Elongated Hainzel has reappeared to their west. Often thought to be double, it is easily seen tonight to be triple. If Hainzel has reappeared, then so must have its elongated sibling, Schiller, west of Longomontanus. Finally, look again at Scheiner and Blancanus southwest of Clavius.



Names of lunar formations — **23.77-day-old Moon**

Crater
Agartharchides
Agartharchides A
Anaximander
Anaximenes
Blancanus
Bullialdus
Bullialdus W
Campanus
Capuanus
Carpenter
Clavius
Copernicus
Desargues
Euclides
Fra Mauro
Hainzel
Hermite
Hippalus
J. Herschel
Kepler
Kies
König
Lagalla
Lansberg
Longomontanus
Lubiniezky
Mercator
Montanari
Pascal
Philolaus
Poncelet
Reinhold
Scheiner
Schiller
Sylvester
Tycho
Wilhelm

Mare – sea
Mare Cognitum
Mare Frigoris
Mare Imbrium
Mare Nubium

Mons and montes – mountain(s)
Kies Pi (dome)
Montes Carpatus (Carpathians)
Montes Recti (Straight Range)
Montes Riphaeus (Riphaen mountains, also called Ural Mountains)

Palus – marsh
Palus Epidimiarum

Rima and rimae – rille(s)
Rima Agatharchides
Rima Hesiodus
Rimae Hippalus

Sinus – bay
Sinus Iridum

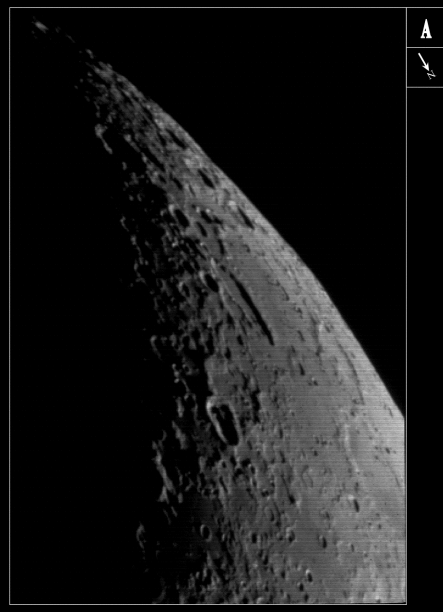


Photo A: Schiller and Schickard
Schiller and Mee are two easily-recognised elongated structures in the southwest limb region. Schiller points towards vast Schickard.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
24 mm XP eyepiece projection yielding f/65 Sky condition: 4/10
Date: 19th Jul. 1998 Film: Kodak Ektachrome 400

Photo B: Copernicus
If there is a contest to be the crown-jewel of the Moon, Copernicus must be one of the main contenders. Montes Carpatus fringe it on the north. Gay-Lussac lies within the mountains while Rima Gay-Lussac is prominent on the adjoining mare surface.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
2× Barlow projection yielding f/39 Sky condition: 7/10
Date: 20th May 1998 Film: Kodak Ektachrome 400

Photo C: Sinus Iridum and Mare Frigoris
Sinus Iridum is a prominent outpouching into the highlands separating Mare Imbrium and Mare Frigoris. Promontorium Laplace and Promontorium Heraclides are its eastern and western apices. In the correct lighting, just after sunrise, the latter takes on the appearance of a long-haired woman, the celebrated Moon Maiden. Across Mare Frigoris, J. Herschel is the largest crater in the picture.

Photographic data
Instr: 40-cm f/13 Cassegrain Exp: 1 s (Nikon F3)
2× Barlow projection yielding f/39 Sky condition: 7/10
Date: 20th May 1998 Film: Kodak Ektachrome 200

Lunar data

DTG (Local)	:	18 Jul. 98 (Sat.) 0625 hrs
DTG (UT)	:	17 Jul. 98 (Fri.) 2225 hrs
Lunation	:	No. 934
Age	:	23.77-day-old Moon
Illumination	:	35.4%
Diameter/dist.	:	32′46″/370,176 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	5/10 (10/10 being perfect)
Moon altitude	:	62°12′ from N horizon

The 25th-day Moon

The twenty-fifth day and the Moon is a distinct waning crescent. Unfortunately, the term 'waning crescent' is a self-contradiction and the Moon in this phase (as any music student will know) should actually be referred to as being 'decrescent'.

Now that Copernicus has disappeared and Sinus Iridum is disappearing, what shall we look at tonight? There are two obvious choices – Aristarchus in the north and Gassendi in the south. There are, however, enough objects left that the systematic way is still the method of choice.

As usual, we begin in the north where the angle of illumination tonight brings out the low relief of the old craters here to advantage. Easily delineated is the pentagon formed by the trilobed Carpenter–Anaximander complex, J. Herschel, South, Babbage and Pythagoras. The last-named, with its terraced walls and central peak, is a good landmark to replace Philolaus. Babbage contains within its low walls the contrasting young craterlet, Babbage A. Horrebow encroaches on the walls of J. Herschel while little Robinson lies between South and J. Herschel. Attached to Babbage on the west is equally ruined Oenopides.

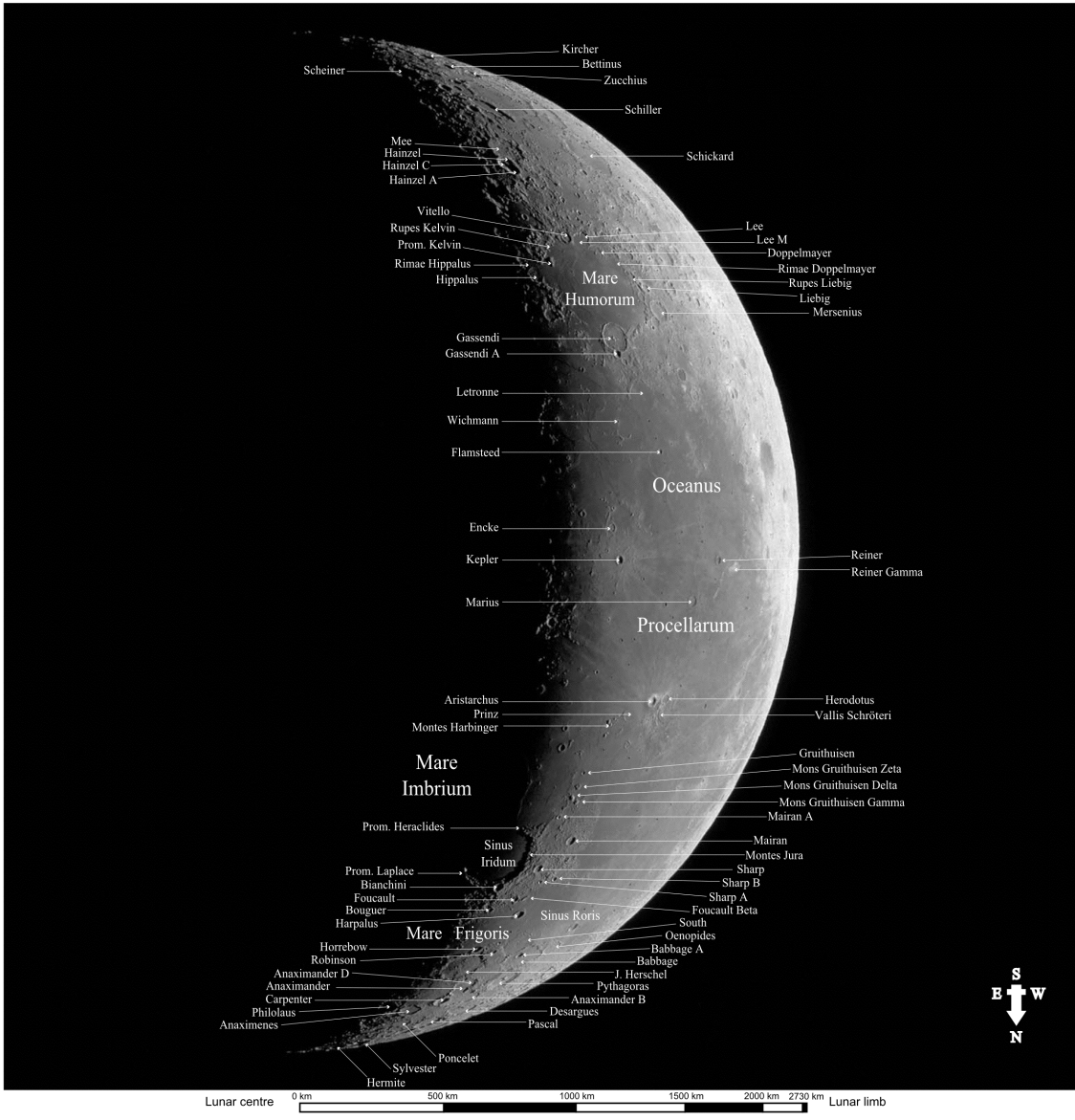
Triangular figures abound here in Mare Frigoris and the Jura mountains. Harpalus, Foucault and Bouguer form one such with a right-angle at Foucault. Foucault Beta, an isolated mountain ridge, lies just to its west. Another larger, but oppositely orientated triangle is formed by Harpalus, Bianchini and Sharp. Sharp eyes may discern here a short arc that is a little valley leading south from Sharp to Sharp A. The westernmost crater in the mountains is Mairan. Immediately to its south, on the shores of Oceanus Procellarum, the domes Gruithuisen Gamma and Delta are now very conspicuous, as is the mountain massif Gruithuisen Zeta. Before we venture further, however, take a last lingering look at Sinus Iridum and the lengthening shadows there.

Three features provide much needed orientation on the vastness of Oceanus Procellarum. Most conspicuous, and northernmost, is Aristarchus and the Herodotus–Vallis Schröteri complex. The other two more southerly objects, Kepler and Reiner Gamma, lie on the same line of latitude. Aristarchus still shines, though not with the same harsh intensity as before. As the night progresses, it will rapidly lose lustre and its interior sink into Stygian darkness. Vallis Schröteri stands out as a conspicuous curved arc northwest of Aristarchus. Herodotus is clearly not its point of origin. If you look carefully, you can see that the complex forms part of a diamond-shaped plateau, the Aristarchus uplift, which rises from the surface of Oceanus. For the sake of completeness, note partially submerged Prinz and the Harbinger mountains northeast of Aristarchus.

On the way to Kepler, pause at Marius. As the night wears on, the hilly region to its north will become more obvious as an irregular area that contrasts with the smoothness of the surrounding lava flows. Much of Kepler's interior is shrouded in darkness but note how it hurls a ray west towards Reiner and Reiner Gamma. Kepler's northeastern neighbour, Encke, is a bit of a surprise because its floor still remains clearly visible and is distinctly uneven. Southern Oceanus Procellarum is a haven for incomplete and ghost rings. Encke lies within a large one and another lies immediately west. Further south, Flamsteed, the only conspicuous crater in this region, also lies within another example. Two more lie along a line that extends southeast from Flamsteed. Note little Wichmann at the tip of one of the ridges formed by the one nearer to Flamsteed. Perhaps the best example is Letronne, situated adjacent to the mountains that fringe the southern shore. If the lighting is correct, you might even be able to see Letronne's central peak, lying on a wrinkle ridge that bisects the crater.

Mare Humorum is the last complete mare that you'll be able to see in any lunation and tonight is the last night that you can see it complete. Just as Sinus Iridum draws the attention in Mare Imbrium, Gassendi catches the eye in Mare Humorum. Its central peak is triple and the floor, though flooded, distinctly uneven. Good lighting and good eyes will detect several rilles in the floor. Doppelmayer, also flooded, lies on the opposite side of the mare. Its rille system, Rimae Doppelmayer, runs northwards, from west of the crater, more-or-less parallel to the mare boundary. More prominent, however, is Rupes Liebig, also parallel to the west margin of the mare. Adjacent to Doppelmayer, recall Lee M, Lee and Vitello. Rupes Kelvin, a fault, runs parallel to the eastern boundary of the mare towards Hippalus and is also parallel to the Hippalus rilles. Promontorium Kelvin catches the setting Sun and casts a triangular shadow eastwards.

Entering the southern highlands, Hainzel is mostly dark but its elderly neighbour, Mee, is an interesting sight. Schiller is conspicuous and draws the eye toward reappearing Schickard. Lastly, identify the dark streaks Zucchius, Bettinus and Kircher in the extreme south.



Names of lunar formations							24.79-day-old Moon
Crater Anaximander Aristarchus Babbage Babbage A Bettinus Bianchini Bouguer Carpenter Doppelmayer	Encke Flamsteed Foucault Gassendi Hainzel Harpalus Herodotus Hippalus Horrebow	J. Herschel Kepler Kircher Lee Lee M Letronne Mairan Marius Mee	Oenopides Philolaus Prinz Pythagoras Reiner Robinson Schickard Schiller Sharp	Sharp A South Vitello Wichmann Zucchius	**Mare – sea** Mare Frigoris Mare Humorum Mare Imbrium **Mons and montes – mountain(s)** Mons Foucault Beta Mons Gruithuisen Delta Mons Gruithuisen Gamma Mons Gruithuisen Zeta Montes Harbinger Montes Jura	**Oceanus – ocean** Oceanus Procellarum **Promontorium –promontory** Prom. Kelvin **Rima and rimae – rille(s)** Rimae Doppelmayer Rimae Hippalus	**Rupes – scarp** Rupes Kelvin Rupes Liebig **Sinus – bay** Sinus Iridum **Vallis – valley** Vallis Schröteri **Others** Reiner Gamma (swirl)

DAY 25

Lunar data			**Photographic data**		
DTG (Local)	:	22 May 98 (Fri.) 0623 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	21 May 98 (Thu.) 2223 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 932	Exposure time	:	1 s (Pentax 67 camera)
Age	:	25.44-day-old Moon	Slide film (120)	:	Kodak Ektachrome 64
Illumination	:	20.6%	Sky condition	:	2/10 (10/10 being perfect)
Diameter/dist.	:	33′08″/364,697 km	Moon altitude	:	40°56′ from N horizon

Lunar data

DTG (Local)	:	19 Jul. 98 (Sun.) 0644 hrs
DTG (UT)	:	18 Jul. 98 (Sat.) 2244 hrs
Lunation	:	No. 934
Age	:	24.79-day-old Moon
Illumination	:	24.7%
Diameter/dist.	:	32′38″/371,181 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	4/10 (10/10 being perfect)
Moon altitude	:	53°07′ from N horizon

The 26th-day Moon

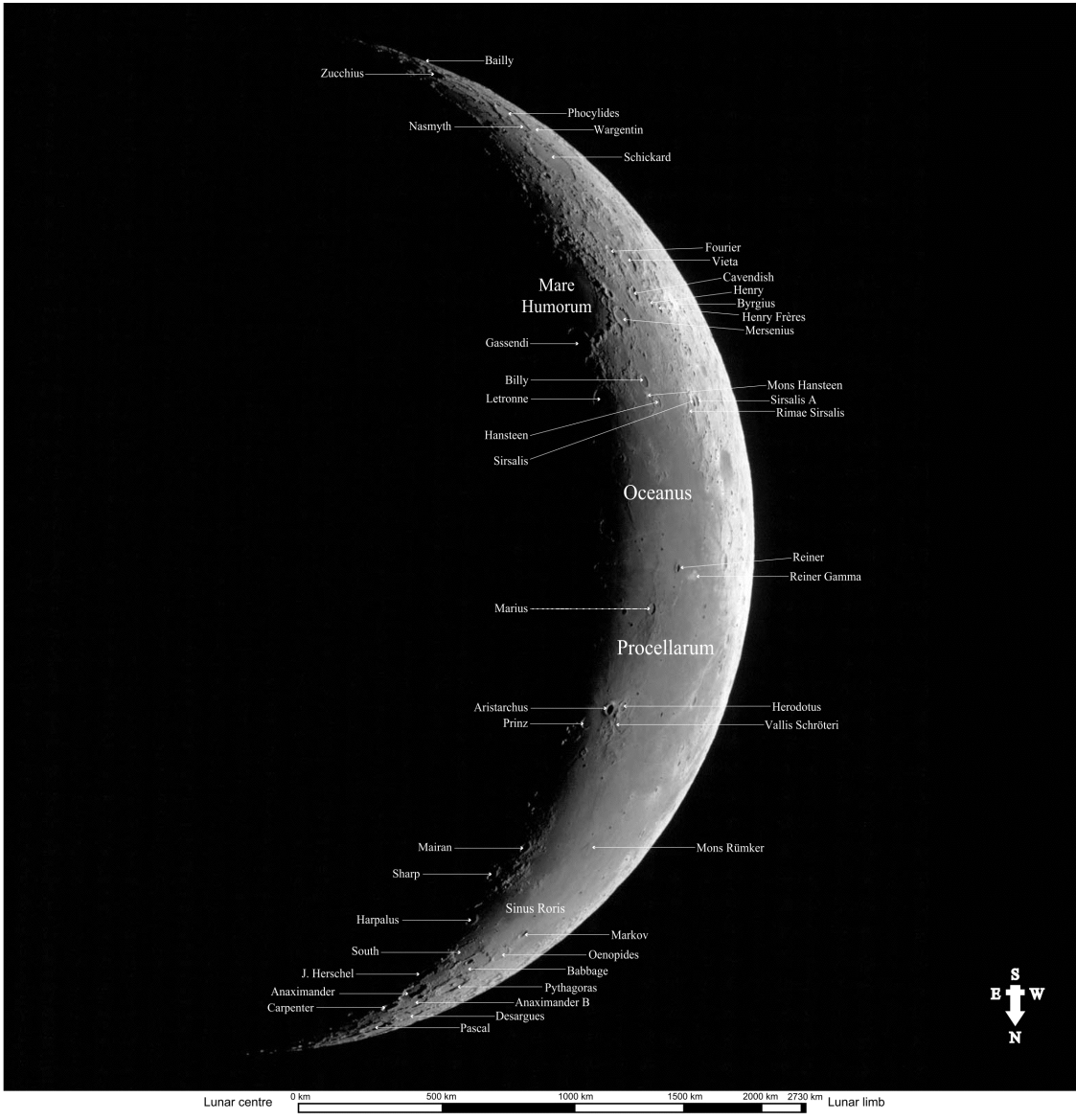
This 26th day of the lunation is dominated by vast Oceanus Procellarum. It doesn't contain many craters and the glare on the west limb hasn't decreased enough to show them well. These two factors mean that there isn't really much to see this morning. Note, however, that Earthshine is back.

In the north, the terminator has swallowed J. Herschel and left last night's pentagon incomplete. The Anaximander complex will soon suffer the same fate. Compare Markov to Oenopides to see what crater depth can do to appearance. Although Oenopides lies further west, the whole of its interior is still visible. In contrast, Markov, because it has higher walls, is already beginning to show the touch of the shadow. Mons Rümker is reappearing again west of Mairan but you might have to look a bit to detect it. The interior of Aristarchus is completely dark and all that remains of its previous splendour is the bright east rim. Herodotus and Schroter's valley resemble a spermatozoon. Look quickly at the hills next to Marius and at Reiner and Reiner Gamma.

You should be able to see the central peak in Letronne tonight. Billy and Hansteen to its west again offer a contrast in colour but, as their floors darken, they will look more and more alike. Bright Mons Hansteen lies between them. Still further west, Sirsalis and Sirsalis A are beginning to show some detail. Unfortunately, the glare may still blot out the Sirsalis rille.

Gassendi, so impressive last night, is almost completely lost. Look closely at Mersenius to confirm the convexity of its floor. Byrgius, Mersenius and Vieta form an easily recognised triangle. Within the triangle, recall Cavendish, Henry and the brothers Henry (Henry Frères).

