Discover the Moon

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Preface

Ever looked at the Moon through a telescope? You have? Then you will have felt 'astronomical awe' for yourself.

The Moon . . . It is the strangest place! A rough, dry mineral sphere with a cloudless sky that is inky black even in bright daylight, waterless seas decked in dust that no winds ever blow, and worn mountains that have never echoed to the slightest sound . . . It is understandable, then, why our satellite should be the favourite target for aspiring astronomers. And it is to help them to become better observers and to enjoy their discoveries to the full that this book has been devised.

It is all very well to stand and stare, but it is so much better to understand what you are looking at. You will want to see the most interesting and most intriguing regions of the Moon. But how do you find them in your telescope's field of view? When is the best time to look for them?

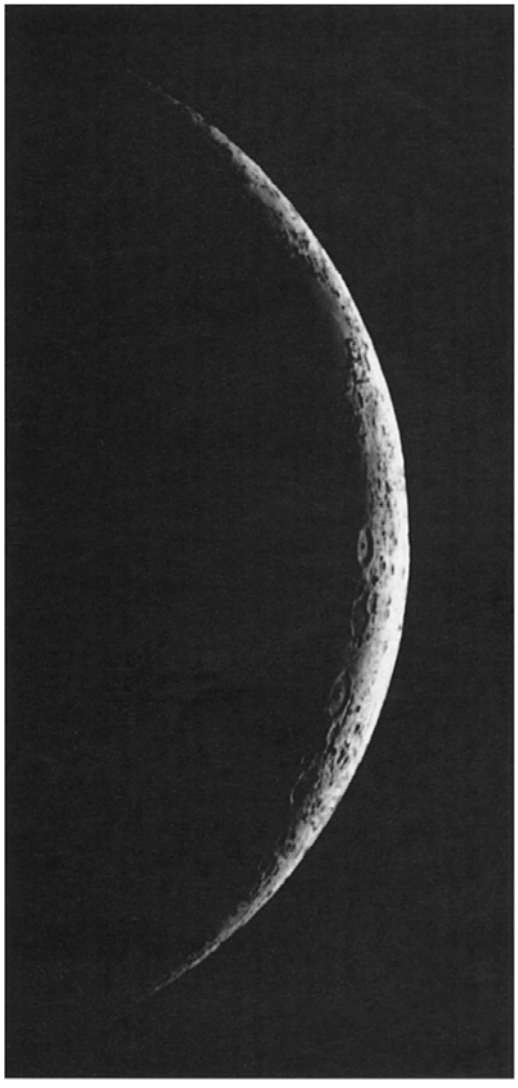
Then, with a little experience, you will be able to keep a watch on places where 'something' might be going on . . .

The Moon is easy enough to observe even with the light pollution of modern cities. Even the smallest telescope will show the maria or 'seas', countless craters and a few mountain ranges. The Moon's spectacular relief and the wondrous calm of its desolate landscapes viewed through a telescope lend it a fascination you will never tire of.

In this book we do not try to present an exhaustive survey of lunar studies; we try simply to answer some of the questions of the 'moonstruck' by providing material to assist in observation. This explorer's guidebook will help them to find their way around.

So, to your telescopes, for some fantastic trips to the Moon!

Contents



How to use this book

This guidebook is devised to make it easier to identify and observe the most interesting lunar features. It uses two sets of photos showing the Moon as it appears through the three types of instrument most commonly used by amateur astronomers – refracting telescopes, catadioptric telescopes and Newtonian telescopes. This has not been done before.

Which way is up?

It is often difficult to use a map to locate a lunar feature in a telescope. The thing is, lunar charts show the Moon as it appears to the naked eye (and have done since 1961; see box). If you view the Moon through binoculars there is no difference with the map because binoculars do not invert the image but, instead, show the Moon just as it looks to the unaided eye.

But when the Moon is viewed through any astronomical telescope (be it a refractor or a reflector) without accessories, the images are not the same way round. The objective lens or mirror produces an inverted image.

