THE MOON

BY

OLIVER C. FARRINGTON

CURATOR OF GEOLOGY

GEOLOGY

LEAFLET 6

FIELD MUSEUM OF NATURAL HISTORY

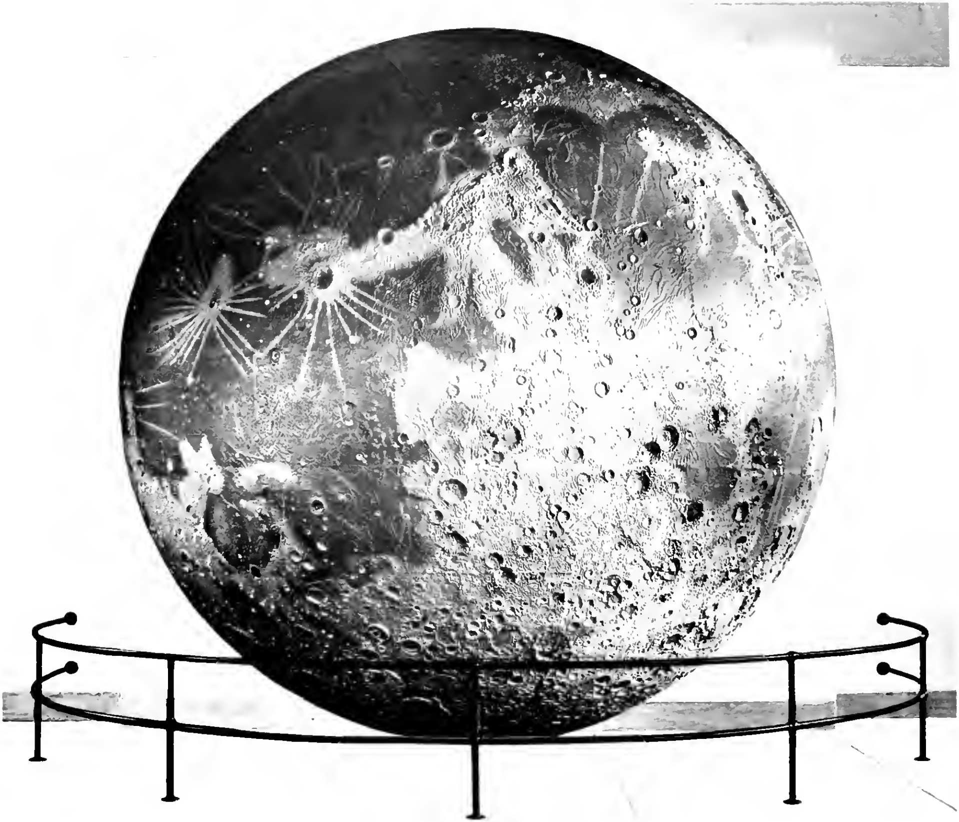
CHICAGO

1925

LIST OF GEOLOGICAL LEAFLETS ISSUED TO DATE

D. C. DAVIES, DIRECTOR

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO, U. S. A.



PHOTOGRAPH OF MODEL IN RELIEF OF THE VISIBLE HEMISPHERE OF THE MOON. HALL 35.

The model is 19 feet in diameter.

PLATE I.

FIELD MUSEUM OF NATURAL HISTORY
DEPARTMENT OF GEOLOGY
CHICAGO, 1925

LEAFLET NUMBER 6

THE MOON

Except for occasional comets and meteors, the Moon is the celestial body nearest the Earth. Its mean distance from the Earth is 237,640 miles, but as it moves in an elliptical orbit, it has at one point a remoteness of 253,263 miles and opposite to this one of 221,436 miles. The diameter of the Moon is about one-fourth that of the Earth, or 2,160 miles, and its volume is 1/49 that of the Earth. The mass of the Moon (volume multiplied by density) is 1/81 and the density 3/5 that of the Earth. The period of the Moon's revolution about the Earth is 27 days, 7 hours, 43 minutes and 11½ seconds. As its period of rotation on its axis is the same, only one side of the Moon is ever seen from the Earth. Since, however, the Moon's axis is inclined about 83° to the plane of its orbit, we sometimes see a little distance beyond each of its poles, and, since the rate of motion of the Moon in its orbit varies slightly, we sometimes see a little beyond the eastern and western edges of the hemisphere. The total result of these *librations*, as they are called, is to make four-sevenths of the Moon's surface visible to us. Of the remaining three-sevenths, nothing is known. So far as is known, the Moon is not flattened at the poles.

Owing to its slow rotation on its axis, the Moon's day has a length of 29½ of our days. Each portion of its surface is therefore exposed to or shielded from the light of the Sun for a fortnight continuously.