Schickard dominates the southwest. Recall Phoclides–Nasmyth and Wargentin. Unfortunately, if you saw Bailly well two weeks ago, libration will have swung it into an unfavourable position now.



Names of lunar formations							25.79-day-old Moon
Crater Anaximander Aristarchus Bailly Billy Byrgius Cavendish	Gassendi Hansteen Henry Henry Frères Herodotus J. Herschel	Letronne Mairan Marius Markov Mersenius Nasmyth	Oenopides Phocylides Reiner Schickard Sirsalis Sirsalis A	Vieta Wargentin	**Mons and montes – mountain(s)** Mons Hansteen Mons Rümker	**Oceanus – ocean** Oceanus Procellarum **Rima and rimae – rille(s)** Rimae Sirsalis	**Vallis – valley** Vallis Schröteri **Others** Reiner Gamma (swirl)

Lunar data (earthshine)

DTG (Local)	:	20 Jul. 98 (Mon.) 0645 hrs
DTG (UT)	:	19 Jul. 98 (Sun.) 2245 hrs
Lunation	:	No. 934
Age	:	25.79-day-old Moon
Illumination	:	15.6%
Diameter/dist.	:	32′24″/372,764 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	75 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	6/10 (10/10 being perfect)
Moon altitude	:	40°06′ from N horizon

Lunar data

DTG (Local)	:	20 Jul. 98 (Mon.) 0641 hrs
DTG (UT)	:	19 Jul. 98 (Sun.) 2241 hrs
Lunation	:	No. 934
Age	:	25.79-day-old Moon
Illumination	:	15.6%
Diameter/dist.	:	32′24″/372,759 km

Photographic data

Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	6/10 (10/10 being perfect)
Moon altitude	:	39°11′ from N horizon

The 27th-day Moon

Almost finished now, it's the 27th morning of the lunation and there's only one more morning to get up early. Already, early morning glare is beginning to affect visibility of the decrescent Moon.

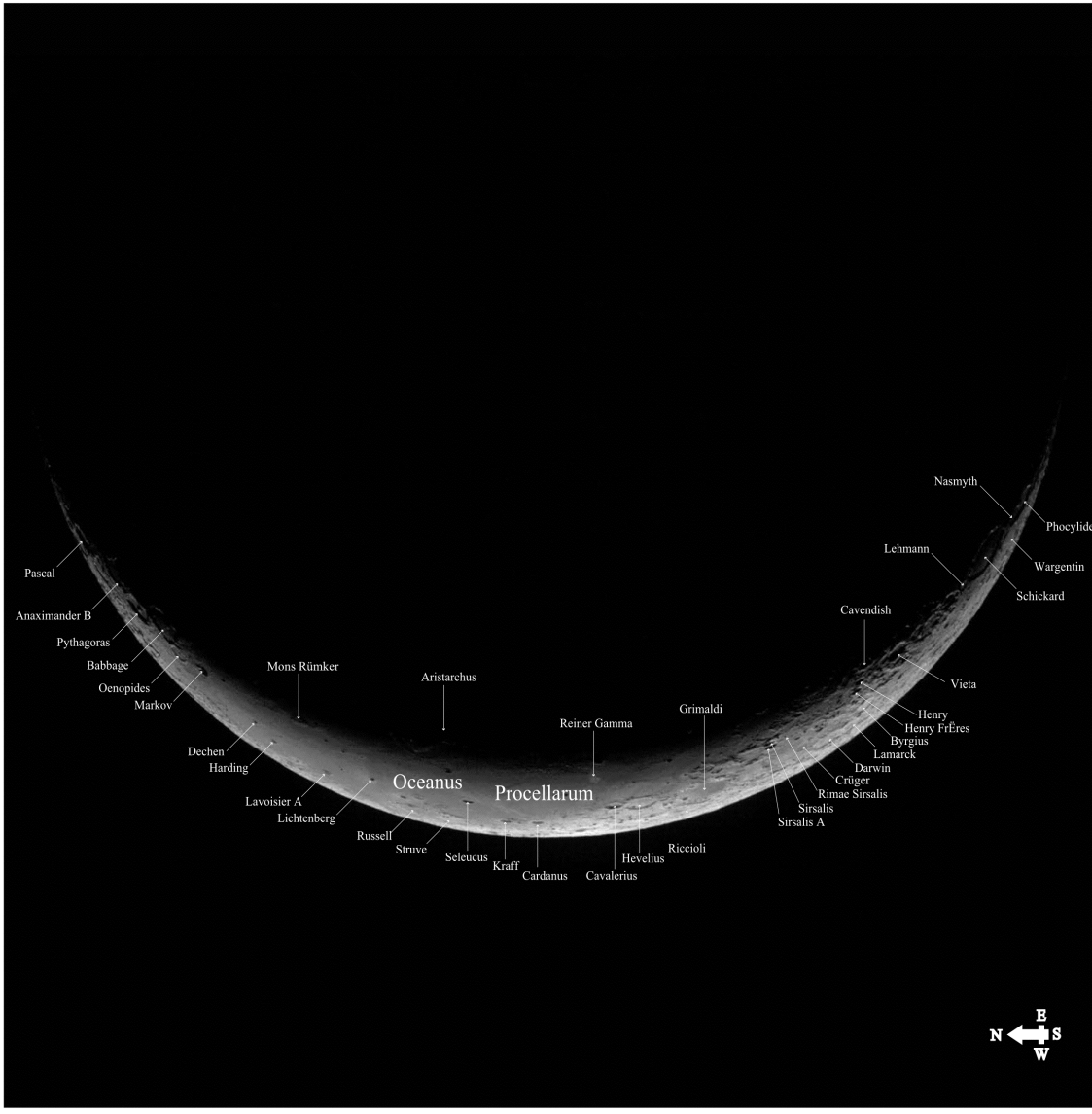
Pythagoras, with its central mountain, still stands out in the northwest although the shadows are beginning to close in. Similarly, Babbage to its south is also starting to feel the approaching gloom. Anaximander B, to its north, and somewhat further east, is already bisected by the sunset terminator. Oenopides and Markov are, however, still worth looking at.

Several little craters, mostly dark this morning, are strewn on the smooth surface of Oceanus Procellarum. There is one surprise – look how the dome complex Mons Rümker has popped up out of nowhere. Bright Aristarchus is gone but the lozenge-shape of Reiner Gamma still retains its individuality east of Cavalerius and Hevelius.

To their south, Grimaldi remains as a dark patch, though its walls are very indistinct in this lighting. Its neighbour, Riccioli, is surprisingly distinct and can be seen to be only slightly smaller than Grimaldi. Usually, all that one sees of Riccioli is its dark internal spot and that gives the misleading impression that Riccioli is much smaller than Grimaldi.

The Sirsalis pair stands out as two dark ellipses. Look for the dark oval of Crüger to their southwest. It serves as the signpost for Darwin and Lamarck, both surprisingly easily identified in this oblique illumination. You might even be able to trace the Sirsalis rille all the way to them.

Vast Schickard needs no reintroduction but reacquaintance will have to be quick. And of course, to its south is the Phocylides–Nasmyth bootprint.



Names of lunar formations							26.79-day-old Moon
Crater Anaximander B Aristarchus Babbage	Cavalerius Crüger Darwin	Grimaldi Hevelius Lamarck	Markov Nasmyth Oenopides	Phocylides Pythagoras Riccioli	Schickard Sirsalis Sirsalis A	**Mons and montes – mountain(s)** Mons Rümker **Oceanus – ocean** Oceanus Procellarum	**Rima and rimae – rille(s)** Rimae Sirsalis **Others** Reiner Gamma (swirl)

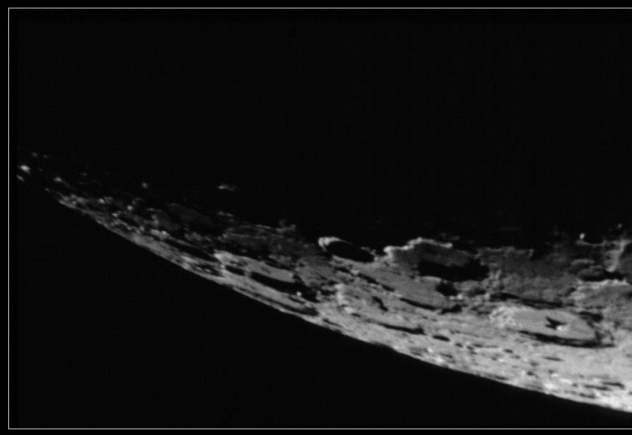


Photo A: Pythagoras and the north polar region (binocular view)
Among the old craters in this region, young Pythagoras, with terraced walls and a central peak, is a distinct outsider.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 20th Jul. 1998
Exp: 1 s (Nikon F3)
Sky: 6/10
Film: Kodak Ektachrome 400

Photo B: Aristarchus and Vallis Schröteri at sunset
Aristarchus forms a diamond-ring at sunset while Herodotus and Vallis Schröteri resemble a spermatozoon. The bright dot of Mons Herodotus stands out.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 20th Jul. 1998
Exp: 2 s (Nikon F3)
Sky: 6/10
Film: Kodak Ektachrome 400

Photo C: The Southwest Limb (binocular view)
The bootprint of Phocylides and Nasmyth is much distorted by foreshortening due to a poor libration. Schickard is easily recognised but Wargentin is almost imperceptible further towards the limb.

Photographic data
Instr: 40-cm f/13 Cassegrain
24 mm XP eyepiece projection yielding f/65
Date: 20th Jul. 1998
Exp: 2 s (Nikon F3)
Sky: 6/10
Film: Kodak Ektachrome 400

DAY 27
(naked eye/binocular view)

Lunar data		
DTG (Local)	:	21 Jul. 98 (Tue.) 0654 hrs
DTG (UT)	:	20 Jul. 98 (Mon.) 2254 hrs
Lunation	:	No. 934
Age	:	26.79-day-old Moon
Illumination	:	8.3%
Diameter/dist.	:	32′08″/374,992 km

Photographic data		
Instrument	:	40-cm f/13 Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/2 s (Pentax 67 camera)
Slide film (120)	:	Fujichrome Velvia 50
Sky condition	:	3/10 (10/10 being perfect)
Moon altitude	:	29°16′ from N horizon

The 28th-day Moon

What is there to say about the 28th-day Moon? It is difficult to observe, rising just before sunrise as a narrow (de)crescent that soon fades into the daylight. Most apt, perhaps, is the old Roman traveller's greeting, 'Hail friend; hail, and farewell'.

And so we've reached the end of this lunation. Did you manage to see everything that you wanted this time round? Of course you didn't. Well, tomorrow is New Moon and the start of a new cycle.

As an afterthought, the youngest New Moon visible is about 12 hours old; that should mean that the oldest Moon visible must be just about 12 hours before new. For the extreme 'lunatic', therefore, would you like to try and see the old and new Moons within the same 24-hour period?

DAY 28
(naked eye/binocular view)

Lunar data			**Photographic data**		
DTG (Local)	:	17 Dec. 98 (Thu.) 0628 hrs	Instrument	:	40-cm f/13 Cassegrain
DTG (UT)	:	16 Dec. 98 (Wed.) 2228 hrs	Technique	:	Prime focus (Cass. Focus)
Lunation	:	No. 939	Exposure time	:	4 s (Pentax 67 camera)
Age	:	27.75-day-old Moon	Slide film (120)	:	Kodak Ektachrome 64
Illumination	:	4.0%	Sky condition	:	3/10 (10/10 being perfect)
Diameter/dist.	:	29′43″/403,534 km	Moon altitude	:	12°59′ from N horizon

The 29th-day Moon

New Moon again – the end of the month and the beginning of the next month. 'What's a month?' you ask. Well, a month is . . ., come to think of it , 'What exactly is a month?'.

To begin with, the year is divided into 12 calendar months – but months seem to vary. There are 30-day months and 31-day months and there's February, which is a 28-day month, except in leap years when it's a 29-day month. In the aftermath of the Y2K nonbug, everyone now knows that there are some years that should be leap years but actually aren't. All this confusion results because the Earth's orbital period, which determines the year, and the lunar cycle, which determines the month, aren't commensurate. Twelve calendar months of 30 days each only gives you 360 days while the Earth actually takes 365.25 days to go around the Sun. That means you need another 5.25 days, and these extra days are distributed to make up the months as we know them. The 0.25 day means that we need leap years because an extra day is needed every 4 years. However, it's actually 0.242 198 79 days (and not 0.25 days) and that's why leap years must also be divisible by 400. This last correction means that over a 400-year period, the average length of the year becomes 365.24225 days (and in case you're interested, it means that you only need a further correction every 20 000 years).

The month (or the 'moonth' as it originally was) is the time taken for the Moon to go around the Earth once (i.e. the Moon's period is 1 month). Unfortunately, there are many subtleties in this apparently simple concept; and depending on how you define the period, there are several different types of month.

First, if you draw a line between the Earth and a fixed star, the time taken for the Moon to go round the Earth and return to that same line is 27.32166 days – this is the sidereal month. However, the positions of the stars aren't really fixed, because the Earth's axis isn't fixed (technically this is called 'precession'). If you take this into account, then you get the tropical month, which is 27.32158 days. Now, suppose that this 'fixed' line joins the Earth and the Sun. Then, during one sidereal (or tropical) month, the Earth has also moved somewhat in its orbit round the Sun and that means that the 'fixed' line joining the Earth and Sun has also moved. Taking this into account gives the synodic month – 29.53059 days – and it is this period that we usually talk about when we refer to a lunation and the phases of the Moon (that's why we had to write this chapter). If one takes into account the changing shape of the Moon's orbit round the Earth, then the anomalistic month, the time from perigee to perigee, is 27.55455 days.

That isn't all – there's one more month to go. The nodical (or draconic) month is the time taken for the Moon to move from ascending node to ascending node in its orbit round the Earth, and that is 27.212 22 days. And that's why this last chapter shows another solar eclipse. For the sake of variety, however, we decided to show an annular eclipse (see Figure 5), instead of another total solar eclipse.

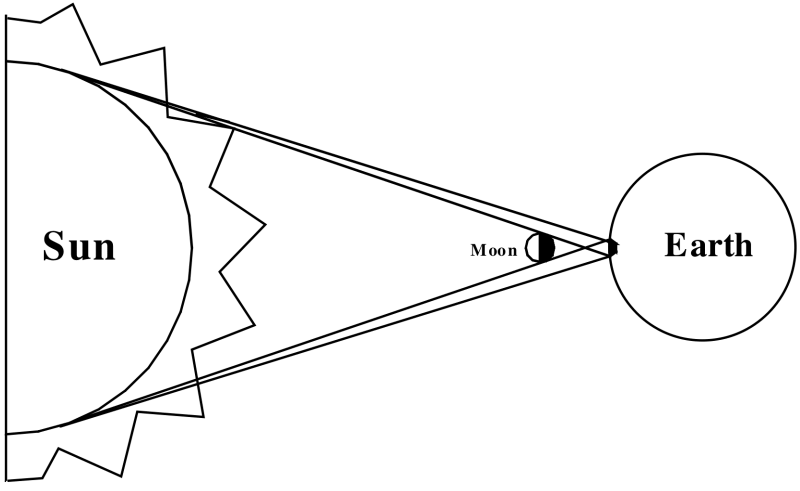
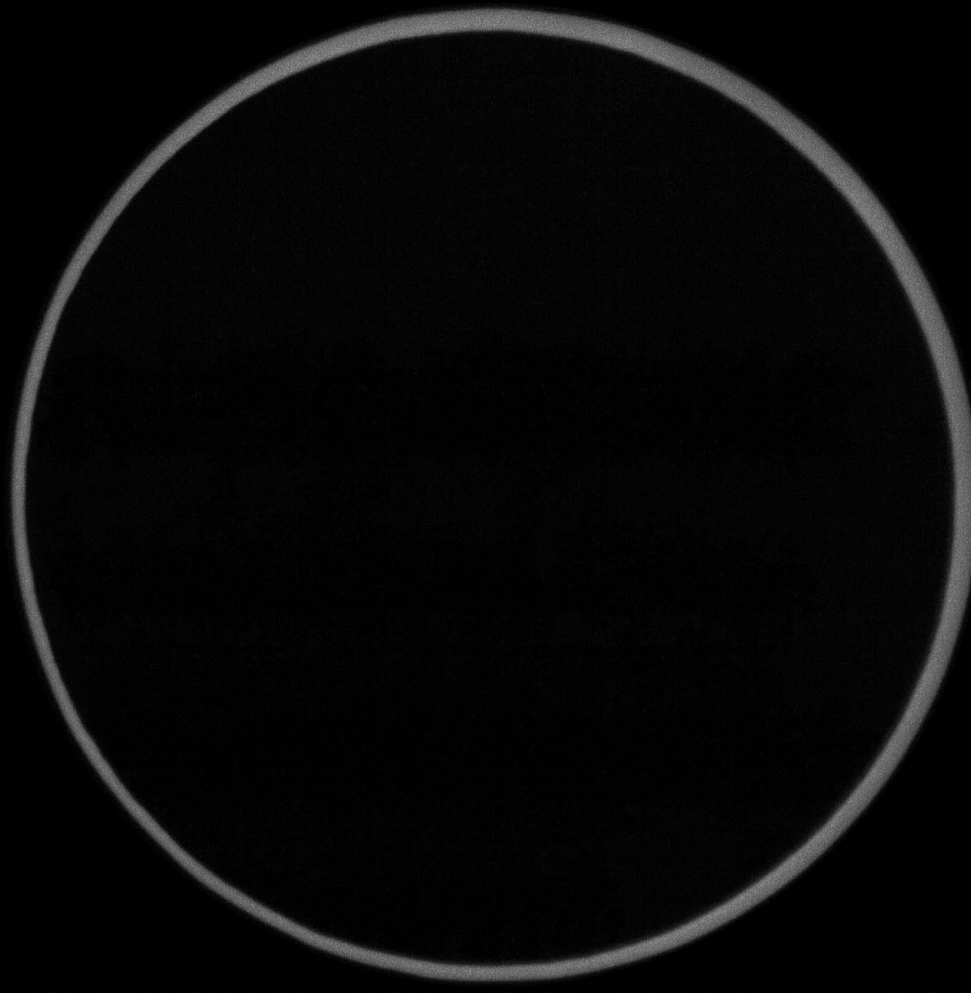


Figure 5 Annular solar eclipse
This occurs when the Moon's shadow does not completely cover the Sun.



Lunar data (annular solar eclipse)

DTG (Local)	:	22 Aug. 98 (Sat.) 0821 hrs
DTG (UT)	:	22 Aug. 98 (Sat.) 0021 hrs
Lunation	:	No. 935
Age	:	29.5-day-old Moon
Illumination	:	0.0%
Diameter/dist.	:	30′30″/393,820 km
Location	:	Mersing, Malaysia

Photographic data

Instrument	:	3.5-inch f/16 Mak. Cassegrain
Technique	:	Prime focus (Cass. Focus)
Exposure time	:	1/60 s (Nikon F3 camera)
Slide film (120)	:	Fujichrome 100
Sky condition	:	5/10 (10/10 being perfect)
Moon altitude	:	18°18′ from N horizon
Filter	:	Type 2 Solar Filter

Further reading

Someday, we'd like to sit down and prepare a fully annotated bibliography. Until then, however, these brief comments will have to do.

Lunar atlases

1 Rukl, A., *Atlas of the Moon*, Hamlyn, UK, 1990 (2nd edition published by Kalmbach Publishing, Waukesha, WI, 1992).
2 Cook, J. (ed.), *The Hatfield Photographic Lunar Atlas*, Springer, London, 1998.
3 Westfall, J.E., *Atlas of the Lunar Terminator*, Cambridge University Press, 2000.
4 Lunar and Planetary Laboratory, *Lunar Quadrant Maps*, University of Arizona, Tucson, 1964.