In a reflecting telescope, the secondary mirror inside it alters the image again! So, with a Newtonian telescope like the famous 115-mm (4.5-inch) model, the image is completely inverted with north at the bottom and east on the left. A lunar map has to be turned through 180° if it is to show the same alignment.

However, with instruments that have a star diagonal such as astronomical refractors or Cassegrain, Maksutov or Schmidt–Cassegrain catadioptric telescopes (like the Celestron or Meade makes), the image is erected by the star diagonal so that the north of the Moon is at the top and south at the bottom, but east is still on the left and west on the right! This time you would need to view the map in a mirror held alongside it for the chart to match what you see through this type of telescope!

DON'T PANIC!

It may be that what you observe on any given night does not exactly match the photo in the book. Some of the craters may not be illuminated in quite the same way. This is because of librations that make the Moon 'rock and roll' (see p. 15).

The photos are there to help you locate the positions of features relative to each other. The appearance of any given landform will always be different with each phase of the Moon. This is what makes discovering the lunar surface so fascinating time and again.

A SENSE OF DIRECTION

In 1961, the International Astronomical Union stipulated that lunar maps should have north at the top, south at the bottom, east on the right and west on the left. But do not be surprised if you find that older books do the opposite. So now you see why Mare Orientale (the Eastern Sea) has found itself on the Moon's western edge!

As seen through the telescope

This book is unique in that it overcomes these difficulties of orientation by presenting two photos for each lunar region or site. The photos are actually the same but oriented differently:

• the left-hand page shows the view through a refracting telescope or a catadioptric telescope with a star diagonal

• the right-hand page shows the view through a Newtonian telescope.

Night-by-night, 14 guided observing sessions

• A guidebook based on the Moon's phases
Each chapter presents the Moon on a different night throughout the series of phases from New Moon to Full Moon. We have given precedence to evening observations. Most observers prefer this because getting up early is harder than staying up late!

For each evening's observation there is a general photo first, with both possible orientations depending on the telescope used. The locations of features of interest to observe that night are marked by numbers. Boxed regions are described in more detail in the pages that follow.

