Introducing the Lunar 100

Let this Moon observer's hit list guide your telescopic explorations of Earth's nearest neighbor. | **By Charles A. Wood**

JUST ABOUT EVERY TELESCOPE USER is familiar with French comet hunter Charles Messier's catalog of fuzzy objects. Messier's 18th-century listing of 109 galaxies, clusters, and nebulae contains some of the largest, brightest, and most visually interesting deep-sky treasures visible from the Northern Hemisphere. Little wonder that observing all the M objects is regarded as a virtual rite of passage for amateur astronomers.

But the night sky offers an object that is larger, brighter, and more visually captivating than anything on Messier's list: the Moon. Yet many backyard astronomers never go beyond the astro-tourist stage to acquire the knowledge and understanding necessary to really appreciate what they're looking at, and how magnificent and amazing it truly is. Perhaps this is because after they identify a few of the Moon's most conspicuous features, many amateurs don't know where to look next.

The Lunar 100 list is an attempt to provide Moon lovers with something akin to what deep-sky observers enjoy with the Messier catalog: a selection of telescopic sights to ignite interest and enhance understanding. Presented here is a selection of the Moon's 100 most interesting regions, craters, basins, mountains, rilles, and domes. I challenge observers to find and observe them all and, more important, to consider what each feature tells us about lunar and Earth history.

Anatomy of the Lunar 100

Objects in the Lunar 100 are arranged from the easiest to view to the most difficult. This is more systematic than the haphazard approach that produced the Messier list. Indeed, just by knowing a feature's Lunar 100 number, you have some idea of how easy or challenging it will be to see. For example, the Moon itself is L1, while L2 is earthshine and L3 is the light/dark dichotomy between lunar highlands and maria ("seas"). I'd be surprised if anyone reading this couldn't tick those off the list right now. Higher-numbered objects are smaller, less conspicuous, or positioned closer to the limb, making them more challenging to locate and view.

The Messier objects are scattered all over the sky, but all are theoretically observable during marathon nights in March and April every year. By contrast, the Lunar 100 are concentrated in just ½° of sky, yet they can't all be seen in a single night, or even in a single month. Some lunar sights can be observed only with grazing solar illumination, while others are albedo features that require full-Moon conditions to be seen. And others are positioned near (or sometimes even over) the limb of the Moon, requiring a very favorable libration to bring them into view. I don't know how quickly all 100 can be observed, but I'm sure that some competitive amateur will complete it faster than I dare guess!

How big a telescope do you need to view the Lunar 100? The smallest features listed are 3 kilometers in diameter and thus nominally visible in 3-inch (76-millimeter) telescopes employing magnifications of about 150× to 200×. And many can be found with smaller scopes at lower power. But a few Lunar 100 objects — such as narrow rilles — are best seen with 6- or 8-inch telescopes used at high power. The goal, however, is not just to find the objects, but to understand what they tell us abut the Moon.

Any selection of lunar features is bound to lead to many difficult judgments, and I'm sure that at least a few of my choices and rankings will generate considerable debate. Some of my choices were obvious, some were not. Some were influenced by my personal sense of what crater appears more dramatic than another, or which rille best demonstrates an aspect of the Moon's evolution. Aesthetics aside, my choices were principally governed by a desire to include features that tell us something important or interesting about the Moon itself.

Exploring and Understanding

Observing all 100 features (and understanding the geological significance of each one) constitutes a short course in lunar science. Here are some examples of how our modern understanding of the Moon is illustrated by particular objects:

Craters of different sizes result from meteor and comet impacts of different energies. Small craters such as Mösting A (L61) have simple shapes, with steep, smooth walls leading to small, flat floors. Such craters look as if they were mass-produced on a lathe. With higher-energy impacts, the wall rocks collapse toward the crater's center, creating irregular slumps and jumbles of material on the wall and floor. Compression of the rocks directly under the impact energizes them into responding like a splash of water, with rocks from below the surface rebounding to make a small central peak.

As the energy of an impact event increases (due to a larger-mass or higher-velocity projectile), the surrounding rocks collapse more uniformly along a series of circular faults, downdropping massive terraces toward the crater's floor. The central rebound is more intense and produces complex mountains composed of rocks from deep below the surface. The archetypal example is Copernicus (L5), but most relatively fresh craters larger than about 35 km have this morphology.