We found all of the above useful. With the exception of the *Lunar Quadrant Maps*, they all suffer, however, from the significant disadvantage that they require large amounts of page-flipping. The *Quadrant Maps* are large-format and require unrolling. This is why we have no hesitation in quite shamelessly recommending:

5 Chong, S.M., Lim, A. and Ang, P.S., *Photographic Atlas of the Moon*, Cambridge University Press, 2002.

Two excellent lunar atlases available on line are:

6 *Consolidated Lunar Atlas*, at *www.lpi.usra.edu/research/cla/menu.html*
7 *Digital Lunar Orbiter Photographic Atlas of the Moon*, at *www.lpi.usra.edu/research/lunar_orbiter/index.html*

Observing guides

1 Wilkins, H.P. and Moore, P., *The Moon*, Faber & Faber, London 1961.
2 Cherrington, H., Jr., *Exploring the Moon through Binoculars and Small Telescopes*, Dover, New York, 1984.
3 Kitt, M.T., *The Moon – An Observing Guide for Backyard Telescopes*, Kalmbach Publishing, Waukesha, WI, 1991.
4 North, G., *Observing the Moon*, Cambridge University Press, 2000.
5 Wlasuk, P.T., *Observing the Moon*, Springer, London, 2000.

For years, there was a dearth of observing guides for the Moon. While preparing this book, however, the guides by North and by Wlasuk (careful, don't confuse them) both popped up and we heartily recommend both.

Background reading about the Moon

1 Ottewell, G., *The Astronomical Companion*, USA, 1979, (available from Sky Publishing Corporation).

This is the first astronomy book that you should ever own.

2 Compton, W.D., *Where No Man Has Gone Before – A History of Apollo Lunar Exploration Missions*, NASA, Washington, DC, 1989.
3 Wilhelms, D.E., *To A Rocky Moon – A Geologist's History of Lunar Exploration*,University of Arizona Press, Tucson, 1993.
4 Heiken, G., Vaniman, D. and French, B.M. (eds.), *Lunar Sourcebook: A User's Guide to the Moon*, Cambridge University Press, 1991.
5 Spudis, P.D., *The Once and Future Moon*, Smithsonian Institution Press, Washington, DC, 1996.
6 Whitaker, E., *Mapping and Naming the Moon: A History of Lunar Cartography and Nomenclature*, Cambridge University Press, 1999.

For wonderful stories about the sort of lunacy that has afflicted observers through the years, we cannot but recommend:

7 Ashbrook, J., *Astronomical Scrapbook*, Sky Publishing Corporation, Cambridge, USA and Cambridge University Press, UK, 1984.

Astrophotography

1 Covington, M.A., *Astrophotography for the Amateur*, 2nd edn, Cambridge University Press, 1999.
2 Dragesco, J., *High Resolution Astrophotography*, Cambridge University Press, 1995.

Magazines

Astronomy enthusiasts have two outstanding monthly magazines –*Astronomy* and *Sky & Telescope*.

8 *Astronomy* is published monthly by Kalmbach Publishing Co., Box 1612, Waukesha, WI 53187 (web site: *www.astronomy.com*)
9 *Sky & Telesope* is published monthly by Sky Publishing Corporation, 49 Bay State Road., Cambridge, MA 02138, USA (web site: *www.skypub.com*). Every issue contains Lunar Notebook, a monthly column by C.A. Wood that describes interesting lunar features.

Some articles from *Sky & Telescope* that we have found useful are:

(a) Thin crescents
  (i) Doggett, L.E., Seidelmann, P.K. and Schaefer, B.E., Moonwatch – July 14th, 1988, **76**(1),34–35, July 1988.
  (ii) Doggett, L.E. and Schaefer, B.E., Results of the July Moonwatch, **77**(4), 373–375, April 1989.
  (iii) Observers' Page, Breaking the New-Moon record, **78**(3), 322–323, September 1989.
  (iv) Durrani, M.N., A still younger Moon (letter), **79**(6), 582, June 1990.
  (v) Bortle, J., April's old and young Moon, **80**(2), 215, August 1990.
  (vi) Bieda, S.W. Jr, A lunar double whammy (letter), **81**(1), 5–6, January 1991.
  (vii) Laing, D., More on record Moons (letter), **81**(6), 573, June 1991.
  (viii) O'Meara, S.J., Sighting the opposing crescents, **89**(5), 105, May 1995.
  (ix) Victor, R.C., December's young-old Moon, **90**(6), 71, December, 1995.
  (x) Pepin, M.B.P., In quest of the youngest Moon, **92**(6), 104–106, December 1996.

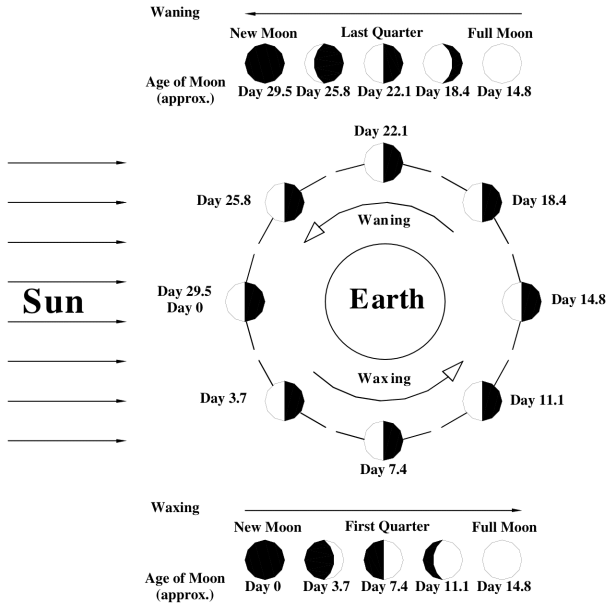
(b) 'One giant leap for all mankind'
  (i) MacRobert, A.M., Celestial calendar, Apollo 11 on the Moon, **86**(1), 80, July 1994.

(c) The rille in the Alpine Valley
  (i) MacRobert, A.M., Celestial calendar, The rille in the alpine valley, **88**(4), 72–73, October 1994.

(d) The south polar region
  (i) Westfall, J.E., The Luna Incognita Project, **82**(5), 556–559, November 1991.
  (ii) MacRobert, A.M., Exploring the Moon's south pole, **86**(4), 66–67, October 1993.
  (iii) Observer's notebook, A lunar polar peek, **93**(4), 112–113, April 1997.

An online index to all these (and more) is available at the web site: *www.skypub.com*

Appendix 1 Phases of the Moon



Appendix 2 Chronology of lunar selenography

Firstly, this appendix is by no means complete. The authors hoped that it will however, provide some background to Selenography up to 1964.

Year	Who	Description
BC1300?	Chinese and others	Imaginary rabbit or hare pounding rice in the Moon.
BC1193–1280	Saint Albert Bollstadt	Traced the figures of the dragon, the tree and the man in the Moon.
BC46–AD120	Plutarch	1st selenographic book – first mention of geographical features, 'Caspia'and 'Penetralia Hectares', on the Moon.
AD965–1039	al-Haitham (Alhazen)	Second pretelescopic book on selenography: *On the Nature of the Spots Seen in the Moon*.
AD1500?	Jan van Eyck	Earliest known paintings of Moon with markings.
AD1513	Leonardo da Vinci	Second known drawing of Moon with markings.
AD1564–1616	William Shakespeare	Traced the figures of dog, the bush and the man in the Moon.
AD1600	William Gilbert	First known lunar drawing containing named features.
AD1609	Thomas Harriot	First crude telescopic observations of the Moon.
AD1610	Galileo Galilei	First systematic telescopic lunar study and publication.
AD1611	Thomas Harriot	Produced the first telescopic lunar map.
AD1614	Christopher Scheiner	Made 9 cm-diameter Quarter Moon drawing with labels.
AD1619	Charles Malapert	Made crude sketch of Quarter Moon.
AD1620	Giuseppe Biancani	Made crude Quarter Moon sketch with labels.
AD1627	Christopher Borri	Made Quarter Moon sketch with labels.
AD1628	Pierre Gassendi	Probably first person to name telescopic lunar features.

Year	Who	Description
AD1629	Francisco Fontana	Made some full and other Moon sketches.
AD1635	Claud Mellan	Made, based on Gassendi's and Peirsec's observations, three engravings of first quarter, Full Moon and last quarter images more accurate than any previous.
AD1645	Michiel van Langren	Produced first true Lunar Map from his 30 drawings.
AD1645	Rheita	Published a 18.5 cm diameter copperplate lunar map later but of lower quality than van Langren's.
AD1646	Francisco Fontana	Published first Moon atlas, but it was totally inaccurate and of no value to selenography.
AD1647	Johannes Hevelius	Published finest Moon book/maps: *Selenographia*.
AD1649	Eustachio Divini	Published 'copy' of Hevelius's Moon map.
AD1651	Gerolamo Sersale	Published a 34 cm diameter Moon map based on his lunar observations of July 1650.
AD1651	Riccioli / Grimaldi	Responsible for production and publication of two Moon maps better than all previous in *Almagestum Novum*. Also introduced lunar nomenclature still in use today.
AD1661	Christopher Wren	First lunar globe – now lost.
AD1662	Geminiano Montanari	Produced a series of lunar drawings from crescent to nearly full based on observations from 12 consecutive clear nights in Oct. 1662.
AD1665	Robert Hooke	Published his famous work *Micrographia*. Produced drawing of crater Hipparchus more detailed than Hevelius' or Riccioli's.
AD1671	Cherubin	Copied Hevelius's Moon map wholesale in his published book on optics in 1671.
AD1675?	Philippe de La Hire	Produced general map of the Moon – now lost.
AD1679	Giovani D. Cassini	Produced aesthetic 21-inch (*54 cm*) Moon map with assistance from Leclerc and Patigny.
AD1676–1707	Maria Clara Muller	More than 300 lunar drawings – now lost.
AD1686	Christiaan Huygens	Describes three famous lunar features – the Straight Wall, Rima Hyginus and Schroter's Valley.
AD1686	Giovani D. Cassini	Combined his drawings into a Full Moon chart some 13 feet in diameter – this chart now lost.
AD1696	Georg C. Eimmart	Published the least successful large-scale Moon map containing gross deficiencies.
AD1728	Francesco Bianchini	Published two drawings of Plato and Alpine region in his book on Venus.
AD1748	Tobias Mayer	First to introduce the idea of using a micrometer for preparation of Moon map.
AD1753	Roger Boscovich	Published *De Lunae Atmosphera*. Conclusively refuting the existence of a lunar atmosphere, as suggested by Euler.
AD1775	Tobias Mayer	Publication of first small but accurate Moon map by G.C. Lichtenberg, 13 years after Mayer's death.
AD1776	Johann H. Lambert	Published *Berlinder Astronomisches Jahrbuch* containing small lunar images and data on 66 measured positions of features.
AD1791	Johann H. Schröter	Published *Selenographische Fragmente* Vol. 1. Schröter was the first to observe similar features under different illuminations and to discover lunar rilles.
AD1797	John Russell	Produced approximately seven 30 cm 'Selenographias' Moon globes.
AD1802	Johann H. Schröter	Published *Selenographische Fragmente* Vol. 2.
AD1805	John Russell	Published two excellent Full Moon images, each 36 cm in diameter.
AD1824	Wilhelm G Lohrmann	The first true modern selenographer. Published four sections of his famous 25-section Moon map in *Topography of the Visible Surface of the Moon, First Installment*.
AD1825	Franz v. P.Gruithuisen	Published 'copy' of Mayer's whole Moon map and caused uproar in the astronomical community with the announcement of his observation of a 'lunar city', possibly with lunar inhabitants.
AD1834	J. Mädler & W. Beer	Published the first part of their four-quadrant Moon map – the first large-scale Moon map based on micrometric measurements.
AD1835	Richard A. Locke	Published a series of fictitious articles in *The New York Sun* describing how John Herschel allegedly discovered lunar humanoids.
AD1836	J. Mädler & W. Beer	Published all four quadrants of their Moon map titled *Mappa Selenographica* – the most detailed and precise Moon map published to date.
AD1837	J. Mädler & W. Beer	Published one of the most famous of all Moon books – *Der Mond* (*The Moon*) – as accompanying text to their four-quadrant Moon map of 1836.
AD1850	Th. Dickert	Produced a Moon globe 19 feet (*5.8 m*) in diameter whose plastered surface was based on Mädler's and Beer's Moon map of 1836.
AD1865	William R. Birt	Began an attempt by the British Association to map the Moon in great detail. The map was a complete failure as its complex scheme and line drawings were meaningless.

Year	Who	Description
AD1876	Edmund Neison	Published the first excellent observer's guide to the Moon with a 24-inch (*60 cm*) diameter Moon map in 22 sections.
AD1878	Wilhelm G Lohrmann	Lohrmann's 25-section Moon map finally published by J.F. Julius Schmidt 30 years after his death.
AD1878	J.F. Julius Schmidt	Schmidt's own 25-section Moon map modelled after Lohrmann's format was published. It remains the finest Moon map prior to the photographic era.
AD1879	Tobias Mayer	Mayer's second large Moon map belatedly published by W. Klinkerfues, Director of Gottingen Observatory, who was inspired by the Lohrmann and Schmidt maps published in 1878. If it had been published a century earlier, instead of 117 years after Mayer's death, this Moon map would have been the finest.
AD1895	Thomas Gwyn Elger	Published simplified and most usable Moon map, 18 inches (*46 cm*) in diameter, in four sections in his book, *The Moon: A Full Description and Map of its Principal Physical Features*.
AD1894	Ladislaus Weink	Published *Selenographic Studies, Based on Negatives of the Moon taken at the Lick Observatory*, based on his process of producing drawings from negatives as replacements for positive photographic prints.
AD1895	Philipp Fauth	Published his initial maps on the Moon with 25 drawings of selected lunar features on 20 sheets.
AD1897	E.S. Holden	Director for Lick Observatory – published Moon atlas titled *Observatory Atlas of the Moon.*
AD1897–1900	Ladislaus Weink	Published first volume of 200 images of *Photographischer Mond-Atlas, vornehmlich auf Grund von focalen Negativen der Lick-Sterwarte in Masstabe eines Monddurchmessers von 10 fuss ausgef hrt*. This atlas was issued in 10 batches – each with 20 plates – over the course of the 3 years.
AD1898	J.N. Krieger	Published his best 28 lunar drawings, selected from 125 completed between 1890–1894 at Trieste, as the first volume of his lunar atlas.
AD1900	G.W. Ritchey	'Celestial photography with the 40-inch visual telescope of the Yerkes Observatory' published in *The Astrophysical Journal*, Vol 12, pp. 352–360 and plate XXI 'Lunar Crater Theophilus and Surrounding Region'. Ritchey was probably the most skilful lunar photographer of the twentieth century.
AD1903	William H Pickering	Published affordable photographic lunar atlas, *The Moon: A Summary of the Existing Knowledge of our Satellite*. This atlas set the standard for all others to follow.
AD1909	Loewy & Puiseux	First high quality photographic lunar atlas, *Atlas Photographique de la Lune*, based on work undertaken at Paris Observatory between 1896 and 1909.
AD1910	Walter Goodacre	First Moon map to use the new xi/eta coordinate system.
AD1912	J.N. Krieger	Seeliger, assisted by Rudolf König, published two magnificent volumes of Krieger's lunar atlas, *Joh. Nep. Kriegers Mond Atlas – Neue Folge*, after his death in 1902. This work established Krieger's drawings as the finest in the world. His drawings remain unequalled today.
AD1913	Julius Franz	Four-quadrant outline lunar map, *Die Randlandschaften des Mondes* (*The Border region of the Moon*) based on Lick Observatory photographs in orthographic projection.
AD1913	Samuel A. Saunder	Completed measurements of the central lunar region. W H Wesley drew three of the four central squares based on the new xi / eta coordinate system and then completed fourth central square.
AD1913	Mary A. Blagg	*Collated List of Lunar Formations* (1913) with 4789 lunar entries.
AD1919	IAU	International Astronomical Union (IAU) was Founded, with the objective of coordinating astronomical research worldwide.
AD1922	IAU	IAU Commission 17's first meeting to deal with the issues of lunar nomenclature.
AD1931	Francis Pease	Series of remarkable lunar photographs taken with the 100-inch Hooker reflector between 12th and 15th September 1919 and published by Walter Goodacre in *The Moon, With a Description of its Surface Formations*.
AD1935	Blagg and Müller	Published two volumes of *Named Lunar Formations* as official IAU documents accepted internationally. Volume 1 is a catalogue while Volume 2 is a map.
AD1936	Philipp Fauth	34-inch (*86.4 cm*) diameter Moon map in six sections in 1936 along with his book *Unser Mond* (*Our Moon*). This map uses the advanced xi/eta grid system first established by the IAU.
AD1938	IAU	Commission 17 renamed 'Movement and Figure of the Moon' and its members migrated into Commission 16 – 'Commission for the Physical Observations of Planets and Satellites'.
AD1964	Philipp Fauth	His son Hermann completed and published his Moon atlas *Mondatlas* (*Moon Atlas*) – a culmination of Fauth's work from 1911 with his excellent 15.5 inch (*39.4 cm*) apochromatic refractor.