MEANINGFUL PHOTOS

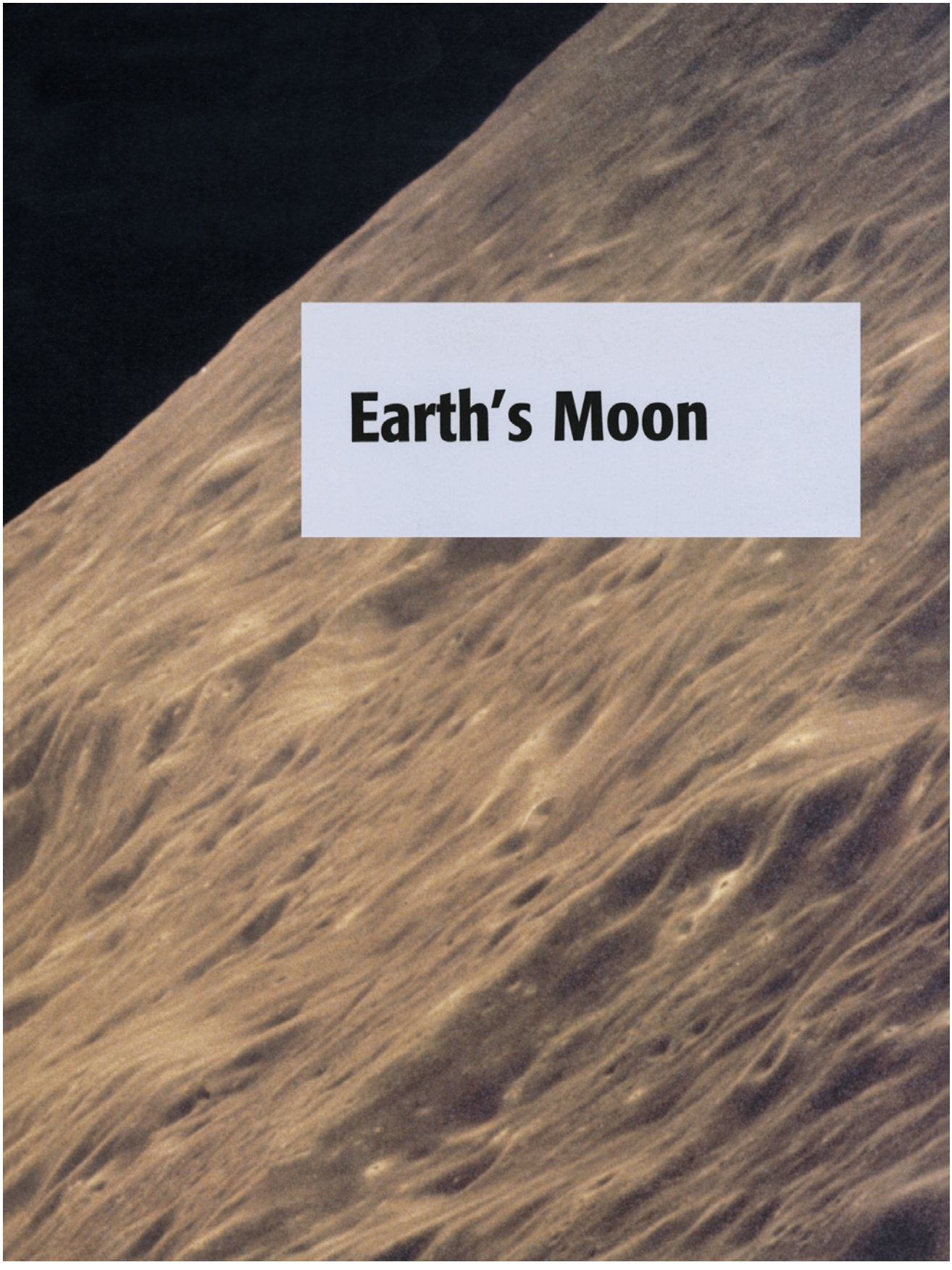
Where possible the photos shown are typical of what can be seen with a 100–150-mm telescope. We could have opted for the finest photographs or CCD images available, but we decided against using photos with too much detail so that readers would not lose their way among the mass of features they would show. For some features we have used photos taken when the Moon was waning and so the shadows are cast in the opposite direction to those seen for the waxing Moon described in the programme of observations.

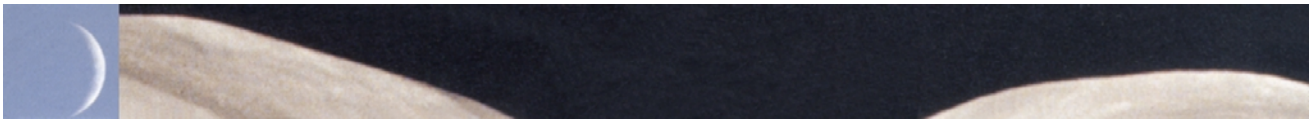
• Detailed descriptions of characteristic regions
Each of the following double-page spreads in the chapter is about a particular region. The important features are precisely described so you know what to look for.
The photos show details down to distances of about 3 km. This way you can test the resolution of your telescope.

• Feature size indications
Each detailed photo has a scale bar so you can compare the dimensions of the different features and get some idea of the true size of these lunar landscapes.

FLAP MAPS

On the front and back flaps of the book are lunar maps. The front-flap map shows the Moon as it appears through a refractor or a catadioptric telescope fitted with a star diagonal. The back-flap map shows the Moon as seen through a Newtonian telescope (or, if you turn it upside down, through binoculars).