In the early 1960s, dozens of depressions bigger than normal impact craters and featuring concentric and radial structures were first recognized. These are the impact basins. The arcuate Apennine (L4) and Altai (L7) mountains are simply the rims of the Imbrium and Nectaris impact basins. And the line of tall peaks near the south pole (the Leibnitz Mountains, L96) is the rim of a huge far-side basin. The Alpine Valley (L19) and Rheita Valley (L58) are the most prominent of a series of radial fractures and secondary crater chains found around most basins.

The great diameters and depths of impact basins make it clear that vast amounts of excavated lunar material must have been strewn across the surface of the Moon. This explains why many craters close to basin rims are intensely battered and buried. Look near the ruined craters Boscovich and Julius Caesar (L63) close to the center of the Moon's face and J. Herschel, Babbage, and W. Bond (L76) near the north pole. All were instantly degraded when ejecta from the Imbrium impact surged over them 3.84 billion years ago. The Apollo 14 astronauts landed in the Fra Mauro region (L67) specifically to collect ejecta from the Imbrium impact. Ejecta from smaller craters made the glorious rays of Tycho (L6), the bright nimbus surrounding Linné (L82), and the pit-peppered surface clearly visible east of Copernicus (L5).

Fractures created by basin-forming impacts provided conduits for magmas to rise to the surface and fill deep basins. The weight of the lavas caused the basin floors to subside, with the greatest amount of bending occurring near the edges, forming concentric rilles such as those near the crater Hippalus (L54) on the rim of the Humorum basin. Some of the lava flows folded as a result of compression, producing mare ridges like the Serpentine Ridge (L33) in Mare Serenitatis.

Lavas erupted over hundreds of millions of years in some basins, and their chemical compositions varied through time. Multispectral imaging is usually required to identify lava flows of different compositions and ages, but the dark collar around southeastern Serenitatis (L18) is easily visible in a telescope. The faint rilles hugging the southern shore of Serenitatis occur only in this dark annulus of lava. High-resolution spacecraft photos show that this older material tilted toward the center of the basin before the younger, lighter-hued flows erupted onto the surface.

Mare lava seeped under and into craters along mare shores. The rising magma lifted and tilted crater floors, creating concentric cracks and rilles and often leaking onto the surface. Gassendi (L13), Posidonius (L20), and Taruntius (L31) are all variations of this floor-fracturing process. Other craters, mostly on the floors of basins, were deeply filled by mare lavas that rose up through crater fractures produced by the crater-forming impact. Thus, deep pools of solidified lavas conceal the central peak of Archimedes (L27).

Lunar lavas were much less viscous than those on Earth and consequently flowed much greater distances. Most lunar lava flows were not very deep, and their edges became feathered by subsequent small-scale impact cratering. However, with low-angle solar illumination, keen-eyed observers may spot the edges of the hundred-kilometer-long lava flows (L98) passing into Imbrium from vents near the La Hire mountains.

Swiftly moving lavas flowing downhill from small volcanic craters also produced snakelike channels. The Apollo 15 landing site was selected partly to study the sinuous Hadley Rille (L66). Numerous barely visible sinuous rilles (L86) also cascade downslope north of the crater Prinz.