Appendix 3 Index of lunar named features

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Catena – (crater chain)							
Catena Krafft	14	15.0 N	72.0 W	60.0	1976	Named after nearby crater.	17, 28
Crater							
Abel	15	34.5 S	87.3 E	122.0	1964	Niels H., Norwegian mathematician (1802–1829).	69, IV
Abenezra	7, 21	21.0 S	11.9 E	42.0	1935	Abraham Bar Rabbi Ben Erza, Spanish Jewish mathematician, astronomer (1092–1167).	56
Abulfeda	7, 21	13.8 S	13.9 E	65.0	1935	Abu'L-fida, Ismail (1273–1331), Syrian geographer.	45
Adams	16	31.9 S	68.2 E	66.0	1970	John Couch, British astronomer (1819–1892); Charles H., American astronomer (1868–1951); Walter S., American astronomer (1876–1956).	69
Adams B	16	—	—	—	—	No official name by IAU.	69
Adams D	16	—	—	—	—	No official name by IAU.	69
Agarthachides	11, 12, 24	19.8 S	30.9 W	48.0	1935	Greek geographer (unknown – about 150 BC).	52
Agarthachides A	24	—	—	—	—	No official name by IAU.	52
Agrippa	1, 7, 20, 21	4.1 N	10.5 E	44.0	1935	Greek astronomer (unknown – *fl.* AD 92).	34
Airy	8	18.1 S	5.7 E	36.0	1935	George Biddell, British astronomer (1801–1892).	55, 56
Albategnius	7, 8, 9	11.7 S	4.3 E	114.0	1935	Al-Batani, Muhammed Ben Geber C., Iraqi astronomer, (850–929).	44, 45
Alexander	7, 20, 21	40.3 N	13.5 E	81.0	1935	Alexander the Great, of Macedon, Greek geographer (356–323 BC).	13
Alfraganus	7, 20	5.4 S	19.0 E	20.0	1935	Al Fargani, Muhammed Ebn Ketir, Persian astronomer (unknown – *c.* 840).	46
Alhazen	3	15.9 N	71.8 E	32.0	1935	Abu Ali Al-Hasan Ibn Al Haitham, Iraqi mathematician (987–1038).	27
Aliacensis	8, 9, 21	30.6 S	5.2 E	79.0	1935	D'Ailly, Pierre, French geographer (1350–1420).	55, 65
Almanon	7, 21	16.8 S	15.2 E	49.0	1935	Abdalla Al Mamun, Persian astronomer (786–833).	56
Alpetragius	9, 22	16.0 S	4.5 W	39.0	1935	Nur Ed-Din Al Betrugi, Moroccan astronomer (unknown – *c.* 1100).	55
Alphonsus	9, 22	13.7 S	3.2 W	108.0	1935	Alfonso X, Spanish astronomer (1223–1284).	44
Amundsen	15	84.3 S	85.6 E	101.0	1964	Roald E., Norwegian explorer (1872–1928).	73, 74, V
Anaxagoras	1, 10, 15, 16, 20, 22	73.4 N	10.1 W	50.0	1935	Greek astronomer (500–428 BC).	4
Anaximander	1, 12, 13, 24, 25, 26	66.9 N	51.3 W	67.0	1935	Greek astronomer (*c.* 611–547 BC).	2
Anaximander B	13, 27	—	—	—	—	No official name by IAU.	2
Anaximenes	12, 24	72.5 N	44.5 W	80.0	1935	Greek astronomer (585–528 BC).	3
Anaximenes G	12	—	—	—	—	No official name by IAU.	3
Ansgarius	2, 16	12.7 S	79.7 E	94.0	1935	St. Ansgar, German theologian (801–864).	49, IV
Apianus	7, 21	26.9 S	7.9 E	63.0	1935	Bienewitz, Peter, German mathematician, astronomer (1495–1552).	56
Apollonius	3, 16	4.5 N	61.1 E	53.0	1935	Apollonius of Perga third century BC, Greek mathematician.	38
Arago	6	6.2 N	21.4 E	26.0	1935	Dominique Francois Jean, French astronomer (1786–1853).	35
Aratus	8	23.6 N	4.5 E	10.0	1935	Greek astronomer (315–245 BC ?).	22
Archimedes	1, 9, 11, 22	29.7 N	4.0 W	82.0	1935	Greek physicist, mathematician (*c.* 287–212 BC).	12, 22
Archytas	8, 9, 21	58.7 N	5.0 E	31.0	1935	Greek mathematician (428–347 BC ?).	4
Argelander	8	16.5 S	5.8 E	34.0	1935	Friedrich Wilhelm August, German astronomer (1799–1875).	56
Ariadaeus	6	4.6 N	17.3 E	11.0	1935	Arrhidaeus, Philipus, King of Babylon chronologer (unknown – 317 BC).	35
Aristarchus	1, 12, 13, 14, 25, 26, 27	23.7 N	47.4 W	40.0	1935	Greek astronomer (310–230 BC ?).	18
Aristillus	1, 8, 9, 22	33.9 N	1.2 E	55.0	1935	Greek astronomer (*fl. c.* 280 BC).	12
Aristoteles	1, 7, 19, 20, 21	50.2 N	17.4 E	87.0	1935	Greek astronomer, philosopher (383–322 BC).	5
Arnold	6, 19	66.8 N	35.9 E	94.0	1935	Christoph, German astronomer (1650–1695).	5
Arzachel	9, 22	18.2 S	1.9 W	96.0	1935	Al Zarkala, Spanish-Arabic astronomer (*c.* 1028–1087).	55
Atlas	1, 5, 6, 17, 18	46.7 N	44.4 E	87.0	1935	Mythological Greek Titan.	15

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Atwood	4	5.8 S	57.7 E	29.0	1976	G., British mathematician, physicist (1745–1807).	49
Autolycus	1, 8, 9, 22	30.7 N	1.5 E	39.0	1935	Greek astronomer (unknown – *c.* 330 BC).	12
Azophi	7, 21	22.1 S	12.7 E	47.0	1935	Al-Sufi, Abderrahman, Persian astronomer (903–986).	56
Babbage	13, 14, 25, 27	59.7 N	57.1 W	143.0	1935	Charles, British mathematician (1792–1871).	2
Babbage A	13, 25	—	—	—	—	No official name by IAU.	2
Back	2	1.1 N	80.7 E	35.0	1976	Ernst E.A., German physicist (1881–1959).	38, III
Baco (Bacon in IAU's website)	6, 20	51.0 S	19.1 E	69.0	1935	First named by JH Madler after Roger Bacon, British natural philosopher, optician (1214–1294). Crater name Baco used in *Who's Who in the Moon* (1938), in *The Moon* by Wilkins and Moore (1955) and in *Lunar Chart (LPC-1)*, NASA (1970).	74
Baco A	6	—	—	—	—	No official name by IAU.	74
Baillaud	6, 7	74.6 N	37.5 E	89.0	1935	Benjamin, French astronomer (1848–1934).	5
Bailly	9, 13, 14, 15, 26	66.5 S	69.1 W	287.0	1935	Jean Sylvain, French astronomer (1736–1793).	71, VI
Bailly B	15	—	—	—	—	No official name by IAU.	71, VI
Balboa	15	19.1 N	83.2 W	69.0	1964	Vasco N. de, Spanish explorer (1475–1517).	17, VIII
Balmer	3	20.3 S	69.8 E	138.0	1964	Johann J., Swiss mathematician, physician (1825–1898).	60
Banachiewicz	2	5.2 N	80.1 E	92.0	1964	Tadeusz, Polish astronomer, mathematician (1882–1954).	38, III
Bancroft	22	28.0 N	6.4 W	13.0	1976	W.D., American chemist (1867–1953).	21
Barkla	3	10.7 S	67.2 E	42.0	1979	C.G., British physicist, Nobel laureate (1877–1944).	49
Barocius	6, 7, 21	44.9 S	16.8 E	82.0	1935	Francesco, Italian mathematician (unknown – *fl.* 1570).	66
Barrow	7, 8, 20, 21	71.3 N	7.7 E	92.0	1935	Isaac, British mathematician (1630–1677).	4
Bayer	12	51.6 S	35.0 W	47.0	1935	Johann, German astronomer (1572–1625).	71
Beaumont	6	18.0 S	28.8 E	53.0	1935	Leonce Elie de, French geologist (1798–1874).	57, 58
Beer	22	27.1 N	9.1 W	9.0	1935	Wilhelm, German astronomer (1797–1850).	21
Behaim	2, 16	16.5 S	79.4 E	55.0	1935	Martin, German navigator, cartographer (1436–1506).	60, IV
Bel'kovich	2	61.1 N	90.2 E	214.0	1964	Igor V., Soviet astronomer (1904–1949).	6, 7, II
Bernoulli	3, 4, 17	35.0 N	60.7 E	47.0	1985	Jacques, Swiss mathematician (1654–1705); Jean, Swiss mathematician (1667–1748).	16
Berosus	3, 16	33.5 N	69.9 E	74.0	1935	Berosus the Chaldean, Babylonian astronomer (unknown – *c.* 250 BC).	16
Bessel	7, 21	21.8 N	17.9 E	15.0	1935	Friedrich Wilhelm, German astronomer (1784–1846).	24
Bettinus	12, 13, 25	63.4 S	44.8 W	71.0	1935	Mario, Italian mathematician, astronomer (1582–1657).	71
Bianchini	11, 12, 25	48.7 N	34.3 W	38.0	1935	Francesco, Italian astronomer (1662–1729).	2, 10
Biela	4, 5, 18	54.9 S	51.3 E	76.0	1935	Wilhelm von, Austrian astronomer (1782–1856).	75, 76
Biela A	5	—	—	—	—	No official name by IAU.	75, 76
Biela B	4	—	—	—	—	No official name by IAU.	75, 76
Bilharz	4	5.8 S	56.3 E	43.0	1976	T., German doctor (1825–1862).	49
Billy	13, 26	13.8 S	50.1 W	45.0	1935	Jacques de, French mathematician (1602–1679).	40
Biot B	4	—	—	—	—	No official name by IAU.	59
Birt	9, 10, 22	22.4 S	8.5 W	16.0	1935	William R., British selenographer (1804–1881).	54
Blagg	8, 22	1.3 N	1.5 E	5.0	1935	Mary Adela, British astronomer (1858–1944).	33
Blancanus	10, 11, 12, 23, 24	63.8 S	21.4 W	117.0	1935	Biancani, Giuseppe, Italian mathematician, astronomer (1566–1624).	72
Blanchinus	8	25.4 S	2.5 E	61.0	1935	Bianchini, Giovanni, Italian astronomer (unknown – *fl.* 1458).	55
Bode	9, 22	6.7 N	2.4 W	18.0	1935	Johann Elert, German astronomer (1747–1826).	33
Boguslawsky	6, 7, 15, 16, 17	72.9 S	43.2 E	97.0	1935	Palon Heinrich Ludwig von, German astronomer (1789–1851).	74
Bohnenberger	6	16.2 S	40.0 E	33.0	1935	Johann Gottlieb Friedrich Von, German astronomer (1765–1831).	58
Bohr	15	12.4 N	86.6 W	71.0	1964	Niels H.D., Danish physicist, Nobel laureate (1885–1962).	28, VIII
Bonpland	10, 23	8.3 S	17.4 W	60.0	1935	Aime, French botanist (1773–1858).	42
Boole	15	63.7 N	87.4 W	63.0	1964	George, British mathematician (1815–1864).	2, I
Boscovich	7, 20	9.8 N	11.1 E	46.0	1935	Ruggiero Giuseppe, Italian physicist (1711–1787).	34
Bouguer	12, 25	52.3 N	35.8 W	22.0	1935	Pierre, French hydrographer (1698–1758).	2
Boussingault	4, 6, 7, 15, 16, 17	70.2 S	54.6 E	142.0	1935	Jean Baptiste Dieudonne, French chemist (1802–1887).	74, 75

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Boussingault E	6	—	—	—	—	No official name by IAU.	74, 75
Brayley	11	20.9 N	36.9 E	14.0	1935	Edward William, British geographer (1801–1870).	19
Breislak	6, 20	48.2 S	18.3 E	49.0	1935	Scipione, Italian chemist, geologist, mathematician (1748–1826).	66
Brenner	19	39.0 S	39.3 E	97.0	1935	Leo, Austrian astronomer (1855–1928).	68
Brianchon	15	75.0 N	86.2 W	134.0	1964	Charles J., French mathematician (1783–1864).	2, 3, I
Bruce	8, 22	1.1 N	0.4 E	6.0	1935	Catherine Wolfe, American philanthropist, astronomer (1816–1900).	33
Buch	6, 20	38.8 S	17.7 E	53.0	1935	Christian Leopold von, German geologist (1774–1853).	66
Bullialdus	10, 11, 23, 24	20.7 S	22.2 W	60.0	1935	Boulliaud, Ismael, French astronomer (1605–1694).	53
Bullialdus B	10	—	—	—	—	No official name by IAU.	53
Bullialdus W	24	—	—	—	—	No official name by IAU.	53
Bunsen	15	41.4 N	85.3 W	52.0	1964	Robert W., German chemist (1811–1899).	8, VIII
Burckhardt	3, 4, 17	31.1 N	56.5 E	56.0	1935	Johann Karl, German astronomer (1773–1825).	16
Burckhardt E	4	—	—	—	—	No official name by IAU.	16
Burckhardt F	4	—	—	—	—	No official name by IAU.	16
Bürg	6, 19	45.0 N	28.2 E	39.0	1935	Johann Tobias, Austrian astronomer (1766–1834).	14
Büsching	6, 20	38.0 S	20.0 E	52.0	1935	Anton Friedrich, German geographer (1724–1793).	66
Byrd	8, 15, 16, 21	85.3 N	9.8 E	93.0	1964	Richard E., American explorer, aviator, navigator (1888–1957).	4, II
Byrgius	13, 14, 26	24.7 S	65.3 W	87.0	1935	Burgi, Joost, Swiss horologist (1552–1632).	50, 51
Byrgius A	1, 14	—	—	—	—	No official name by IAU.	50, 51
Byrgius D	14	—	—	—	—	No official name by IAU.	50, 51
C. Herschel	11, 21, 23	34.5 N	31.2 W	13.0	1935	Caroline, British astronomer (1750–1848).	10
C. Mayer	7	63.2 N	17.3 E	38.0	1935	Christian, German astronomer, mathematician, physicist (1719–1783).	5
Calippus	7, 20	38.9 N	10.7 E	32.0	1935	Calippus of Cyzicus, Greek astronomer (*c.* 330 BC).	13
Campanus	11, 24	28.0 S	27.8 W	48.0	1935	Campano, Giovanni, Italian astronomer (*c.* 1200 – unknown).	53
Capella	6, 19	7.5 S	35.0 E	90.0	1935	Martianus, Roman astronomer (*c.* AD 400 – unknown).	47
Capuanus	10, 11, 24	34.1 S	26.7 W	59.0	1935	Francesco Capuano Di Manfredonia, Italian astronomer (*c.* 1400 – unknown).	63
Cardanus	14	13.2 N	0.0 E	49.0	1935	Cardano, Girolamo, Italian mathematician (1501–1576).	28
Carpenter	12, 13, 15, 24, 25	69.4 N	50.9 W	59.0	1935	James, British astronomer (1840–1899); Edwin F., American Astronomer (1898–1963).	2, 3
Carrington	4	44.0 N	62.1 E	30.0	1935	Richard Christopher, British astronomer (1826–1875).	15
Casatus	10, 11, 12, 23	72.8 S	29.5 W	108.0	1935	Casati, Paolo, Italian mathematician (1617–1707).	72, VI
Cassini	8	40.2 N	4.6 E	56.0	1935	Giovanni Domenico, Italian–French astronomer (1625–1712); Jacques J., French astronomer (1677–1756).	12
Catharina	6, 9, 19, 20	18.1 S	23.4 E	104.0	1935	St. Catherine of Alexandria, Greek theologian, philosopher (unknown – *c.* 307).	57
Catharina P	6	—	—	—	—	No official name by IAU.	57
Cauchy	5, 19	9.6 N	38.6 E	12.0	1935	Augustin Louis, French mathematician (1789–1857).	36
Cavalerius	13, 14, 27	5.1 N	66.8 W	57.0	1935	Cavalieri, Buonaventura, Italian mathematician (1598–1647).	28
Cavendish	13, 26	24.5 S	53.7 W	56.0	1935	Henry, British chemist, physicist (1731–1810).	51
Cavendish E	13	—	—	—	—	No official name by IAU.	51
Cayley	7	4.0 N	15.1 E	14.0	1935	Arthur, British astronomer, mathematician (1821–1895).	34
Censorinus	1, 6, 19	0.4 S	32.7 E	3.0	1935	Roman astronomer (*fl.* 238 – unknown).	47
Cepheus	5, 18	40.8 N	45.8 E	39.0	1935	Mythological astronomer, father of Andromeda.	15
Chacornac	6, 7, 19	29.8 N	31.7 E	51.0	1935	Jean, French astronomer (1823–1873).	14, 25
Challis	8, 15, 16, 21	79.5 N	9.2 E	55.0	1935	James, British astronomer, mathematician, physicist (1803–1862).	4
Chevallier	4	44.9 N	51.2 E	52.0	1935	Temple, British astronomer (1794–1873).	15
Chladni	8, 9	4.0 N	1.1 E	13.0	1935	Ernst Florens Friedrich, German physicist (1756–1827).	33
Cichus	10, 11	33.3 S	21.1 W	40.0	1935	F. D. Stabili (Cecco D'Ascoli), Italian astronomer (1275–1327).	63
Cichus B	1	—	—	—	—	No official name by IAU.	63
Cichus C	10	—	—	—	—	No official name by IAU.	63

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Clairaut	7, 20, 21	47.7 S	13.9 E	75.0	1935	Alexis Claude, French mathematician (1713–1765).	66
Clausius	12	36.9 S	43.8 W	24.0	1935	Rudolf Julius Emmanuel, German physicist (1822–1888).	62
Clavius	9, 10, 11, 21, 22, 23, 24	58.8 S	14.1 W	245.0	1935	Christopher Klau, German mathematician (1537–1612).	72, 73
Cleomedes	3, 4, 5, 17	27.7 N	56.0 E	125.0	1935	Greek astronomer (unknown – *c.* 50 BC).	26
Cleostratus	15	60.4 N	77.0 W	62.0	1935	Greek astronomer (unknown – *c.* 500 BC).	1, I
Colombo	5, 18	15.1 S	45.8 E	76.0	1935	Columbus,Christopher, Spanish explorer (*c.* 1446–1506).	59
Colombo A	5	—	—	—	—	No official name by IAU.	59
Condorcet	3, 16	12.1 N	69.6 E	74.0	1935	Jean de, French mathematician (1743–1794).	38
Conon	8, 9	21.6 N	2.0 E	21.0	1935	Conon of Samos, Greek astronomer (*c.* 260 BC).	22
Cook	4, 5, 18	17.5 S	48.9 E	46.0	1935	James, British explorer (1728–1779).	59
Copernicus	1, 10, 11, 12, 17, 22, 23, 24	9.7 N	20.1 W	107.0	1935	Nicholas, Polish astronomer (1473–1543).	31
Cremona	15	67.5 N	90.6 W	85.0	1964	Luigi, Italian mathematician (1830–1903).	I
Crüger	14, 27	16.7 S	66.8 W	45.0	1935	Peter, German mathematician (1580–1639).	50
Curtius	7, 8, 21	67.2 S	4.4 E	95.0	1935	Curtz, Albert, German astronomer (1600–1671).	73
Cusanus	4, 5, 15, 16	72.0 N	70.8 E	63.0	1935	Nikolaus Krebs, German mathematician, philosopher (1401–1464).	6, II
Cuvier	7, 8, 20, 21	50.3 S	9.9 E	75.0	1935	Georges, French natural scientist, paleontologist (1769–1832).	74
Cyrillus	6, 7, 9, 19, 20	13.2 S	24.0 E	98.0	1935	Saint Cyril, Egyptian theologian, chronologist (unknown – AD 444).	46
Cysatus	9, 10	66.2 S	6.1 W	48.0	1935	Cysat, Jean-Baptiste, Swiss mathematician, astronomer (1588–1657).	73
D'Arrest	7	2.3 N	14.7 E	30.0	1935	Heinrich Ludwig, German astronomer (1822–1875).	34
Daguerre	19	11.9 S	33.6 E	46.0	1935	Louis, French artist, chemist, photographer (1789–1851).	47
Dalton	15	17.1 N	84.3 W	60.0	1964	John, British chemist, physicist (1766–1844).	17, VIII
Damoiseau	13	4.8 S	61.1 W	36.0	1935	Marie Charles Theodor De, French astronomer (1768–1846).	39
Darwin	13, 14, 27	20.2 S	69.5 W	120.0	1935	Charles, British natural scientist (1809–1882).	50
Darwin C	14	—	—	—	—	No official name by IAU.	50
Davy	23	11.8 S	8.1 W	34.0	1935	Humphry, British physicist (1778–1829).	43
Dawes	6	17.2 N	26.4 E	18.0	1935	William Rutter, British astronomer (1799–1868).	24
De la Rue	4, 5, 6, 18	59.1 N	52.3 E	134.0	1935	Warren, British astronomer (1815–1889).	6
De Morgan	7	3.3 N	14.9 E	10.0	1935	Augustus, British mathematician (1806–1871).	34
De Sitter	7, 16	80.1 N	39.6 E	64.0	1964	Willem, Dutch astronomer (1872–1934).	5, II
De Sitter M	16	—	—	—	—	No official name by IAU.	5, II
Debes	5	29.5 N	51.7 E	30.0	1961	Ernest, German cartographer (1840–1923).	26
Delambre	7, 20, 21	1.9 S	17.5 E	51.0	1935	Jean-Baptiste Joseph, French astronomer (1749–1822).	46
Delaunay	8	22.2 S	2.5 E	46.0	1935	Charles Eugene, French astronomer (1816–1872).	55
Delisle	11, 12, 21	29.9 N	34.6 W	25.0	1935	Joseph Nicolas, French astronomer (1688–1768).	9, 19
Dembowski	7, 20	2.9 N	7.2 E	26.0	1935	Baron Ercole, Italian astronomer (1815–1881).	34
Democritus	6, 7, 18, 19	62.3 N	35.0 E	39.0	1935	Greek astronomer, philosopher (*c.* 460–360 BC)	5
Demonax	7, 15, 17	77.9 S	60.8 E	128.0	1935	Greek philosopher (unknown – *c.* 100 BC).	74, V
Desargues	15, 24	70.2 N	73.3 W	85.0	1964	Gerard, French mathematician, engineer (1593–1662).	2, I
Descartes	7, 20, 21	11.7 S	15.7 E	48.0	1935	Rene, French mathematician, philosopher (1596–1650).	45
Deslandres	9, 22	33.1 S	4.8 W	256.0	1948	Henri Alexandre, French astrophysicist (1853–1948).	64, 65
Dionysius	1, 6, 20	2.8 N	17.3 E	18.0	1935	St. Dionysius the Areopagite, Greek astronomer (AD 9–120).	35
Diophantus	11, 12, 21	27.6 N	34.3 W	17.0	1935	Greek mathematician (unknown – *c.* AD 300).	19
Dollond E	20	—	—	—	—	No official name by IAU.	45
Donati	8	20.7 S	5.2 E	36.0	1935	Giovanni Battista, Italian astronomer (1826–1873).	55
Doppelmayer	12, 25	28.5 S	41.4 W	63.0	1935	Johann Gabriel, German mathematician, astronomer (1671–1750).	52
Drygalski	15	79.3 S	84.9 W	149.0	1964	Erich D. von, German geographer, geophysicist (1865–1949).	72, VI
Dubyago	3	4.4 N	70.0 E	51.0	1964	Dmitrij I., Russian astronomer (1850–1918); Alexander D., Soviet astronomer (1903–1959).	38
Eddington	14, 15	21.3 N	72.2 W	118.0	1964	Sir Arthur S., British astrophysicist, mathematician (1882–1944).	17