The Moon has no atmosphere. Hence, it can have no diffused light, and nothing can be seen on it except where the Sun's rays shine directly. "If a man stepped into the shadow of a lunar crag," says Todd, "he would instantly become invisible. For a similar reason, no sound, however loud, can be heard on the Moon. The rolling of a rock down the wall of a lunar crater, will be known only by the tremor it produces." Moreover, changes of temperature on the Moon are rapid and violent. Where the Sun's rays strike, a temperature about that of boiling water is believed to be reached, while in unilluminated portions it is thought to go as low as 100° below zero.

The force of gravity upon the surface of the Moon is only 1/6 of that on the Earth. Therefore, a man weighing 150 pounds on the Earth, would weigh only 25 pounds on the Moon, and the same muscular energy by which he could jump 6 feet on the Earth would carry him a distance of 36 feet on the Moon. On the Earth a body falls 16 feet in one second; on the Moon only 2.6 feet in the same time.

The surface of the Moon is made up of mountains, valleys and plains, resembling in general appearance those of the Earth. As a whole, however, the surface of the Moon is much more uneven than that of the Earth. Some of the mountains of the Moon have a height of over 20,000 feet. As there is no sea-level to measure from, this figure expresses height above the surrounding surface, it being determined by the length of the shadows cast by the mountains.

In order to represent in a vivid and accurate manner the character and appearance of the Moon's surface, the construction of a large model of the Moon was undertaken a number of years ago by Th. Dickert, Curator of the Natural History Museum of Bonn, Germany and Dr. J. F. Julius Schmidt, Director of the Observatory of Athens, Greece and an eminent selenographer. The model was presented to the Museum by the late Lewis Reese of Chicago, and is installed at the west end of Hall 35 of the Museum. The model is 19.2 feet in diameter, and is by far the largest and most elaborate representation of the Moon's surface ever made. Its horizontal scale is 1:600,000, one inch on the model equaling $9\frac{47}{100}$ miles on the surface of the Moon, and its vertical scale is 1:200,000, one inch equaling $3\frac{15}{100}$ miles on the Moon.

Some characteristic features of the Moon's surface which are especially well illustrated on the model are the following:

1. GRAY PLAINS or "SEAS." These are the darker portions of the Moon's surface as it is seen with the naked eye. They were thought by earlier observers to be seas and were so named. We now know, however, that there is no water on the Moon's surface and that the so-called "seas" are really lowland plains, some of them of vast extent. The Oceanus Procellarum, for instance, covers an area of 90,000 square miles. As seen from the Earth, the plains show a gray-green color, often of varying intensity and sometimes a little bluish in portions. The brightest green color is shown by the area known as Mare Serenitatis. Though appearing perfectly level, a close study shows that these plains have undulating surfaces. They occupy about one-third of the visible surface of the Moon.

2. MOUNTAINS and HIGHLANDS. These constitute the bright portions of the Moon's surface as it is seen with the naked eye.

Although these elevated areas are conveniently called mountains, Shaler has drawn attention to the fact that they are unlike those on the Earth since they lack features due to erosion and there is absence of order in their association. The average declivity of their slopes is also much greater than that of the mountains on the Earth. It has been estimated that the average angle of the lunar surface to its horizon is 52°, while on the Earth it does not amount to more than one-tenth of that figure. This difference is probably due to the lack of water on the Moon, the work of which on the Earth tends continually to reduce slopes to a level. Using the term mountains for convenience, however, those on the Moon may be divided into the following classes:

a. MOUNTAIN CHAINS. These may have a length of 80 to 100 miles and heights of from 5,000 to 17,000 feet. As in the case with the mountains of the Earth, they are usually steeper on one side than on the other. The range called the Appenines, seen near the north pole of the Moon, is a good illustration of such mountain chains. Other ranges are the so-called Alps and Caucasus. These names were applied by Hevelius, an astronomer of Danzig, who made the first map of the Moon in 1647. He gave to the features of the Moon's surface names of localities similar to those on the Earth which they most resembled. His system was largely abandoned by later astronomers, however, the later method being to name the different features of the Moon after celebrated astronomers and philosophers.

b. HIGHLANDS SURROUNDED BY MOUNTAINS. These are partly with and partly without well-determined directions.

c. ISOLATED MOUNTAINS. These usually occur on the gray plains. They vary from 4,000 to 7,000 feet in height.

d. VEIN MOUNTAINS. These occur only on the gray plains. They are long, narrow, contorted ridges, usually from 700 to 1,000 feet in height.

e. CIRCULAR MOUNTAINS. These are the most characteristic and peculiar features of the Moon's surface. They vary in size from the so-called "Walled Plains," 150 to 15 miles in diameter, to crater mountains whose diameters range from 15 miles down to a few hundred feet. Thirty-three thousand of these crater mountains have been counted by one astronomer, the number increasing as the size diminishes.