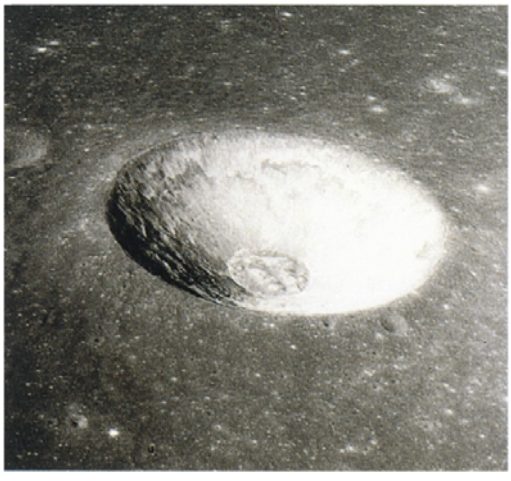
What is there to see on the Moon?

Even the unaided eye gives a hint of what the lunar surface is like. Large dark patches can be made out, which early observers called 'seas', with brighter areas, known as 'highlands', between them. The practised eye can even make out a few bright spots within the seas.

Waterless seas

The Moon's surface is characterised by its 'seas' or maria, so named by the early astronomers who saw them as the counterparts of the Earth's oceans. We now know, though, that the maria contain no water in liquid form. They are vast, mostly flat expanses of basalt some 3.8 to 3.1 billion years old. They cover 17% of the lunar surface and very many more of them lie on the near side than on the far side of the Moon.

These maria are probably the result of giant meteorites striking the Moon some 600 million years after it first began to form.



The lunar maria are pitted with numerous craterlets like this one.

WHERE DOES THE MOON COME FROM?

There are a number of theories about how our satellite originated:

- Roche's 1873 'double-planet hypothesis' by which the Moon accreted from the same cloud of dust as the Earth.
- The 'fission hypothesis' that it formed by a bulge of soft material spinning off from the still-molten primitive Earth as proposed by George Darwin in the 1880s.
- The 'capture hypothesis'. A suggestion first made by Lee in 1909 is that the Moon formed beyond the orbit of Uranus, moved closer to Earth because it was slowed by dust particles cluttering the solar system and was finally captured.
- The 'giant impact hypothesis' according to which it was torn off the Earth as suggested by Hartmann and Davis in 1974. This theory is based on the composition of lunar rocks brought back by the Apollo and Luna missions because they contain terrestrial elements and 'extraneous' elements. It is thought that the Moon was produced by a collision between the newly formed Earth and a mini-planet in formation some 4 billion years ago. The impact supposedly tore debris from the Earth which mixed with the material of the planetoid to form the Moon.

It is thought that these meteorite strikes pierced the primitive crust causing the still-molten rocky mantle to spill out over the surface.

Marine ridges

The maria are made up of basaltic lava with high proportions of iron, titanium and magnesium. Their surfaces are often ridged by very elongate, low hills known as 'dorsa' or 'wrinkle ridges', which sometimes branch out. Although only a hundred or so metres high, wrinkle ridges may extend for several thousand kilometres. They are thought to have formed by compression of the terrain as the surfaces of the maria cooled.

Gently sloping mountains

The Moon has many mountains that are the remains of the primitive crust. There are also entire mountain ranges which are the rims of the impact basins where the maria formed. Lunar mountains slope gently at gradients of 15–20°, very occasionally reaching 30–35°. Some 20 or so mountain ranges have been catalogued.

There are also isolated mountains, generally occurring as peaks emerging from the lava of the maria. They are remnants of the initial underlying surface before it was covered by the molten basalt. About 15 isolated mountains are recorded.