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Egede	20, 21	48.7 N	10.6 E	37.0	1935	Hans, Danish natural historian (1686–1758).	5, 13
Eimmart	3	24.0 N	64.8 E	46.0	1935	Georg Christoph, German astronomer (1638–1705).	27
Einstein	15	16.3 N	88.7 W	198.0	1964	Albert, German–American physicist, Nobel laureate (1879–1955).	17, VIII
Encke	11, 12, 25	4.6 N	36.6 W	28.0	1935	Johann Franz, German mathematician, astronomer (1791–1865).	30
Endymion	1, 4, 5, 6, 16, 17, 18	53.9 N	57.0 E	123.0	1935	Greek mythological character.	7
Epigenes	9, 22	67.5 N	4.6 W	55.0	1935	Greek astronomer (unknown – *c.* 200 BC).	4
Eratosthenes	9, 10, 22	14.5 N	11.3 W	58.0	1935	Greek astronomer, geographer (*c.* 276–196 BC).	21, 32
Euclides	1, 11, 24	7.4 S	29.5 W	11.0	1935	Euclid, Greek mathematician (unknown – *c.* 300 BC).	41
Euctemon	7	76.4 N	31.3 E	62.0	1935	Greek astronomer (unknown – *fl.* 432 BC).	5
Eudoxus	1, 7, 19, 20, 21	44.3 N	16.3 E	67.0	1935	Greek astronomer (*c.* 408–355 BC).	13
Euler	1, 11, 23	23.3 N	29.2 W	27.0	1935	Leonhard, Swiss mathematician (1707–1783).	20
Fabricius	5	42.9 S	42.0 E	78.0	1935	Goldschmidt, David, Dutch astronomer (1564–1617).	68
Faraday	7, 8, 21	42.4 S	8.7 E	69.0	1935	Michael, British chemist, physicist (1791–1867).	66
Faye	8	21.4 S	3.9 E	36.0	1935	Herve, French astronomer (1814–1902).	55
Fernelius	8	38.1 S	4.9 E	65.0	1935	Jean, French doctor, astronomer (1497–1558).	65
Feuillée	22	27.4 N	9.4 W	9.0	1935	Louis, French natural scientist (1660–1732)	21
Firmicus	3, 16	7.3 N	63.4 E	56.0	1935	Maternus, Italian astronomer (unknown – *c.* 330).	38
Flammarion	9	3.4 S	3.7 W	74.0	1935	Camille, French astronomer (1842–1925).	44
Flamsteed	12, 25	4.5 S	44.3 W	20.0	1935	John, British astronomer (1646–1720).	40
Fontenelle	10, 11, 23	63.4 N	18.9 W	38.0	1935	Bernard Le Bovier De, French astronomer (1657–1757).	3
Foucault	12, 25	50.4 N	39.7 W	23.0	1935	Leon, French physicist (1819–1868).	2
Fourier	13	30.3 S	53.0 W	51.0	1935	Jean-Baptiste Joseph, French mathematician (1768–1830).	51, 61
Fra Mauro	10, 11, 23, 24	6.1 S	17.0 W	101.0	1935	Italian geographer (unknown – 1459).	42, 43
Fracastorius	6, 19	21.5 S	33.2 E	112.0	1935	Fracastoro, Girolamo, Italian doctor, astronomer (1483–1553).	58
Franklin	5, 18	38.8 N	47.7 E	56.0	1935	Benjamin, American inventor (1706–1790).	15
Fraunhofer	3	39.5 S	59.1 E	56.0	1935	Joseph von, German astronomer, optician (1787–1826).	69
Furnerius	3, 17	36.0 S	60.6 E	135.0	1935	Furner, Georges, French mathematician (unknown – *fl.* 1643).	69
Furnerius A	1	—	—	—	—	No official name by IAU.	69
G. Bond	19	32.4 N	36.2 E	20.0	1935	George Philip, American astronomer (1826–1865).	15
Galen	8	21.9 N	5.0 E	10.0	1973	Claudius, Greek doctor (*c.* 129–200).	22
Galilaei	14	10.5 N	62.7 W	15.0	1935	Galileo, Italian astronomer, physicist (1564–1642).	28
Galle	7	55.9 N	22.3 E	21.0	1935	Johann Gottfried, German astronomer (1812–1910).	5
Galvani	15	49.6 N	84.6 W	80.0	1961	Luigi, Italian physicist (1737–1798).	1, 8, I
Gambart	23	1.0 N	15.2 W	25.0	1935	Jean Felix, French astronomer (1800–1836).	32
Gärtner	6, 19	59.1 N	34.6 E	115.0	1935	Christian, German mineralogist, geologist (*c.* 1750–1813).	6
Gassendi	1, 11, 12, 13, 25, 26	17.6 S	40.1 W	101.0	1935	Pierre, French astronomer, mathematician (1592–1655).	52
Gassendi A	12	—	—	—	—	No official name by IAU.	52
Gassendi B	12	—	—	—	—	No official name by IAU.	52
Gaudibert	6, 19	10.9 S	37.8 E	34.0	1935	Casimir Marie, French astronomer (1823–1901).	47
Gauricus	9, 10, 23	33.8 S	12.6 W	79.0	1935	Gaurico, Luca, Italian astronomer (1476–1558).	64
Gauss	2, 3, 16	35.7 N	79.0 E	177.0	1935	Karl Friedrich, German mathematician (1777–1855).	16, III
Gay-Lussac	10	13.9 N	20.8 W	26.0	1935	Joseph Louis, French physicist (1778–1850).	31
Geber	7, 21	19.4 S	13.9 E	44.0	1935	Gabir Ben Aflah, Spanish-Arab astronomer (unknown – *c.* 1145)	56
Geminus	3, 4, 17	34.5 N	56.7 E	85.0	1935	Greek astronomer (unknown – *c.* 70 BC).	16
Gemma Frisius	7, 21	34.2 S	13.3 E	87.0	1935	Jemma, Reinier, Dutch doctor (1508–1555).	66
Gilbert	2	3.2 S	76.0 E	112.0	1964	Grove K., American geologist (1843–1918).	49
Gill	16	63.9 S	75.9 E	66.0	1964	Sir David, British astronomer (1843–1914).	75, V
Gioja	15, 16, 21	83.3 N	2.0 E	41.0	1935	Flavio, Italian inventor (unknown – *fl.* 1302).	4, I, II
Goclenius	1, 5, 18	10.0 S	45.0 E	72.0	1935	Gockel, Rudolf, German physicist, doctor, mathematician (1572–1621).	48
Godin	1, 7, 20, 21	1.8 N	10.2 E	34.0	1935	Louis, French astronomer, mathematician (1704–1760).	34

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Goldschmidt	9, 10, 20, 22	73.2 N	3.8 W	113.0	1935	Hermann, German astronomer (1802–1866).	4
Goodacre	7, 21	32.7 S	14.1 E	46.0	1935	Walter, British selenographer (1856–1938).	66
Gould	10, 23	19.2 S	17.2 W	34.0	1935	Benjamin Apthorp, American astronomer (1824–1896).	53
Greaves	4	13.2 N	52.7 E	13.0	1976	William Michael Herbert, British astronomer (1897–1955).	37
Grimaldi	1, 14, 15, 27	5.5 S	68.3 W	172.0	1935	Francesco Maria, Italian astronomer, physicist (1618–1663).	39
Gruemberger	9, 10	66.9 S	10.0 W	93.0	1935	Christoph, Austrian astronomer (1561–1636).	73
Gruithuisen	12	32.9 N	39.7 W	15.0	1935	Franz von, German astronomer (1774–1852).	9
Guericke	10, 23	11.5 S	14.1 W	63.0	1935	Otto von, German physicist, engineer, naturalist (1602–1686).	43
Gutenberg	5, 18	8.6 S	41.2 E	74.0	1935	Johann, German inventor (*c.* 1398–1468).	48
Hagecius	5, 6, 18	59.8 S	46.6 E	76.0	1935	Hayek, Thaddaeus, Czechoslovakian astronomer, mathematician (1525–1600).	75
Hahn	3, 16	31.3 N	73.6 E	84.0	1935	Friedrich von, German astronomer (1741–1805; Otto, German chemist (1879–1968).	16
Hainzel	11, 12, 24, 25	41.3 N	33.5 W	70.0	1935	Paul, German astronomer (unknown – *fl.* 1570).	63
Hainzel A	12	—	—	—	—	No official name by IAU.	63
Hainzel C	12	—	—	—	—	No official name by IAU.	63
Hall	19	33.7 N	37.0 E	35.0	1935	Asaph, American astronomer (1829–1907).	15
Halley	7, 8	8.0 S	5.7 E	36.0	1935	Edmond, British astronomer (1656–1742).	45
Hanno	15, 16	56.3 S	71.2 E	56.0	1935	Roman explorer (unknown – *c.* 500 BC).	76, V
Hansen	3, 16	14.0 N	72.5 E	39.0	1935	Peter Andreas, Danish astronomer (1795–1874).	38
Hansteen	13, 26	11.5 S	52.0 W	44.0	1935	Christopher, Norwegian astronomer (1784–1873).	40
Harpalus	12, 13, 25	52.6 N	43.4 W	39.0	1935	Greek astronomer (unknown – *c.* 460 BC).	2
Hase	3	29.4 S	62.5 E	83.0	1935	Johann Matthias, German mathematician (1684–1742).	59
Hase D	3	—	—	—	—	No official name by IAU.	59
Hausen	15	65.0 S	88.1 W	167.0	1961	Christian August, German astronomer, mathematician, physicist (1693–1743).	71, VI
Hayn	3, 15	64.7 N	85.2 E	87.0	1964	Friedrich, German astronomer (1863–1928).	6, II
Hecataeus	2, 15, 16	21.8 S	79.4 E	167.0	1935	Greek geographer (unknown – *c.* 476 BC).	60, IV
Hedin	14	2.0 N	76.5 W	150.0	1964	Sven A., Swedish explorer (1865–1952).	28
Heinsius	10	39.5 S	17.7 W	64.0	1935	Gottfried, German astronomer (1709–1769).	64
Heis	11	32.4 N	31.9 W	14.0	1935	Eduard, German astronomer (1806–1877).	10
Helicon	10, 11, 23	40.4 N	23.1 W	24.0	1935	Greek astronomer, mathematician (unknown – *c.* 400 BC).	10
Hell	9, 22	32.4 S	7.8 W	33.0	1935	Maximilian, Hungarian astronomer (1720–1792).	64
Helmholtz	4, 15, 16, 17	68.1 S	64.1 E	94.0	1935	Hermann Von, German doctor (1821–1894).	75, V
Henry	13, 26	24.0 S	56.8 W	41.0	1970	Joseph, American physicist (1792–1878).	51
Henry Frères	13, 26	23.5 S	58.9 W	42.0	1961	Prosper, French astronomer (1849–1903); Paul, French astronomer (1848–1905).	51
Heraclitus	7, 8, 21	49.2 S	6.2 E	90.0	1961	Greek philosopher (*c.* 540–480 BC).	73
Hercules	1, 5, 6, 17, 18	46.7 N	39.1 E	69.0	1935	Greek mythological hero.	14
Hermite	15, 16, 24	86.0 N	89.9 W	104.0	1964	Charles, French mathematician (1822–1901).	4, I
Herodotus	13, 25, 26	23.2 N	49.7 W	34.0	1935	Of Halikarnassus, Greek historian (*c.* 484–408 BC).	18
Herschel	9, 21	5.7 S	2.1 W	40.0	1935	William, British astronomer (1738–1822).	44
Hesiodus	10, 23	29.4 S	16.3 W	42.0	1935	Hesiod, Greek humanitarian (*c.* 735 BC).	54
Hesiodus A	10, 23	—	—	—	—	No official name by IAU.	54
Hevelius	13, 14, 27	2.2 N	67.6 W	115.0	1935	Howelcke, Johann, Polish astronomer (1611–1687).	28
Hind	7	7.9 S	7.4 E	29.0	1935	John Russell, British astronomer (1823–1895).	45
Hippalus	11, 12, 24, 25	24.8 S	30.2 W	57.0	1935	Greek explorer (unknown – *c.* 120).	52, 53
Hipparchus	7, 8, 9	5.1 S	5.2 E	138.0	1935	Greek astronomer (unknown – *fl.* 140 BC).	44, 45
Hommel	6, 18, 19	54.7 S	33.8 E	126.0	1935	Johann, Greek astronomer, mathematician (1518–1562).	75
Hooke	4	41.2 N	54.9 E	36.0	1935	Robert, British physicist, inventor (1635–1703).	15
Horrebow	12, 25	58.7 N	40.8 W	24.0	1935	Peder, Danish astronomer (1679–1764).	2
Horrocks	8	4.0 S	5.9 E	30.0	1935	Jeremiah, British astronomer (1619–1641).	45
Hortensius	11	6.5 N	28.0 W	14.0	1935	Hove, Martin van den, Dutch astronomer (1605–1639).	30
Hubble	2	22.1 N	86.9 E	80.0	1964	Edwin P., American astronomer (1889–1953).	27, III
Huggins	9	41.1 S	1.4 W	65.0	1935	Sir William, British astronomer (1824–1910).	65

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Humboldt	2, 3, 15, 16	27.0 S	80.9 E	189.0	1935	Wilhelm von, German philologist (1767–1835).	60, IV
Hyginus	8	7.8 N	6.3 E	9.0	1935	Caius Julius, Spanish astronomer (unknown – *c.* AD 100).	34
Ibn-Rushd	20	11.7 S	21.7 E	32.0	1976	Spanish–Arab philosopher, doctor (1126–1198).	46
Inghirami	13, 14	47.5 S	68.8 W	91.0	1935	Giovanni, Italian astronomer (1779–1851).	61, 62
Isidorus	6, 19	8.0 S	33.5 E	42.0	1935	St. Isidore of Seville, Roman astronomer (*c.* 570–636).	47
J. Herschel	11, 12, 24, 25, 26	62.0 N	42.0 W	165.0	1935	John, British astronomer (1792–1871).	2
Jacobi	7, 8, 20, 21	56.7 S	11.4 E	68.0	1935	Karl Gustav Jacob, German mathematician (1804–1851).	74
Janssen	5, 18, 19	13.5 N	28.7 E	23.0	1935	Janszoon, Zacharias, Dutch optician (1580–*c.* 1638).	67, 68
Julius Caesar	7, 20, 21	9.0 N	15.4 E	90.0	1935	Roman emperor (*c.* 102–44 BC).	34
Kaiser	8	36.5 S	6.5 E	52.0	1935	Frederick, Dutch astronomer (1808–1872).	65, 66
Kane	7	63.1 N	26.1 E	54.0	1935	Elisha Kent, American explorer (1820–1857).	5
Kant	20	10.6 S	20.1 E	33.0	1935	Immanuel, German philosopher (1724–1804).	46
Kapteyn	3	10.8 S	70.6 E	49.0	1964	Jacobus C., Dutch astronomer (1851–1922).	49
Kästner	2, 16	6.8 S	78.5 E	108.0	1961	Abraham Gotthelf, German mathematician, physicist (1719–1800).	49
Kästner G	2	—	—	—	—	No official name by IAU.	49
Keldysh	5	51.2 N	43.6 E	33.0	1982	Mstislav V., Soviet mathematician (1911–1978).	6
Kepler	1, 11, 12, 17, 24, 25	8.1 N	38.0 W	31.0	1935	Johannes, German astronomer (1571–1630).	30
Kies	10, 23, 24	26.3 S	22.5 W	45.0	1935	Johann, German mathematician, astronomer (1713–1781).	53
Kinau	20	60.8 S	15.1 E	41.0	1935	C.A., German botanist, selenographer (unknown – *fl.* 1850).	74
Kircher	12, 13, 25	67.1 S	45.3 W	72.0	1935	Athanasius, German humanitarian (1601–1680).	71, 72
Kirchhoff	6	30.3 N	38.8 E	24.0	1935	Gustav Robert, German physicist (1824–1887).	15
Klaproth	10, 11, 12, 23	69.8 S	26.0 W	119.0	1935	Martin Heinrich, German chemist, mineralogist (1743–1817).	72
Klein	8	12.0 S	2.6 E	44.0	1935	Hermann Joseph, German astronomer (1844–1914).	44
Knox-Shaw	2	5.3 N	80.2 E	12.0	1973	Harold, British astronomer (1885–1970).	38, III
König	10, 23, 24	24.1 S	24.6 W	23.0	1935	Rudolf, Austrian mathematician, astronomer (1865–1927).	53
Krafft	14	16.6 N	72.6 W	51.0	1935	Wolfgang Ludwig, German astronomer, physicist (1743–1814).	17
Krusenstern	7	26.2 S	5.9 E	47.0	1935	Adam Johann, Baron Von, Russian explorer (1770–1846).	55, 56
Kundt	23	11.5 S	11.5 W	10.0	1976	August, German physicist (1839–1894)	43
La Caille	8	23.8 S	1.1 E	67.0	1961	Nicholas Louis De, French astronomer (1713–1762).	55
La Condamine	11, 12	53.4 N	28.2 W	37.0	1961	Charles Marie De, French astronomer, physicist (1701–1774).	2
La Condamine A	12	—	—	—	—	No official name by IAU.	2
La Pérouse	2, 3, 16	10.7 S	76.3 E	77.0	1935	Jean Francois de Galoup, Comte De La Pérouse, French explorer (1741–1788).	49
Lade	7	1.3 S	10.1 E	55.0	1935	Heinrich Eduard von, German astronomer (1817–1904).	45
Lagalla	10, 11, 23, 24	44.6 S	22.5 W	85.0	1935	Giulio Cesare, Italian philosopher (1571–1624).	63
Lagrange	14	32.3 S	72.8 W	225.0	1935	Joseph Louis, Italian mathematician (1736–1813).	61
Lalande	9, 22	4.4 S	8.6 W	24.0	1935	Joseph Jerome Le Francois De, French astronomer (1732–1807).	43
Lamarck	14, 27	22.0 S	69.8 W	100.0	1964	Jean B.P.A. De M., French natural historian (1744–1829).	50
Lambert	10, 11, 23	25.8 N	21.0 W	30.0	1935	Johann Heinrich, German astronomer, mathematician, physicist (1728–1777).	20
Lamé	3	14.7 S	64.5 E	84.0	1964	Gabriel, French mathematician (1795–1870).	49, 60
Lamont	6	4.4 N	23.7 E	106.0	1935	John, Scottish astronomer (1805–1879).	35
Langley	15	51.1 N	86.3 W	59.0	1964	Samuel P., American astronomer, physicist (1834–1906).	1, I
Langrenus	1, 3, 4, 5, 16, 17	8.9 S	61.1 E	127.0	1935	Langren, Michel Florent van, Belgian selenographer, engineer (*c.* 1600–1675).	49
Lansberg	11, 23, 24	0.3 S	26.6 W	38.0	1935	Philippe van, Belgian astronomer (1561–1632).	42
Lavoisier	15	38.2 N	81.2 W	70.0	1935	Antoine Laurent, French chemist (1743–1794).	8, VIII
Le Monnier	7, 19	26.6 N	30.6 E	60.0	1935	Pierre Charles, French astronomer, physicist (1715–1799).	24, 25
Le Verrier	10, 11, 23	40.3 N	20.6 W	20.0	1961	Urbain Jean, French astronomer, mathematician (1811–1877).	11
Lee	12, 25	30.7 S	40.7 W	41.0	1935	John, British astronomer, humanitarian (1783–1866).	62
Lee M	12, 25	—	—	—	—	No official name by IAU.	62