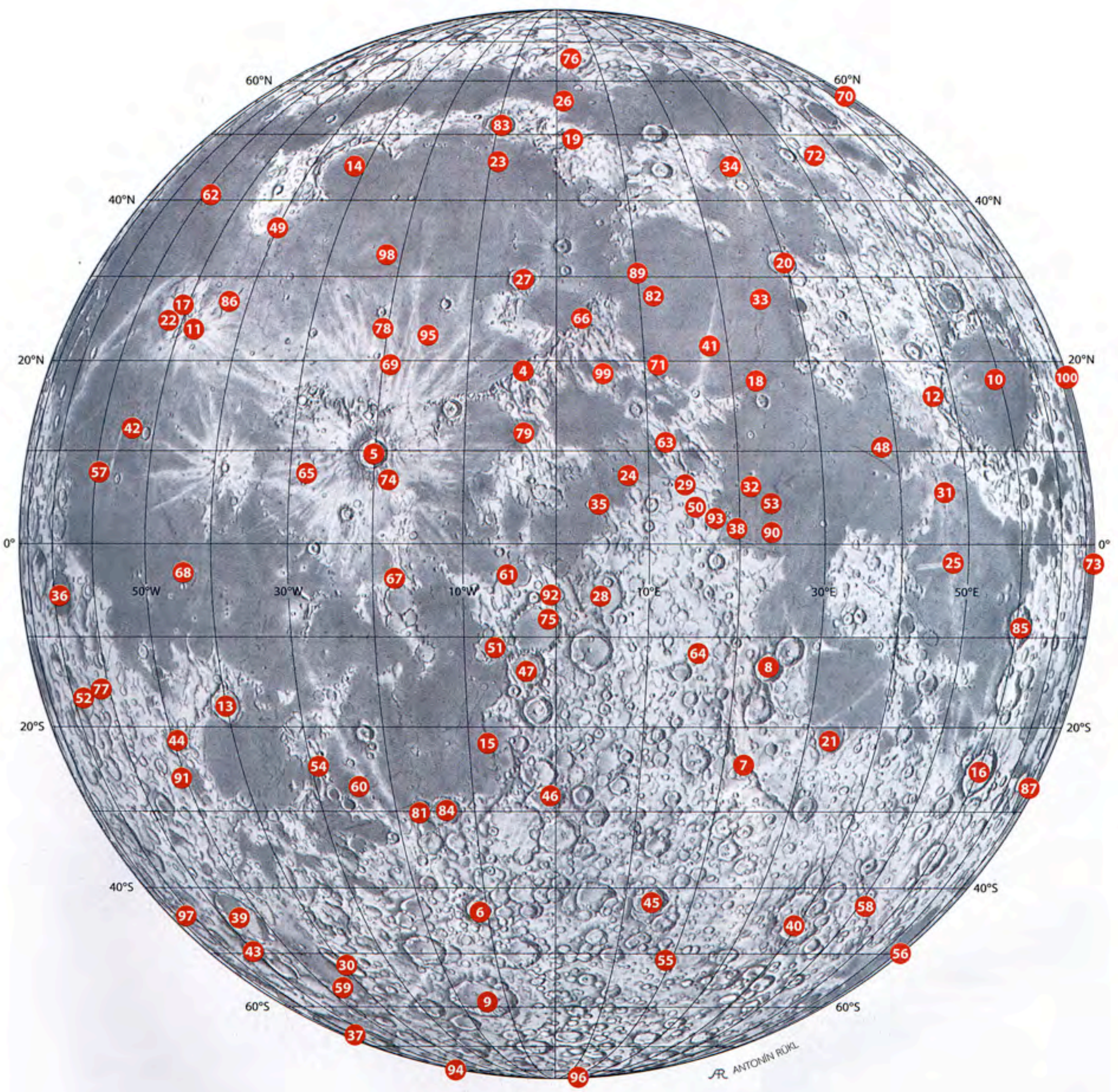
Lavas that erupted slowly onto the lunar surface cooled sufficiently to solidify before they could flow very far. These slow flows formed circular mounds or domes. For reasons we do not understand, domes did not form in all lunar maria but are concentrated in certain areas. Subtle crater-topped domes are visible at low-angle illumination near the craters Hortensius (L65) and Arago (L32). And a field of hundreds of pronounced domes and small hills is concentrated west of the crater Marius (L42).

I invite you to use the Lunar 100 to guide your explorations of the Moon. The complete list appears on pages 115 and 116. Forthcoming columns will provide detailed descriptions of each feature listed in the Lunar 100.

The Moon awaits!