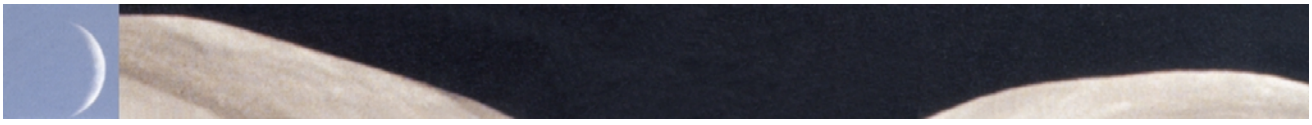
Countless craters

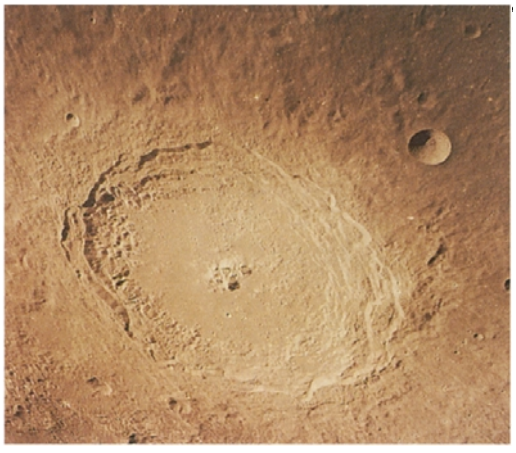
The most characteristic features of the lunar surface are the countless meteorite craters ranging in size from 300 km down to less than 1 m in diameter. The near side of the Moon has more than 300 000 craters of more than 1 km in diameter.

A distinction is made by size between walled plains, classical craters and craterlets, but it is sometimes difficult to know quite which category to classify a formation in.

- Walled plains are large, often dilapidated and deformed mountainous rings of anything from 100 to 300 km in diameter. Their floors, which are often flat with many craters, craterlets, ridges and hills, sometimes follow the curvature of the Moon.
- Craters proper range from 10 to 100 km across. They have three separate parts: the outer slopes, the inner wall and the floor. The outer slopes are made up of ejecta and rise gently from the surrounding terrain to the often steep crater rim. The inner wall has ledge-like terraces in craters wider than 50 km. The floor is often flat

The Apollo missions confirmed that the lunar mountains were smooth and rounded.





Close-up of a large crater clearly showing the gently dipping outer slopes, the slumped terraces of the crater wall and its rather rugged floor with a central peak.

with one or more central peaks or sometimes an inner ring of mountains. It is commonly cluttered by material or may be scarred by narrow, branching rilles.

- Craterlets are very prominent circular formations no more than 10 to 20 km across, with bowl-shaped floors.

Crater chains

Although rare, a few crater chains are found on the Moon. It is highly likely that all the craters in a chain were formed by the same event since there is a very low probability of a dozen or so craters forming a regular alignment over the course of time. Crater chains are thought to result from impacts from a single meteorite that broke up into a number of pieces just before striking the Moon.

Enigmatic clefts

Rilles are another typical formation. They are sometimes sinuous, branching furrows running for several hundred kilometres. Comparisons with the few specimens found on Earth suggest that they are ancient underground tunnels that once conveyed lava but whose roofs have since collapsed.

Other straighter clefts are grabens formed where plates of the lunar crust have moved apart.

Spectacular scarps

The lunar surface counts a handful of magnificent tectonic faults that show up marvellously when illuminated at a low angle when near the terminator. They rise to a few hundred metres and may be more than 100 km long. They are never sheer; indeed, most of them dip at less than 45°.

DON'T FORGET YOUR SPACESUIT!

The Moon has only a pseudo-atmosphere composed of traces of helium from the degassing of rocks and from their erosion by the solar wind. Atmospheric pressure is not even one-millionth of the Earth's. A number of phenomena support this hypothesis: the edge of the Moon appears very sharply with no blurring; the terminator has no twilight zone; no clouds hide the Moon's surface; stars vanish instantly behind the Moon's disc when occulted. This absence of any atmosphere has a number of consequences: there is no water, no wind and no noise; the sky is not blue but black, with the Sun shining beside the coloured stars and the blue-tinted Earth; temperatures are extreme (from +100 °C in daytime to −150 °C at night); there are no shooting stars but meteorite falls; there is a constant rain of micro-meteorites (several tens of tonnes of dust per day).

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The bold figures refer to sites shown in the photos and described in the text. The others refer to sites shown in photos only.