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Legendre	3, 16	28.9 S	70.2 W	78.0	1935	Adrien Marie, French mathematician (1752–1833).	59, 60
Letronne	12, 25, 26	10.8 S	42.5 W	116.0	1935	Jean Antoine, French archaeologist (1787–1848).	40
Lexell	9, 22	35.8 S	4.2 W	62.0	1935	Anders Johann, Swedish mathematician, astronomer (1740–1784).	65
Licetus	7, 8, 21	47.1 S	6.7 E	74.0	1935	Liceti, Fortunio, Italian physicist, philosopher, doctor (1577–1657).	65
Lick	4	12.4 N	52.7 E	31.0	1935	James, American benefactor (1796–1876).	37
Liebig	12, 13	24.3 S	48.2 W	37.0	1935	Justus, Baron von Liebig, German chemist (1803–1873).	51
Lilius	7, 8, 21	54.5 S	6.2 E	61.0	1935	Luigi Giglio, Italian doctor, philosopher, chronologist (unknown – 1576).	73
Lindenau	6, 20	32.2 S	24.9 E	53.0	1935	Bernhard von, German astronomer (1780–1854).	67
Linné	7, 20	27.7 N	11.8 E	2.0	1935	Carl von, Swedish botanist (1707–1778).	23
Littrow	6, 19	21.5 N	31.4 E	30.0	1935	Johann Josef von, Czechoslovakian astronomer (1781–1840).	25
Lohrmann	14	0.5 S	67.2 W	30.0	1935	Wilhelm Gotthelf, German selenographer (1796–1840).	39
Lohse	3	13.7 S	60.2 E	41.0	1935	Oswald, German astronomer (1845–1915).	49
Longomontanus	9, 10, 11, 23, 24	49.6 S	21.8 W	157.0	1935	Christian Sorensen, Danish astronomer, mathematician (1562–1647).	64, 72
Lubiniezky	10, 23, 24	17.8 S	23.8 W	43.0	1935	Stanislaus, Polish astronomer (1623–1675).	53
Lyapunov	2	26.3 N	89.3 E	66.0	1964	Aleksandr M., Russian mathematician, engineer (1857–1918).	27, III
Lyot	15, 16	49.8 S	84.5 E	132.0	1964	Bernard F., French astronomer (1897–1952).	69, 76, V
MacLear	6	10.5 N	20.1 E	20.0	1961	Thomas, Irish astronomer (1794–1879).	35
Macrobius	5, 18	21.3 N	46.0 E	64.0	1935	Ambrosius Aurelius Theodosius, Roman writer (unknown – *fl. c.* 410).	26
Mädler	6, 19	11.0 S	29.8 E	27.0	1935	Johann Heinrich, German astronomer (1794–1874).	47
Maestlin	12	4.9 N	40.6 W	7.0	1961	Michael, German mathematician (1550–1631).	29
Magelhaens	5, 18	11.9 S	44.1 E	40.0	1935	Fernao De (Ferdinand Magellan), Portuguese explorer (1480–1521).	48
Magelhaens A	5	—	—	—	—	No official name by IAU.	48
Maginus	9, 10, 22	50.5 S	6.3 W	194.0	1935	Magini, Giovanni Antonio, Italian astronomer, mathematician (1555–1617).	65, 73
Main	8, 15, 16, 21	80.8 N	10.1 E	46.0	1935	Robert, British astronomer (1808–1878).	4
Mairan	12, 25, 26	41.6 N	43.4 W	40.0	1935	Jean Jacques D'Ortous De, French geophysicist (1678–1771).	9
Manilius	1, 7, 20, 21	14.5 N	9.1 E	38.0	1935	Marcus, Roman writer (unknown – *c.* 50 BC).	23, 34
Manners	6	4.6 N	20.0 E	15.0	1935	Russell Henry, British astronomer (1800–1870).	35
Manzinus	6, 7, 8, 19, 20	67.7 S	26.8 E	98.0	1935	Manzini,Carlo Antonio, Italian astronomer (1599–1677).	74
Maraldi	6, 19	19.4 N	34.9 E	39.0	1935	Giovanni Domenico, Italian astronomer, geodesist (1709–1788); Jacques Philippe, French astronomer (1665–1729).	25
Marinus	15, 16	39.4 N	76.5 E	58.0	1935	Of Tyre, Greek geographer (unknown – *c.* 100).	69, IV
Marius	13, 25, 26	11.9 N	50.8 W	41.0	1935	Mayer, Simon, German astronomer (1570–1624).	29
Markov	13, 14, 26, 27	53.4 N	62.7 W	40.0	1964	Aleksandr V., Soviet astrophysicist (1897–1968); Andrei A., Russian mathematician (1856–1922).	1
Maskelyne	6	2.2 N	30.1 E	23.0	1935	Nevil, British astronomer (1732–1811).	36
Mason	6	42.6 N	30.5 E	33.0	1935	Charles, British astronomer (1730–1787).	14
Maupertuis	11, 12	49.6 N	27.3 W	45.0	1935	Pierre Louis De, French mathematician (1698–1759).	2
Maurolycus	6, 7, 8, 20, 21	42.0 S	14.0 E	114.0	1935	Maurolico, Francesco, Italian mathematician (1494–1575).	66
Mee	11, 12, 25	43.7 S	35.3 W	126.0	1935	Arthur Butler Phillips, Scottish astronomer (1860–1926).	63
Menelaus	1, 7, 8, 20, 21	16.3 N	16.0 E	26.0	1935	Of Alexandria, Greek geometer, astronomer (*c.* AD 98).	23
Mercator	10, 11, 24	29.3 S	26.1 W	46.0	1935	Gerard De Kremer (Gerhardus Mercator), Belgian cartographer, geographer, mathematician (1512–1594).	53
Mercurius	3, 4, 16	46.6 N	66.2 E	67.0	1935	Mercury, Roman mythical messenger.	15, 16
Mersenius	12, 13, 26	21.5 S	49.2 W	84.0	1935	Mersenne, Marin, French mathematician, physicist (1588–1648).	51
Messala	3, 4, 17	39.2 N	60.5 E	125.0	1935	AA (Ma-Sa-Allah), Jewish astronomer (unknown – *c.* 815).	16
Messier	5, 18	1.9 S	47.6 E	11.0	1935	Charles, French astronomer (1730–1817).	48
Messier A (Pickering in IAU website)	5, 18	2.9 S	7.0 E	15.0	1935	Edward Charles, American astronomer (1846–1919); William H., American astronomer (1858–1938).	48

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Metius	5	40.3 S	43.3 E	87.0	1935	Adriaan Adriaanszoon, Dutch astronomer (1571–1635).	68
Meton	7, 8, 19, 20, 21	73.6 N	18.8 E	130.0	1935	Greek astronomer (unknown – *fl.* 432 BC).	4, 5
Meton E	20	—	—	—	—	—	NA
Milichius	11	10.0 N	30.2 W	12.0	1935	Milich, Jacob, German doctor, mathematician, astronomer (1501–1559)	30
Miller	9	39.3 S	0.8 E	61.0	1935	William Allen, British chemist (1817–1870).	65
Mitchell	7	49.7 N	20.2 E	30.0	1935	Maria, American astronomer (1818–1889).	5
Moigno	7	66.4 N	28.9 E	36.0	1935	Francois Napoleon Marie, French mathematician, physicist (1804–1884).	5
Moigno A	7	—	—	—	—	No official name by IAU.	5
Monge	5, 18	19.2 S	47.6 E	36.0	1935	Gaspard, French mathematician (1746–1818).	59
Montanari	10, 11, 23, 24	45.8 S	20.6 W	76.0	1935	Geminiano, Italian astronomer, mathematician (1633–1687).	64
Moretus	9, 10, 12, 21	70.6 S	5.8 W	111.0	1935	Moret, Theodore, Belgian mathematician (1602–1667).	73
Mösting	9	0.7 S	5.9 W	24.0	1935	Johan Sigismund Von, Danish benefactor (1759–1843).	43
Mouchez	23	78.3 N	26.6 W	81.0	1935	Ernest Amedee Barthelemy, French astronomer (1821–1892).	3, 4
Murchison	8, 9, 22	5.1 N	0.1 W	57.0	1935	Sir Roderick Impey, Scottish geologist (1792–1871).	33
Mutus	6, 7, 19, 20	63.6 S	30.1 E	77.0	1935	Vincente Mut, or Muth, Spanish astronomer (unknown – 1673).	74
Nansen	7, 15	80.9 N	95.3 E	104.0	1964	Fridtjof, Norwegian explorer (1861–1930).	II
Naonobu	4	4.6 S	57.8 E	34.0	1976	Ajima, Japanese mathemetician (*c.* 1732–1798).	49
Nasireddin	9	41.0 S	0.2 E	52.0	1935	Nasir-Al-Din (Mohammed Ibn Hassan), Persian astronomer (1201–1274).	65
Nasmyth	13, 26, 27	50.5 S	56.2 W	76.0	1935	James, Scottish engineer, astronomer (1808–1890).	70
Neander	5, 19	31.3 S	39.9 E	50.0	1935	Neumann, Michael, German mathematician (1529–1581).	68
Nearch	5, 6, 18, 19	58.5 S	39.1 E	75.0	1935	Greek explorer (unknown – *fl.* 325 BC).	75
Nearch A	5, 19	—	—	—	—	No official name by IAU.	75
Nearch B	19	—	—	—	—	No official name by IAU.	75
Nearch C	19	—	—	—	—	No official name by IAU.	75
Neison	7	68.3 N	25.1 E	53.0	1935	(Neville), Edmund, British astronomer, selenographer 1849–1940).	5
Neper	2, 16	8.5 N	84.6 E	137.0	1935	John, Scottish mathematician (1550–1617).	38, III
Neumayer	15	71.1 S	70.7 E	76.0	1935	Georg Balthasar von, German meteorologist, hydrographer (1826–1909).	75, V
Newcomb	5, 6, 18	29.9 N	43.8 E	41.0	1935	Newcomb, Simon, Canadian-American astronomer (1835–1909).	15, 25
Newcomb A	5	—	—	—	—	No official name by IAU.	15, 25
Newton	10, 12	76.7 S	16.9 W	78.0	1935	Isaac, British mathematician, physicist, astronomer (1643–1727).	73
Nicolai	6	42.4 S	25.9 E	42.0	1935	Friedrich Bernhard Gottfried, German astronomer (1793–1846).	67
Nicollet	10	21.9 S	12.5 W	15.0	1935	Jean Nicholas, French astronomer (1788–1843).	54
Nöggerath	12	48.8 S	45.7 W	30.0	1935	Johann Jakob, German geologist, mineralogist, seismologist (1788–1877).	62, 70
Nonius	8	34.8 S	3.8 E	69.0	1935	Nunez, Pedro, Portuguese mathematician (1492(?)–1578).	65
Oenopides	13, 14, 25, 26, 27	57.0 N	64.1 W	67.0	1935	Of Chios, Greek astronomer, geometrician (500(?)–430 BC).	I
Oersted	18	43.1 N	47.2 E	42.0	1935	Hans Christian, Danish physicist, chemist (1777–1851).	15
Oken	15, 16	43.7 S	75.9 E	71.0	1935	(Okenfuss), Lorenz, German biologist, physiologist (1779–1851).	69, IV
Olbers	14	7.4 N	75.9 W	74.0	1935	Heinrich Wilhelm Malthaus, German astronomer, doctor (1758–1840).	28
Olbers A (new name is now Glushko)	1	—	—	—	1994	Official name Glushko approved by IAU in 1994. Indexed as Olbers A here because of Olbers above.	28
Opelt	10, 23	16.3 S	17.5 W	48.0	1935	Friedrich Wilhelm, German astronomer (1794–1863).	53
Oppolzer	9	1.5 S	0.5 W	40.0	1935	Theodor Egon von, Czechoslovakian astronomer (1841–1886).	44
Orontius	9, 22	40.6 S	4.6 W	105.0	1935	Finnaeus (Oronce Fine), French mathemetician, cartographer (1494–1555)	65

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Palitzsch	3, 17	28.0 S	64.5 E	41.0	1935	Johann Georg, German astronomer (1723–1788).	59
Pallas	9, 22	5.5 N	1.6 W	46.0	1935	Peter Simon, German geologist, natural historian (1741–1811).	33
Parrot	8	14.5 S	3.3 E	70.0	1935	Johann Jacob F. W., Russian doctor, physicist (1792–1840).	44, 55
Parry	10, 23	7.9 S	15.8 W	47.0	1935	William Edward, British explorer (1790–1855).	42, 43
Pascal	15, 24	74.6 N	70.3 W	115.0	1964	Blaise, French mathematician (1623–1662).	3, I
Peary	15, 16, 21	88.6 N	33.0 E	73.0	1964	Robert E., American explorer (1856–1920).	4, II
Peirce	4	18.3 N	53.5 E	18.0	1935	Benjamin, American mathematician, astronomer (1809–1880).	26
Peirescius	3	46.5 S	67.6 E	61.0	1935	Peiresc, Nicolas Claude Fabri De, French astronomer, archaeologist (1580–1637).	68, 69
Pentland	8, 20	64.6 S	11.5 E	56.0	1935	Joseph Barclay, Irish geographer (1797–1873).	73, 74
Petavius	3, 4, 5, 8, 15, 16, 17	25.1 S	60.4 E	188.0	1935	Petau, Denis, French chronologist, astronomer (1583–1652).	59
Petavius B	1	—	—	—	—	No official name by IAU.	
Petermann	4, 5, 15, 16	74.2 N	66.3 E	73.0	1935	August Heinrich, German geographer (1822–1878).	5, II
Petermann R	16	—	—	—	—	No official name by IAU.	5, II
Phillips	2, 16	26.6 S	75.3 E	122.0	1935	John, British geologist, astronomer (1800–1874).	60
Philolaus	11, 12, 15, 22, 23, 24, 25	72.1 N	32.4 W	70.0	1935	Of Croton, Greek mathematician, astronomer, philosopher (unknown – *fl.* 400 BC).	3
Philolaus C	23	—	—	—	—	No official name by IAU.	3
Philolaus D	23	—	—	—	—	No official name by IAU.	3
Phocylides	13, 14, 26, 27	52.7 S	57.0 W	121.0	1935	Johannes Phocylides Holwarda (Jan Fokker), Dutch astronomer (1618–1651).	70
Piazzi	14	36.6 S	67.9 W	134.0	1935	Giuseppe, Italian astronomer (1746–1826).	61
Picard	4	14.6 N	54.7 E	22.0	1935	Jean, French astronomer (1620–1682).	26, 37
Piccolomini	6, 19	29.7 S	32.2 E	87.0	1935	Alessandro, Italian astronomer (1508–1578).	58, 68
Pictet	9	43.6 S	7.4 W	62.0	1935	Pictet-Turretin, Marc-Auguste, Swiss physicist (1752–1825).	64, 65
Pingré	14	58.7 S	73.7 W	88.0	1961	Alexandre Guy, French astronomer (1711–1796).	70, VI
Pitatus	1, 9, 10, 23	29.9 S	13.5 W	106.0	1935	Pitati, Pietro, Italian astronomer, mathematician (unknown – *fl. c.* 1500).	54, 64
Pitiscus	6, 19	50.4 S	30.9 E	82.0	1935	Bartholemaeus, German mathematician (1561–1613).	75
Plana	6	42.2 N	28.2 E	44.0	1935	Baron Giovanni Antonio Amedeo, Italian astronomer, geometrician (1781–1864).	14
Plato	1, 9, 10, 11, 15, 22, 23	51.6 N	9.4 W	109.0	1935	Greek philosopher *c.* 428 – *c.* 347 BC.	3, 4
Playfair	7, 21	23.5 S	8.4 E	47.0	1935	John, Scottish mathematician, geologist (1748–1819) .	56
Plinius	1, 6, 7, 20	15.4 N	23.7 E	43.0	1935	Gaius Plinius Secundus (The Elder), Roman natural scientist (23–79?).	24
Plutarch	2	24.1 N	79.0 E	68.0	1935	Greek biographer *c.* AD 46 – *c.* 120.	27, III
Polybius	6	22.4 S	25.6 E	41.0	1935	Greek historian (204(?)–122(?) BC).	57
Polybius A	1	—	—	—	—	No official name by IAU.	57
Poncelet	24	75.8 N	54.1 W	69.0	1964	Jean V., French mathematician, engineer (1788–1867).	3, I
Pontanus	7, 21	28.4 S	14.4 E	57.0	1935	Pontano, Giovanni Gioviani, Italian astronomer (1427–1503).	56
Pontécoulant	4, 15, 16, 17	58.7 S	66.0 E	91.0	1935	Philippe Gustave Doulcet, Comte De Pontécoulant, French mathematician (1795–1874).	76
Porter	10	56.1 S	10.1 W	51.0	1970	Russell W., American telescope designer (1871–1949).	72
Posidonius	1, 6, 7, 18, 19	31.8 N	29.9 E	95.0	1935	Of Apamea, Greek geographer (135(?)–51(?) BC).	14
Prinz	12, 25	25.5 N	44.1 W	46.0	1935	Wilhelm, German–Belgian astronomer (1857–1910).	19
Proclus	1, 4, 5, 8, 16, 17, 18	16.1 N	46.8 E	28.0	1935	Diadochos (The Successor), Greek mathematician, astronomer, philosopher (410–485).	26
Protagoras	8, 9, 21	56.0 N	7.3 E	21.0	1935	Greek philosopher (481(?)–411(?) BC).	4
Ptolemaeus	9, 21, 22	9.3 S	1.9 W	164.0	1935	Ptolemy, Claudius, Greek astronomer, mathematician, geographer (*c.* AD 87–150).	44
Ptolemaeus A	9	—	—	—	—	No official name by IAU.	44
Purbach	9, 22	25.5 S	2.3 W	115.0	1935	Georg von, Austrian mathematician, astronomer (1423–1461).	55