Charles A. Wood *is a dedicated planetary scientist and lunar explorer.*

The Lunar 100



The Lunar 100

L	Feature name	Significance	Latitude (°)	Longitude (°)	Diameter (km)	Rükl chart*
1	Moon	Large satellite	—	—	3,476	—
2	Earthshine	Twice reflected sunlight	—	—	—	—
3	Mare/highland dichotomy	Two materials with distinct compositions	—	—	—	—
4	Apennines	Imbrium basin rim	18.9N	3.7W	400	22
5	Copernicus	Archetypal large complex crater	9.7N	20.1W	93	31
6	Tycho	Large rayed crater with impact melts	43.4S	11.1W	102	64
7	Altai Scarp	Nectaris basin rim	24.3S	22.6E	425	57
8	Theophilus, Cyrillus, Catharina	Crater sequence illustrating stages of degradation	13.2S	24.0E	110	46, 57
9	Clavius	Lacks basin features in spite of its size	58.8S	14.1W	245	72
10	Mare Crisium	Mare contained in large circular basin	18.0N	59.0E	540	26, 27,37,38
11	Aristarchus	Very bright crater with dark bands on its walls	23.7N	47.4W	40	18
12	Proclus	Oblique-impact rays	16.1N	46.8E	28	26
13	Gassendi	Floor-fractured crater	17.6S	40.1W	101	52
14	Sinus Iridum	Very large crater with missing rim	45.0N	32.0W	260	10
15	Straight Wall	Best example of a lunar fault	21.8S	7.8W	130	54
16	Petavius	Crater with domed and fractured floor	25.1S	60.4E	188	59
17	Schröter's Valley	Giant sinuous rille	26.2N	50.8W	168	18
18	Mare Serenitatis dark edges	Distinct mare areas with different compositions	17.8N	23.0E	N/A	24
19	Alpine Valley	Lunar graben	49.0N	3.0E	165	4
20	Posidonius	Floor-fractured crater	31.8N	29.9E	95	14
21	Fracastorius	Crater with subsided and fractured floor	21.5S	33.2E	112	58
22	Aristarchus Plateau	Mysterious uplifted region mantled with pyroclastics	26.0N	51.0W	150	18
23	Pico	Isolated Imbrium basin-ring fragment	45.7N	8.9W	25	11
24	Hyginus Rille	Rille containing rimless collapse pits	7.4N	7.8E	220	34
25	Messier and Messier A	Oblique ricochet-impact pair	1.9S	47.6E	11	48
26	Mare Frigoris	Arcuate mare of uncertain origin	56.0N	1.4E	1,600	2–6
27	Archimedes	Large crater lacking central peak	29.7N	4.0W	83	12, 22
28	Hipparchus	Subject of first drawing of a single crater	5.5S	4.8E	150	44, 45
29	Aridaeus Rille	Long, linear graben	6.4N	14.0E	250	34
30	Schiller	Possible oblique impact	51.9S	39.0W	180	71
31	Taruntius	Young floor-fractured crater	5.6N	46.5E	56	37
32	Arago Alpha and Beta	Volcanic domes	6.2N	21.4E	26	35
33	Serpentine Ridge	Basin inner-ring segment	27.3N	25.3E	155	24
34	Lacus Mortis	Strange crater with rille and ridge	45.0N	27.2E	152	14
35	Triesnecker Rilles	Rille family	4.3N	4.6E	215	33
36	Grimaldi basin	A small two-ring basin	5.5S	68.3W	410	39
37	Bailly	Barely discernible basin	66.5S	69.1W	303	71
38	Sabine and Ritter	Possible twin impacts	1.7N	19.7E	30	35
39	Schickard	Crater floor with Orientale basin ejecta stripe	44.3S	55.3W	206	62
40	Janssen Rille	Rare example of a highland rille	45.4S	39.3E	199	67, 68
41	Bessel ray	Ray of uncertain origin near Bessel	21.8N	17.9E	N/A	24
42	Marius Hills	Complex of volcanic domes and hills	12.5N	54.0W	125	28, 29
43	Wargentin	A crater filled to the rim with lava or ejecta	49.6S	60.2W	84	70
44	Mersenius	Domed floor cut by secondary craters	21.5S	49.2W	84	51
45	Maurolycus	Region of saturation cratering	42.0S	14.0E	114	66
46	Regiomontanus central peak	Possible volcanic peak	28.0S	0.6W	108	55
47	Alphonsus dark spots	Dark-halo eruptions on crater floor	13.7S	3.2W	119	44
48	Cauchy region	Fault, rilles, and domes	10.5N	38.0E	130	36
49	Gruithuisen Delta and Gamma	Volcanic domes formed with viscous lavas	36.3N	40.0W	20	9
50	Cayley Plains	Light, smooth plains of uncertain origin	4.0N	15.1E	14	34

* Chart numbers refer to Antonín Rükl's *Atlas of the Moon*.