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Pythagoras	13, 14, 15, 25, 27	63.5 N	63.0 W	142.0	1935	Of Samos, Greek philosopher, mathematician (unknown – *fl. c.* 532 BC).	2, I
Pytheas	1, 10, 11, 23	20.5 N	20.6 W	20.0	1935	Of Marseilles, Greek navigator, geographer (born *c.* 308 BC).	20
Rabbi Levi	6, 20	34.7 S	23.6 E	81.0	1935	Gershon, Levi Ben, Spanish–Jewish philosopher, mathematician, astronomer (1288–1344).	67
Ramsden	11	32.9 S	31.8 W	24.0	1935	Jesse, British instrument maker (1735–1800).	63
Réaumur (Réumur) in Rükl	9	2.4 S	0.7 E	52.0	1935	Rene Antoine Ferchault De, French physicist (1683–1757).	44
Regiomontanus	9, 22	28.3 S	1.0 W	108.0	1935	Muller, Johann, German astronomer, mathematician (1436–1476).	55
Regnault	15	54.1 N	88.0 W	46.0	1961	Henri Victor, French chemist, physicist (1810–1878).	1, I
Reichenbach	18	30.3 S	48.0 E	71.0	1935	Georg von, German optician (1772–1826).	59, 69
Reiner	13, 25, 26	7.0 N	54.9 W	29.0	1935	Reinieri, Vincentio, Italian astronomer, mathematician (unknown – 1648).	29
Reinhold	10, 11, 23, 24	3.3 N	22.8 W	42.0	1935	Erasmus, German astronomer, mathematician (1511–1553).	31
Reinhold B	10	—	—	—	—	No official name by IAU.	31
Repsold	14, 15	51.3 N	78.6 W	109.0	1935	Johann Georg, German inventor (1770–1830).	1, I
Rhaeticus	8, 9	0.0 N	4.9 E	45.0	1935	Georg Joachim von Lauchen of Rhaetia, Hungarian astronomer, mathematician (1514–1576).	33, 44
Rheita	5, 18	37.1 S	47.2 E	70.0	1935	Anton Maria Schyrle of Rhaetia, Czechoslovakian astronomer, optician (*c.* 1597–1660).	68
Rheita E	5, 18	—	—	—	—	No official name by IAU.	68
Riccioli	1, 14, 15, 27	3.3 S	74.6 W	139.0	1935	Giovanni Battista, Italian astronomer (1598–1671).	39
Riccius	6, 20	36.9 S	26.5 E	71.0	1935	Ricci, Matteo, Italian mathematician, geographer (1552–1610).	67
Riemann	2	38.9 N	86.8 E	163.0	1964	Georg F.B., German mathematician (1826–1866).	16, III
Ritter	6, 20	2.0 N	19.2 E	29.0	1935	Karl, German geographer (1779–1859); August, German astrophysicist (*fl.* 1890).	35
Robinson	25	59.0 N	45.9 W	24.0	1935	John Thomas Romney, Irish astronomer, physicist, meteorologist (1792–1882).	2
Rocca	14	12.7 S	72.8 W	89.0	1935	Giovanni Antonio, Italian mathematician (1607–1656).	39
Römer	18, 19	25.4 N	36.4 E	39.0	1935	Ole, Danish astronomer (1644–1710).	25
Rosenberger	5, 6, 18, 19	55.4 S	43.1 E	95.0	1935	Otto August, German astronomer, mathematician (1800–1890).	75
Ross	6	11.7 N	21.7 E	24.0	1935	James Clark, British explorer (1800–1862); Frank E., American astronomer, optician (1874–1966).	35
Rost	12	56.4 S	33.7 W	48.0	1935	Leonhard, German astronomer (1688–1727).	71
Rost A	12	—	—	—	—	No official name by IAU.	71
Rothmann	6	30.8 S	27.7 E	42.0	1935	Christopher, German astronomer (unknown – 1600).	67
Russell	14, 15	26.5 N	75.4 W	103.0	1964	Henry Norris, American astronomer (1877–1957); John, British selenographer (1745–1806).	17
Rutherfurd	10	60.9 S	12.1 W	48.0	1935	Lewis Morris, American astronomer (1816–1892).	72
Sabine	6, 20	1.4 N	20.1 E	30.0	1935	Sir Edward, Irish physicist, astronomer (1788–1883).	35
Sacrobosco	7, 20, 21	23.7 S	16.7 E	98.0	1935	John of Holywood, Johannes Sacrobuschus, British astronomer, mathematician (*c.* 1200–1256).	56, 57
Santbech	5, 18	20.9 S	44.0 E	64.0	1935	Daniel Santbech Noviomagus, Dutch mathematician, astronomer (unknown – *fl.* 1561).	59
Saussure	9	43.4 S	3.8 W	54.0	1935	Horace Benedict De, Swiss geologist (1740–1799).	65
Scheiner	10, 11, 12, 23, 24	60.5 S	27.5 W	110.0	1935	Christopher, German astronomer (1575–1650).	72
Schickard	1, 13, 14, 25, 26, 27	44.3 S	55.3 W	206.0	1935	Wilhelm, German astronomer, mathematician (1592–1635).	62
Schiller	11, 12, 13, 24, 25	51.9 S	39.0 W	180.0	1935	Julius, German astronomer (unknown – *fl.* 1627).	71
Schlüter	15	5.9 S	83.3 W	89.0	1964	Heinrich, German astronomer (1815–1844).	39, VII, VIII
Schomberger	7, 15, 19, 20	76.7 S	24.9 E	85.0	1935	Georg, Austrian astronomer, mathematician (1597–1645).	73, 74
Schomberger A	15	—	—	—	—	No official name by IAU.	73, 74
Schröter	9	2.6 N	7.0 W	35.0	1935	Johann Hieronymus, German astronomer (1745–1816).	32
Schubert	2	2.8 N	81.0 E	54.0	1935	Theodor Friedrich Von, Russian cartographer (1789–1865).	38, III

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Schumacher	3, 4	42.4 N	60.7 E	60.0	1935	Heinrich Christian, German astronomer (1780–1850).	16
Scoresby	7, 8, 15, 16, 21	77.7 N	14.1 E	55.0	1935	William, British explorer (1789–1857).	4
Scott	7, 15, 17, 19	82.1 S	48.5 E	103.0	1964	Robert F., British explorer (1868–1912).	73, 74, V
Secchi	5	2.4 N	43.5 E	22.0	1935	Pietro Angelo, Italian astronomer, astrophysicist (1818–1878).	37
Segner	12, 13	58.9 S	48.3 W	67.0	1935	Johann Andreas von, German physicist, mathematician (1704–1777).	71
Seleucus	14, 15	21.0 N	66.6 W	43.0	1935	Babylonian astronomer (unknown – *fl. c.* 150 BC).	17
Seneca	2	26.6 N	80.2 E	46.0	1961	Lucius Annaeus, Roman philosopher, natural scientist (4 BC – AD 65).	27, III
Sharp	11, 12, 25	45.7 N	40.2 W	39.0	1935	Abraham, British astronomer, mathematician (1651–1742).	9, 10
Sharp A	25	—	—	—	—	No official name by IAU.	9, 10
Sheepshanks	7	59.2 N	16.9 E	25.0	1935	Anne, British benefactor (1789–1876).	5
Short	10	74.6 S	7.3 W	70.0	1935	James, Scottish mathematician, optician (1710–1768).	73
Shuckburgh	4	42.6 N	52.8 E	38.0	1935	Sir George, British geographer, benefactor (1751–1804).	15
Simpelius	8, 20	73.0 S	15.2 E	70.0	1935	Sempill, Hugh, Scottish mathematician (1596–1654).	73
Sirsalis	13, 14, 26, 27	12.5 S	60.4 W	42.0	1935	Sersale, Gerolamo, Italian astronomer (1584–1654).	39
Sirsalis A	13, 14, 26, 27	—	—	—	—	No official name by IAU but named 'Bertaud' by Wilkins and Moore. Antonin Rukl labels this crater 'A' near to Sirsalis.	39
Sirsalis D	13	—	—	—	—	No official name by IAU.	39
Sirsalis J	13	—	—	—	—	No official name by IAU.	39
Snellius	4, 18	29.3 S	55.7 E	82.0	1935	Snell, Willebrod van Roijen, Dutch mathematician, astronomer, optician (1591–1626).	59, 69
Sömmering	9	0.1 N	7.5 W	28.0	1935	Samuel Thomas, German doctor (1755–1830).	32, 43
South	13, 25	58.0 N	50.8 W	104.0	1935	James, British astronomer (1785–1867).	2
Spallanzani	6	46.3 S	24.7 E	32.0	1935	Lazzaro, Italian natural scientist, biologist (1729–1799).	67
Stadius	10, 22, 23	10.5 N	13.7 W	69.0	1935	Stade, Jan, Belgian astronomer, mathematician (1527–1579).	32
Steinheil	4, 5, 18	48.6 S	46.5 E	67.0	1935	Karl August von, German astronomer, physicist (1801–1870).	68, 76
Stevinus	4, 18	32.5 S	54.2 E	74.0	1935	Stevin, Simon, Belgian mathematician, physicist (1548–1620).	69
Stevinus A	1	—	—	—	—	No official name by IAU.	69
Stiborius	6, 19	34.4 S	32.0 E	43.0	1935	Stoberl, Andreas, German astronomer, mathematician (1465–1515).	67
Stöfler	7, 8, 21	41.1 S	6.0 E	126.0	1935	Johann, German astronomer, mathematician (1452–1531).	65, 66
Stokes	15	52.5 N	88.1 W	51.0	1964	Sir George G., British mathematician, physicist (1819–1903).	1, I
Strabo	4, 5, 6, 16, 17	61.9 N	54.3 E	55.0	1935	Greek geographer (54 BC – AD 24).	6
Strabo B	16	—	—	—	—	No official name by IAU.	6
Strabo L	16	—	—	—	—	No official name by IAU.	6
Strabo N	16	—	—	—	—	No official name by IAU.	6
Struve	14, 15	22.4 N	77.1 W	164.0	1964	Otto von, Russian astronomer (1819–1905); Otto, American astronomer (1897–1963); Friedrich G.W. von, German astronomer (1793–1864).	17, VIII
Sulpicius Gallus	7	19.6 N	11.6 E	12.0	1935	Gaius, Roman astronomer (unknown – *fl. c.* BC 166).	23
Swift	4	19.3 N	53.4 E	10.0	1976	Lewis, American astronomer (1820–1913).	26
Sylvester	24	82.7 N	79.6 W	58.0	1964	James J., British mathematician (1814–1897).	3, I
T. Mayer	11	15.6 N	29.1 W	33.0	1935	Tobias, German astronomer (1723–1762).	19
T. Mayer A	11	—	—	—	—	No official name by IAU.	19
Taruntius	1, 5, 6, 8, 18	5.6 N	46.5 E	56.0	1935	Firmanus, Lucius, Roman philosopher (unknown – *fl.* 86 BC).	37
Taylor	7, 20, 21	5.3 S	16.7 E	42.0	1935	Brook, British mathematician (1685–1731).	46
Taylor A	7, 20, 21	—	—	—	—	No official name by IAU.	46
Tempel	7, 20	3.9 N	11.9 E	45.0	1935	Ernst Wilhelm Leberecht, German astronomer (1821–1889).	34
Thales	1, 5, 6, 16, 17	61.8 N	50.3 E	31.0	1935	Of Miletos, Greek mathematician, astronomer, philosopher (*c.* 636–546 BC).	6
Theaetetus	8	37.0 N	6.0 E	24.0	1935	Greek geometrician (unknown – *c.* 380 BC).	12
Thebit	9, 22	22.0 S	4.0 W	56.0	1935	Ben Korra, Iraqi astronomer (826–901).	55
Theon Junior	7, 20	2.3 S	15.8 E	17.0	1935	Of Alexandria, Greek astronomer (unknown – *c.* 380).	45, 46
Theon Senior	7, 20	0.8 S	15.4 E	18.0	1935	Of Smyrna, Greek mathematician (unknown – *c.* 100).	45, 46

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Theophilus	6, 9, 19, 20	11.4 S	26.4 E	110.0	1935	Greek astronomer died AD 412.	46, 47
Timaeus	9, 21	62.8 N	0.5 W	32.0	1935	Greek astronomer (unknown – *c.* 400 BC).	4
Timocharis	1, 10, 11, 22, 23	26.7 N	13.1 W	33.0	1935	Greek astronomer (unknown – *fl. c.* 280 BC).	21
Tisserand	5, 18	21.4 N	48.2 E	36.0	1935	Francois Felix, French astronomer (1845–1896).	26
Tolansky	23	9.5 S	16.0 W	13.0	1976	Samuel, British physicist (1907–1973).	42, 43
Tralles	4, 5	28.4 N	52.8 E	43.0	1935	Johann Georg, German physicist (1763–1822).	26
Triesnecker	8, 22	4.2 N	3.6 E	26.0	1935	Francis A. Paula, Austrian astronomer (1745–1817).	33
Tycho	1, 9, 10, 11, 13, 17, 19, 21, 22, 23, 24	43.4 S	11.1 W	102.0	1935	Tycho Brahe, Danish astronomer (1546–1601).	64
Ukert	22	7.8 N	1.4 E	23.0	1935	Friedrich August, German historian, humanitarian (1780–1851).	33
Ulugh Beigh	15	32.7 N	81.9 W	54.0	1961	Ulugh-Beg, Mongolian astronomer, mathematician (1394–1449).	8, VIII
Urey	2	27.9 N	87.4 E	38.0	1985	H., American chemist, Nobel laureate (1893–1981).	27, III
Vasco da Gama	15	13.6 N	83.9 W	83.0	1935	Portuguese navigator, explorer (1469–1524).	28, VIII
Vega	3	45.4 S	63.4 E	75.0	1935	Georg Freiherr von, German mathematician (1756–1802).	68
Vendelinus	3, 4, 5, 16, 17	16.4 S	61.6 E	131.0	1935	Wendelin, Godefroid, Belgian astronomer (1580–1667).	60
Vieta	13, 26	29.2 S	56.3 W	87.0	1935	Francois, French mathematician (1540–1603).	51, 61
Vitello	12, 25	30.4 S	37.5 W	42.0	1935	Witelo, Erazmus Ciokek, Polish physicist, mathematician (1210–1285).	62
Vitruvius	6, 19	17.6 N	31.3 E	29.0	1935	Vitruvius Pollio, Marcus, Roman engineer, architect (unknown – *fl. c.* 25 BC).	25
Vlacq	5, 6, 18, 19	53.3 S	38.8 E	89.0	1935	Adriaan, Dutch mathematician (*c.* 1600–1667).	75
Vogel	8	15.1 S	5.9 E	26.0	1935	Hermann Karl, German astronomer (1841–1907).	56
Volta	15	53.9 N	84.4 W	123.0	1964	Count Allessandro G.A.A., Italian physicist (1745–1827).	56
W. Bond	8, 9, 20, 21, 22	65.4 N	4.5 W	156.0	1935	William Cranch, American astronomer (1789–1859).	4
Wallace	22	20.3 N	8.7 W	26.0	1935	Alfred Russell, British natural historian (1823–1913).	21
Walter (Walther in IAU website)	8, 9, 22	33.1 S	1.0 E	128.0	1935	Bernard, German astronomer (1430–1504).	65
Wargentin	13, 14, 26	49.6 S	60.2 W	84.0	1935	Pehr Vilhelm, Swedish astronomer (1717–1783).	70
Watt	4, 5, 18	49.5 S	48.6 E	66.0	1935	James, Scottish inventor (1736–1819).	76
Weiss	11	31.8 S	19.5 W	66.0	1935	Edmund, German astronomer, mathematician, physicist (1837–1917).	63, 64
Werner	8, 9, 21	28.0 S	3.3 E	70.0	1935	Johann, German mathematician (1468–1528).	55
Whewell	7	4.2 N	13.7 E	13.0	1935	William, British philosopher (1794–1866).	34
Wichmann	25	7.5 S	38.1 W	10.0	1935	Moritz Ludwig Georg, German astronomer (1821–1859).	41
Wilhelm	10, 11, 23, 24	43.4 S	20.4 W	106.0	1935	Wilhelm IV, Landgrave of Hesse, German astronomer (1532–1592).	63, 64
Wilson	12	69.2 S	42.4 W	69.0	1935	Alexander, Scottish astronomer (1714–1786); Charles T.R., Scottish physicist (1869–1959); Ralph E., American astronomer ((1886–1960).	72
Wolf	10, 23	22.7 S	16.6 W	25.0	1935	Maxmilian Franz Joseph Cornelius, German astronomer (1863–1932).	54
Wrottesley	4	23.9 S	56.8 E	57.0	1935	John, Baron Wrottesley, British astronomer (1798–1867).	59
Wurzelbauer	10, 23	33.9 S	15.9 W	88.0	1935	Johann Philipp von, German astronomer (1651–1725).	64
Xenophanes	15	57.5 N	82.0 W	125.0	1935	Of Colophon, Greek philosopher (570(?)–478(?) BC).	1, I
Yerkes	4	14.6 N	51.7 E	36.0	1935	Charles T., American benefactor (1837–1905).	26, 37
Young	4, 5	41.5 S	50.9 E	71.0	1935	Thomas, British doctor, physicist (1773–1829).	68
Young D	4	—	—	—	—	No official name by IAU.	68
Zach	7, 8, 21	60.9 S	5.3 E	70.0	1935	Freiherr von, Hungarian astronomer (1754–1832).	73
Zach F	21	—	—	—	—	No official name by IAU.	73
Zagut	6, 20	32.0 S	22.1 E	84.0	1935	Abraham Ben Samuel, Spanish–Jewish astronomer (unknown – *c.* 1450).	67
Zeno	2, 16	45.2 N	72.9 E	65.0	1935	Of Citium, Greek philosopher (*c.* 335–263 BC).	16, II
Zeno A	16	—	—	—	—	No official name by IAU.	16, II
Zeno B	16	—	—	—	—	No official name by IAU.	16, II

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Zeno D	16	—	—	—	—	No official name by IAU.	16, II
Zöllner	20	8.0 S	18.9 E	47.0	1935	Johann Karl Friedrich, German astrophysicist, astronomer (1834–1882).	46
Zucchius	12, 13, 25	61.4 S	50.3 W	64.0	1935	Zucchi, Niccolo, Italian mathematician, astronomer (1586–1670).	71
Dome							
Cauchy Omega	5	—	—	—	—	No approved dome names by IAU.	36
Cauchy Tau	5	—	—	—	—	No approved dome names by IAU.	36
Kies Pi	10, 23, 24	—	—	—	—	No approved dome names by IAU.	53
Milichius Pi	11	—	—	—	—	No approved dome names by IAU.	30
Dorsa – (Network or group of Wrinkle Ridge)							
Dorsa Aldrovandi	19	24.0 N	28.5 E	136.0	1976	Italian Earth scientist (1522–1605).	24
Dorsa Geikie	4	4.6 S	52.5 E	228.0	1976	Sir Archibald, Scottish geologist (1835–1924).	48
Dorsa Mawson	4	4.6 S	55.7 E	132.0	1979	Douglas, English–Australian Antartic explorer (1882–1958).	48
Dorsa Smirnov	7, 19	27.3 N	25.3 E	156.0	1976	Sergai S., Soviet Earth scientist (1895–1947).	24
Lacus – ('Lake')							
Lacus Aestatis	14	15.0 S	69.0 W	90.0	1970	'Lake of Summer'.	39, 50
Lacus Autumni	14	9.9 S	83.9 W	183.0	1970	'Lake of Autum'.	39, 50, VII
Lacus Bonitatis	5, 6	23.2 N	43.7 E	92.0	1976	'Lake of Goodness'.	25, 26
Lacus Excellentiae	12	35.4 S	44.0 W	184.0	1976	'Lake of Excellence'.	62
Lacus Mortis	6, 19	45.0 N	27.2 E	151.0	1935	'Lake of Death'.	14
Lacus Somniorum	6, 7, 19	38.0 N	29.2 E	384.0	1935	'Lake of Dreams'.	14
Lacus Spei	4, 16	43.0 N	65.0 E	80.0	1976	'Lake of Hope'.	16
Lacus Temporis	4	45.9 N	58.4 E	117.0	1976	'Lake of Time'.	15
Lacus Timoris	12	38.8 S	27.3 W	117.0	1976	'Lake of Fear'.	63
Lacus Veris	14	16.5 S	86.1 W	396.0	1970	'Lake of Spring'.	39, 50, VII
Mare – ('Sea')							
Mare Anguis	3, 5	22.6 N	67.7 E	150.0	1935	'Serpent Sea'.	27
Mare Australe	1, 15, 16	38.9 S	93.0 E	603.0	1935	'Southern Sea'.	76, IV, V
Mare Cognitum	10, 11, 24	10.0 S	23.1 W	376.0	1964	'Sea that has become known'.	42
Mare Crisium	1, 3, 4, 5, 16, 17, 18	17.0 N	59.1 E	418.0	1935	'Sea of Crises'.	26, 27, 37, 38
Mare Fecunditatis	1, 4, 5, 6, 16, 17, 18, 19	7.8 S	51.3 E	909.0	1935	'Sea of Fecundity'.	37, 48, 49, 59
Mare Frigoris	1, 6, 7, 8, 9, 10, 11, 12, 13, 19, 21, 22, 23, 24, 25	56.0 N	1.4 E	1,596.0	1935	'Sea of Cold'.	1–6
Mare Humboldtianum	1, 2, 3, 15, 16, 18	56.8 N	81.5 E	273.0	1935	Humbolt, Alexander von, German natural historian (1769–1859).	7, II
Mare Humorum	1, 11, 12, 25	24.4 S	38.6 W	389.0	1935	'Sea of Moisture'.	51, 52
Mare Imbrium	1, 7, 8, 9, 10, 11, 12, 19, 20, 21, 22, 23, 24, 25	32.8 N	15.6 W	1,123.0	1935	'Sea of Showers'.	9–12, 19–21
Mare Insularum	11	7.5 N	30.9 W	513.0	1976	'Sea of Islands'.	30–32, 41, 42
Mare Marginis	1, 2, 16	13.3 N	86.1 E	420.0	1935	'Sea of the Edge'.	27, 38, III
Mare Nectaris	1, 5, 6, 8, 9, 18, 19	15.2 S	35.5 E	333.0	1935	'Sea of Nectar'.	47, 58
Mare Nubium	1, 9, 10, 11, 12, 21, 23, 24	21.3 S	16.6 W	715.0	1935	'Sea of Clouds'.	53, 54
Mare Orientale	1, 14, 15	19.4 S	92.8 W	327.0	1935	'Eastern Sea'.	50, VII
Mare Serenitatis	1, 6, 7, 8, 9, 19, 20, 21	28.0 N	17.5 E	707.0	1935	'Sea of Serenity'.	13, 14, 23, 24

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Mare Smythii	1, 2, 16	1.3 N	87.5 E	373.0	1935	Symth, William Henry, British astronomer (1788–1865).	38, 49, III, IV
Mare Spumans	3, 5, 16	1.1 N	65.1 E	139.0	1935	'Foaming Sea'.	38
Mare Tranquillitatis	1, 5, 6, 7, 18, 19, 20	8.5 N	31.4 E	837.0	1935	'Sea of Tranquility'.	35, 36
Mare Undarum	3, 16	6.8 N	68.4 E	243.0	1935	'Sea of Waves'.	38
Mare Vaporum	1, 7, 8, 9, 21	13.3 N	3.6 E	245.0	1935	'Sea of Vapors'.	22, 33, 34
Mons – (Mountain)							
Mons Argaeus	6, 7, 19	19.0 N	29.0 E	50.0	1935	Named after peak in Asia Minor (now Erciyas Dagi)	24, 25
Mons Blanc	8	45.0 N	1.0 E	25.0	1935	Named after terrestrial mountain in Alps.	12
Mons Foucault Beta	25	—	—	—	—	Isolated Mountain Ridge.	2
Mons Gruithuisen Delta	12, 25	36.0 N	39.5 W	20.0	1976	Named after nearby crater.	9
Mons Gruithuisen Gamma	12, 25	36.6 N	40.5 W	20.0	1976	Named after nearby crater.	9
Mons Gruithuisen Zeta	25	—	—	—	—	Mountain massif.	9
Mons Hadley	1, 9,	26.5 N	4.7 E	25.0	1935	Hadley, John, British instrument maker (1682–1743).	22
Mons Hansteen	13, 26	12.1 S	50.0 W	30.0	1976	Named after nearby crater.	40
Mons La Hire	11, 21, 23	27.8 N	25.5 W	25.0	1961	Philippe De, French mathematician, astronomer (1640–1718).	20
Mons Maraldi	19	20.3 N	35.3 E	15.0	1976	Named after nearby crater.	25
Mons Penck	20	10.0 S	21.6 E	30.0	1976	Albrecht, German geographer (1858–1945).	46
Mons Pico	1, 9, 21, 22, 23	45.7 N	8.9 W	25.0	1935	Spanish for 'peak'.	11
Mons Pico Beta	9, 23	—	—	—	—	No official name by IAU. Beta feature from Map 11 *Atlas of the Moon* by Antonin Rukl.	11
Mons Piton	1, 8, 9, 21, 22	40.6 N	1.1 W	25.0	1935	Named after Mt. Piton on Tenerife Islands.	12
Mons Rümker	13, 26, 27	40.8 N	58.1 W	70.0	1935	Karl Luwig Christian, German astronomer (1788–1862).	8
Mons Vinogradov	11	22.4 N	32.4 W	25.0	1979	Aleksandr Pavlovich, Soviet geochemist (1895–1975).	19
Mons Wolff	22	17.0 N	6.8 W	35.0	1961	Christian, Baron von, German philosopher (1679–1754).	21
Montes – (Mountain Range or group of Mountains)							
Montes Alpes	1, 8, 9, 10, 21, 22, 23	46.4 N	0.8 W	281.0	1935	Named after terrestrial Alps.	12
Montes Apenninus	1, 7, 8, 9, 10, 20, 21, 22, 23	18.9 N	3.7 W	401.0	1961	Named after terrestrial Apennines.	22
Montes Archimedes	9	25.3 N	4.6 W	163.0	1976	Named after nearby crater.	22
Montes Carpatus (Carpathian Mountains)	1, 10, 11, 21, 23, 24	14.5 N	24.4 W	361.0	1961	Named after terrestrial Carpathians.	20, 31
Montes Caucasus	1, 7, 8, 20, 21	38.4 N	10.0 E	445.0	1961	Named after terrestrial Caucasus Mountains.	13
Montes Cordillera	15	17.5 S	81.6 W	547.0	1961	Spanish for 'mountain chain'.	39, 50, VII
Montes Haemus	6, 7, 8, 20, 21	19.9 N	9.2 E	560.0	1961	Named for range in the Balkans.	23
Montes Harbinger (Harbinger Mountains)	12, 25	27.0 N	41.0 W	90.0	1961	Harbinger of dawn on crater Aristarchus.	19
Montes Jura (Jura Mountains)	10, 11, 25	47.1 N	34.0 W	422.0	1961	Named after terrestrial Jura Mountains.	10
Montes Pyrenaeus	5, 6	15.6 S	41.2 E	164.0	1961	Named after terrestrial Pyrenees.	48, 58
Montes Recti (Straight Range)	1, 9, 21, 24	48.0 N	20.0 W	90.0	1961	Latin for 'straight range'.	11
Montes Riphaeus	1, 10, 11, 24	7.7 S	28.1 W	189.0	1961	Named after range in Asia (now Ural Mountains).	41, 42
Montes Rook	15	20.6 S	82.5 W	791.0	1961	Lawrence, British astronomer (1622–1666).	50, VII
Montes Secchi	5, 6	3.0 N	43.0 E	50.0	1976	Named after nearby crater.	37
Montes Spitzbergen	1, 9, 21	35.0 N	5.0 W	60.0	1961	German for 'sharp peaks', and named for resemblance to the terrestrial island group.	12
Montes Taurus	5, 6, 18, 19	28.4 N	41.1 E	172.0	1935	Named after terrestrial Taurus Mountains.	25
Montes Teneriffe	1, 9, 21, 23	47.1 N	11.8 W	182.0	1935	Named after terrestrial island.	3, 11
Oceanus – (Ocean)							
Oceanus Procellarum	1, 12, 13, 25, 26, 27	18.4 N	57.4 W	2,568.0	1935	'Ocean of Storms'.	8, 9, 17–19, 28, 29, 39–41, VIII

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Palus – (Marsh)							
Palus Epidimiarum	10, 11, 24	32.0 S	28.2 W	286.0	1935	'Marsh of Epidemics'.	63
Palus Putredinis	9	26.5 N	0.4 E	161.0	1935	'Marsh of Decay'.	22
Palus Somni	1, 5, 6, 16, 17, 18	14.1 N	45.0 E	143.0	1935	'Marsh of Sleep'.	26, 37
Promontorium – (Promontory)							
Promontorium Agarum	3	14.0 N	66.0 E	70.0	1935	Named after cape in Sea of Azov.	38
Promontorium Agassiz	8	42.0 N	1.8 E	20.0	1935	Jean Louis Rodolphe, Swiss zoologist, geologist (1807–1873).	12
Promontorium Archerusia	6, 7	16.7 N	22.0 E	10.0	1961	Named after cape on the Black Sea.	24
Promontorium Fresnel	8	29.0 N	4.7 E	20.0	1935	Augustin Jean, French optician (1788–1827).	22
Promontorium Heraclides	11, 13	40.3 N	33.2 W	50.0	1935	Ponticus, Greek astronomer (*c.* 388–310 BC).	10
Promontorium Kelvin	12, 25	27.0 S	33.0 W	50.0	1935	William Thomson, Lord Kelvin, Scottish natural philosopher (1824–1907).	52
Promontorium Laplace	11, 22, 23	46.0 N	25.8 W	50.0	1935	Pierre Simon, French mathematician, astronomer (1749–1827).	10
Promontorium Lavinium	4	—	—	—	—	No official name by IAU.	26
Promontorium Olivium	4, 5	—	—	—	—	No official name by IAU.	26
Rima – (Rille)							
Rima Agatharchides	24	20.0 S	28.0 W	50.0	1964	Named after nearby crater.	53
Rima Ariadaeus	7, 8, 19, 20, 21	6.4 N	14.0 E	250.0	1961	Named after nearby crater.	34
Rima Birt	9	21.0 S	9.0 W	50.0	1964	Named after nearby crater.	54
Rima Bradley	9	23.8 N	1.2 W	161.0	1964	Named after nearby Mons.	22
Rima Calippus	20	37.0 N	13.0 E	40.0	1964	Named after nearby crater.	13
Rima Cauchy	5, 19	10.5 N	38.0 E	140.0	1964	Named after nearby crater.	36
Rima Flammarion	9	2.8 S	5.6 W	80.0	1964	Named after nearby crater.	44
Rima G. Bond	19	33.3 N	35.5 E	168.0	1964	Named after nearby crater.	15
Rima Hadley	9	25.0 N	3.0 E	80.0	1964	Named after nearby Mons.	22
Rima Hesiodus	10, 24	30.0 S	20.0 W	256.0	1964	Named after nearby crater.	53, 54, 63
Rima Hyginus	7, 8, 19, 20, 21	7.4 N	7.8 E	219.0	1961	Named after nearby crater.	33, 34
Rima Oppolzer	9	1.7 S	1.0 E	94.0	1964	Named after nearby crater.	44
Rimae – (Network or group of Rilles)							
Rimae Archimedes	22	26.6 N	4.1 W	169.0	1964	Named after nearby crater.	22
Rimae Doppelmayer	25	25.9 S	45.1 W	162.0	1964	Named after nearby crater.	52
Rimae Fresnel	9	28.0 N	4.0 E	90.0	1964	Named after nearby promontorium.	22
Rimae Goclenius	5	8.0 S	43.0 E	240.0	1964	Named after nearby crater.	48
Rimae Gutenberg	5, 19	5.0 S	38.0 E	330.0	1964	Named after nearby crater.	47
Rimae Hippalus	11, 24, 25	25.5 S	29.2 W	191.0	1964	Named after nearby crater.	52, 53
Rimae Hypatia	6	0.4 S	22.4 E	206.0	1964	Named after nearby crater.	46
Rimae Littrow	19	22.1 N	29.9 E	115.0	1964	Named after nearby crater.	25
Rimae Menelaus	21	17.2 N	17.9 E	131.0	1978	Named after nearby crater.	24
Rimae Plinius	6, 7, 19	17.9 N	23.6 E	124.0	1964	Named after nearby crater.	24
Rimae Römer	19	27.0 N	35.0 E	110.0	1964	Named after nearby crater.	25
Rimae Sirsalis	13, 14, 26, 27	15.7 S	61.7 W	426.0	1964	Named after nearby crater.	39, 50
Rimae Triesnecker	8, 21	4.3 N	4.6 E	215.0	1964	Named after nearby crater.	33, 34
Rupes – (Scarp)							
Rupes Altai	6, 19, 20	24.3 S	22.6 E	427.0	1961	Named after terrestrial Altai Mountains.	57
Rupes Cauchy	5, 19	9.0 N	37.0 E	120.0	1964	Named after nearby crater.	36
Rupes Kelvin	25	27.3 S	33.1 W	78.0	1964	Named after nearby promontorium.	52
Rupes Liebig	12, 25	24.4 S	48.5 W	37.0	1964	Named after nearby crater.	51

Lunar feature name	Lunar day number	Lunar latitude	Lunar longitude	Feature dia. in km	Approved date – IAU	Origin of lunar feature name	Rükl Map No.
Rupes Mercator	11	31.0 S	22.3 W	93.0	1985	Named after nearby crater.	53
Rupes Recta (Straight Wall)	9, 10, 22	22.1 S	7.8 W	134.0	1961	Latin for 'straight cliff' (The Straight Wall).	54
Sinus – ('Bay')							
Sinus Aestuum	9, 11, 21	10.9 N	8.8 W	290.0	1935	'Seething Bay'.	32, 33
Sinus Amoris	19	18.1 N	39.1 E	130.0	1976	'Bay of Love'.	25
Sinus Asperitatis	6	3.8 S	27.4 E	206.0	1976	'Bay of Roughness'.	46, 47
Sinus Iridum	1, 10, 11, 12, 13, 19, 21, 24, 25	44.1 N	31.5 W	236.0	1935	'Bay of Rainbows'.	10
Sinus Medii	1, 8, 9, 21, 22	2.4 N	1.7 E	335.0	1935	'Bay of the center'.	33, 44
Sinus Roris	1, 13	54.0 N	56.6 W	202.0	1935	'Bay of Dew'.	1, 8, 9, I, VIII
Vallies – (Valley)							
Vallis Alpes (Alpine Valley)	8, 9, 22	48.5 N	3.2 E	166.0	1961	'Alpine Valley'.	4, 12
Vallis Inghirami	14	43.8 S	72.2 W	148.0	1964	Named after nearby crater.	61
Vallis Palitzsch	3	26.4 S	64.3 E	132.0	1964	Named after nearby crater.	59
Vallis Rheita	4, 5, 18, 21	42.5 S	51.5 E	445.0	1961	Named after nearby crater.	68
Vallis Schröteri	13, 25, 26	26.2 N	50.8 W	168.0	1961	Schröter's Valley.	18
Vallis Snellius	4, 5, 18, 21	31.1 S	56.0 E	592.0	1964	Named after nearby crater.	59, 69
Others – (Albedo Feature)							
Reiner Gamma	1, 13, 14, 25, 26, 27	—	—	—	—	Reiner Gamma is an approved albedo feature by IAU.	28
Cassini's bright spot	1, 9	—	—	—	—	No official name by IAU and not labelled in Rukl.	65
Probe							
Apollo 11 landing site (Eagle Lunar Module)	6	0.67 N	23.49 E	—	-	Launched 16 July 1969. Landed 20 July 1969 in Mare Tranquillitatis.	p. 193
Apollo 12 landing site (Intrepid Lunar Module)	11	2.94 S	23.45 W	—	—	Launched 14 November 1969. Landed 19 November 1969 near crater Lansberg.	p. 193
Apollo 14 landing site (Antares Lunar Module)	10	3.67 S	17.46 E	—	—	Launched 31 January 1971. Landed 5 February 1971 in Fra Mauro.	p. 193
Apollo 15 landing site (Falcon Lunar Module)	9	26.11 N	3.66 E	—	—	Launched 26 July 1971. Landed 30 July 1971 in Hadley Rille.	p. 193
Apollo 16 landing site (Orion Lunar Module)	7	8.60 S	15.31 E	—	—	Launched 16 April 1972. Landed 20 April 1972 in Descartes.	p. 193
Apollo 17 landing site (Challenger Lunar Module)	6	20.17 N	30.80 E	—	—	Launched 7 December 1972. Landed 11 December 1972 in Taurus–Littrow.	p. 193
Lunar Surveyor 1 landing site	12	2.45 S	43.21 W	—	—	Launched 30 May 1966. Landed 2 June 1966 at Flamsteed P.	p. 193
Luna 2	9	29.10 N	0.00 E	—	—	First probe to reach the Moon on 13 September 1959.	p. 193
Luna 9	13	7.08 N	64.37 W	—	—	First soft landing on the Moon at Planitia Descensus (Plain of Descent) on 3 February 1966.	p. 193
Luna 13	14	18.87 N	62.05 W	—	—	Landed on Christmas Eve – 24 December 1966.	p. 193
Luna 16	4	0.68 S	56.30 E	—	—	Landed on the Moon on 21 September 1970. Robotic lunar lander returned lunar soil samples to Earth.	p. 193
Luna 17 (Lunokhod 1)	12	38.28 N	35.00 W	—	—	Landed 17 November 1970. First robotic Moon rover Lunokhod 1 drove 10.5 km on the lunar surface.	p. 193
Luna 20	3	3.57 N	56.50 E	—	—	Landed on the Moon on 21 February 1972 and returned lunar rock samples to Earth.	p. 193
Luna 21 (Lunokhod 2)	7	25.51 N	30.38 E	—	—	Landed 15 January 1970. Lunokhod 2 robotic Moon rover drove a distance of 37 km on the lunar surface.	p. 193
Luna 24	3	12.25 N	62.20 E	—	—	Landed 18 August 1976. Took lunar core sample from depth of 2m below the lunar surface.	p. 193

Notes: I – refers to lunar features mentioned in the 'Before we begin' chapter.
Rükl Map No. – refers to Map No. from *Atlas of the Moon* by Antonín Rükl.

Index

To find individual features on the Moon, see appendix 2

Photographic Atlas of the Moon

The Photographic Atlas of the Moon is a day-by-day photographic guide to observing the features of the Moon through a small telescope. Compiled by three keen amateur astronomers, each image was produced using a 40-cm telescope and high-resolution low-speed film. Whole Moon images are provided for each day of the 29-day lunar cycle, with labelled features and accompanying descriptive text. Selected lunar features are shown at high magnification to highlight and clearly illustrate certain regions. All lunar features are labelled using current IAU terminology. A comprehensive set of appendices detail the phases of the Moon, give a chronology of lunar selenography, and index all lunar features named in the text. This atlas is an invaluable reference guide for amateurs engaging in lunar observations with a small telescope.

- High-resolution labelled photographs for each day of the complete lunar cycle
- South-up image orientation enables direct comparison with telescopic observations
- Whole Moon images for minimal page-flipping

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