The Lunar 100 *(continued)*

L	Feature name	Significance	Latitude (°)	Longitude (°)	Diameter (km)	Rükl chart*
51	Davy crater chain	Result of comet-fragment impacts	11.1S	6.6W	34	43
52	Crüger	Possible volcanic caldera	16.7S	66.8W	45	50
53	Lamont	Possible buried basin	4.4N	23.7E	106	35
54	Hippalus Rilles	Rilles concentric to Humorum basin	24.5S	29.0W	240	52, 53
55	Baco	Unusually smooth crater floor and surrounding plains	51.0S	19.1E	69	74
56	Mare Australe	A partially flooded ancient basin	49.8S	84.5E	132	76
57	Reiner Gamma	Conspicuous swirl and magnetic anomaly	7.7N	59.2W	70	28
58	Rheita Valley	Basin secondary-crater chain	42.5S	51.5E	445	68
59	Schiller-Zucchius basin	Badly degraded overlooked basin	56.0S	45.0W	335	70, 71
60	Kies Pi	Volcanic dome	26.9S	24.2W	45	53
61	Mösting A	Simple crater close to center of lunar near side	3.2S	5.2W	13	43
62	Rümker Hills	Large volcanic dome	40.8N	58.1W	70	8
63	Imbrium sculpture	Basin ejecta near and overlying Boscovich and Julius Caesar	11.0N	12.0E	—	34
64	Descartes	Apollo 16 landing site; putative region of highland volcanism	11.7S	15.7E	—	45
65	Hortensius domes	Dome field north of Hortensius	7.6N	27.9W	10	30
66	Hadley Rille	Lava channel near Apollo 15 landing site	25.0N	3.0E	—	22
67	Fra Mauro formation	Apollo 14 landing site on Imbrium ejecta	3.6S	17.5W	—	42
68	Flamsteed P	Proposed young volcanic crater; Surveyor 1 landing site	3.0S	44.0W	—	40
69	Copernicus secondary craters	Rays and craterlets near Pytheas	19.6N	19.1W	4	20
70	Humboldtianum basin	Multi-ring impact basin	57.0N	80.0E	650	7
71	Sulpicius Gallus dark mantle	Ash eruptions northwest of crater	19.6N	11.6E	12	23
72	Atlas dark-halo craters	Explosive volcanic pits on the floor of Atlas	46.7N	44.4E	87	15
73	Smythii basin	Difficult-to-observe basin scarp and mare	2.0S	87.0E	740	38, 49
74	Copernicus H	Dark-halo impact crater	6.9N	18.3W	5	31
75	Ptolemaeus B	Saucerlike depression on the floor of Ptolemaeus	8.0S	0.8W	164	44
76	W. Bond	Large crater degraded by Imbrium ejecta	65.3N	3.7E	158	4
77	Sirsalis Rille	Procellarum basin radial rilles	15.7S	61.7W	425	39, 50
78	Lambert R	A buried "ghost" crater	23.8N	20.6W	54	20
79	Sinus Aestuum	Eastern dark-mantle volcanic deposit	12.0N	3.5W	90	33
80	Orientale basin	Youngest large impact basin	19.0S	95.0W	930	50
81	Hesiodus A	Concentric crater	30.1S	17.0W	15	54
82	Linné	Small crater once thought to have disappeared	27.7N	11.8E	2.4	23
83	Plato craterlets	Crater pits at limits of detection	51.6N	9.4W	109	3, 4
84	Pitatus	Crater with concentric rilles	29.8S	13.5W	97	54
85	Langrenus rays	Aged ray system	8.9S	60.9E	132	49
86	Prinz Rilles	Rille system near the crater Prinz	27.0N	43.0W	46	19
87	Humboldt	Crater with central peaks and dark spots	27.0S	80.9E	189	60
88	Peary	Difficult-to-observe polar crater	88.6N	95.3E	104	4, II
89	Valentine Dome	Volcanic dome	30.5N	10.1E	30	13
90	Armstrong, Aldrin, and Collins	Small craters near the Apollo 11 landing site	1.3N	23.7E	3	35
91	De Gasparis Rilles	Area with many rilles	25.9S	50.7W	30	51
92	Gylden Valley	Part of the Imbrium radial sculpture	5.1S	0.7E	47	44
93	Dionysius rays	Unusual and rare dark rays	2.8N	17.3E	18	35
94	Drygalski	Large south-pole region crater	79.3S	84.9W	149	72, VI
95	Procellarum basin	The Moon's biggest basin?	23.0N	15.0W	3,200	—
96	Leibnitz Mountains	Rim of South Pole–Aitken basin	85.0S	30.0E	—	73, V
97	Inghirami Valley	Orientale basin ejecta	44.0S	73.0W	140	61
98	Imbrium lava flows	Mare lava-flow boundaries	32.8N	22.0W	—	10
99	Ina caldera	D-shaped young volcanic caldera	18.6N	5.3E	3	22
100	Mare Marginis swirls	Possible magnetic-field deposits	18.5N	88.0E	—	27, III

* Chart numbers refer to Antonín Rükl's *Atlas of the Moon.*

S&T Lunar 100 Observing Log

L	Date	L	Date	L	Date
1		35		69	
2		36		70	
3		37		71	
4		38		72	
5		39		73	
6		40		74	
7		41		75	
8		42		76	
9		43		77	
10		44		78	
11		45		79	
12		46		80	
13		47		81	
14		48		82	
15		49		83	
16		50		84	
17		51		85	
18		52		86	
19		53		87	
20		54		88	
21		55		89	
22		56		90	
23		57		91	
24		58		92	
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26		60		94	
27		61		95	
28		62		96	
29		63		97	
30		64		98	
31		65		99	
32		66		100	
33		67			
34		68			