The form of these craters is that of pits, which generally have ring-like walls about them. These walls slope very steeply to a central cavity and more gently toward the surrounding country. In all these pits, as pointed out by Shaler, except those of the smallest size, and possibly in these, also, there is, within the ring wall and at a considerable though variable depth below its summit, a nearly flat floor, which often has a central pit of small size or, in its place, a steep cone. When this floor is more than 20 miles in diameter, and in increasing numbers as it is wider, there are generally other pits and cones irregularly scattered upon it. Thus, within the ring called Plato, which is about 60 miles in diameter, there are some scores of these lesser pits. On the interior of the ring walls of the pits over 10 miles in diameter, there are usually more or less distinct terraces, which suggest that the material now forming the solid floors they inclose was once fluid and stood at greater heights in the pit than that at which it became permanently frozen. It is, indeed, tolerably certain that the last movement of this material of the floors was one of interrupted subsidence from an originally greater elevation on the outside of the ring wall. The ring wall is commonly of irregular height, with many peaks.

In some places there may be seen tongues or protrusions of the substance which forms the ring, as if it had flowed a short distance and then had cooled with steep slopes. It may also be noted: (*a*) that the pits or craters in many instances intersect each other, showing that they were not all formed at the same time, but in succession; (*b*) that the larger of them are not found on the plains (seas) but on the upland and apparently the older parts of the surface; and (*c*) that the evidence from the intersections clearly indicates that the larger of these structures are prevailingly the older and that in general the smallest were the latest formed. In other words, says Shaler, whatever was the nature of the action involved in the production of the craters, its energy diminished with time, until in the end it could no longer break the crust. These features indicate that the surface of the Moon has been subject to forces similar to those which produce volcanoes on the Earth, and it is therefore customary to refer to the crater-like mountains of the Moon as volcanoes. As the parallel cannot be drawn too closely, however, Shaler has urged that the term vulcanoids, meaning volcano-like, be applied to these mountains.

3. RILLS or CLEFTS. These are small, deep, ditch-like furrows to be found over various parts of the Moon's surface. Their course seems quite independent of the surface topography, for they traverse mountains and plains with equal facility. They are without doubt the latest formation on the Moon and some of them may have had their origin in modern times.

4. BRIGHT STREAKS. These radiate prominently from many of the great craters of the Moon. They are streaks of narrow width but sometimes nearly a hundred miles in length. They are perhaps

the most puzzling of all the Moon's features. They have been supposed by some observers to represent lava flows whose surface reflected light more brilliantly than other portions of the Moon. It is more generally believed, however, that the streaks do not represent any independent elevations, since they run over the highest mountains as well as through the deepest craters without variation.

GENERAL OBSERVATIONS.

The condition of the Moon's surface as a whole indicates that it has been a theater of extraordinary volcanic activity. In size and number its vulcanoids far exceed the volcanoes of the Earth. The largest terrestrial crater known is that of Kilauea in the Hawaiian Islands which is 2½ miles in diameter. Several craters of the Moon, however, exceed 50 miles in diameter and one measures 114½ miles. While the absolute heights of the mountains of the Moon do not greatly exceed those of the Earth, proportionally they are much higher, since the Moon's diameter is only one-fourth that of the Earth. The vulcanoids of the Moon differ in other respects from the volcanoes of our globe. "On the Earth they are usually openings on the summits or sides of mountains—on the Moon, depressions below the adjacent surface even when it is a plain or valley; on the Earth the mass of the cone usually far exceeds the capacity of the crater—on the Moon they are much nearer equality; on the Earth they are commonly the sources of long lava streams—on the Moon, traces of such outpourings are rare." (Webb.)

DESCRIPTION OF INDIVIDUAL FEATURES.

(Abridged from Nasmyth and Carpenter.)

The numbers refer to those on the accompanying chart.

COPERNICUS. 147. This may deservedly be considered one of the grandest and most instructive of lunar craters. Though its diameter (46 miles) is exceeded by that of other craters, its situation near the center of the lunar disc renders it so conspicuous as to make it a favorite object for observation. Its vast rampart rises to upwards of 12,000 feet above the level of the plateau, nearly in the center of which stands a magnificent group of cones attaining the height of upwards of 2400 feet. The rampart is divided by concentric segmented terraced ridges, which present every appearance of being enormous landslips, resulting from the crushing of their overloaded summits which have slid down in vast segments and scattered their debris on the plateau. Corresponding vacancies in the rampart may be observed from whence these prodigious masses have broken away. The same may be noticed, to a somewhat modified degree, around the exterior of the rampart. For upwards of 70 miles around Copernicus myriads of comparatively minute but perfectly formed craters can be seen. The district on the southeast side is especially rich in them. Many somewhat radial ridges or spurs may be observed leading away from the exterior banks of the great rampart. They appear to be due to the freer egress which the extruded matter found near the focus of disruption.

TRIESNECKER. 150. A fine example of a normal lunar volcanic crater having all the usual characteristic features in great perfection. Its diameter is about 20 miles and it possesses a good example of the central cone and also of interior terracing. The most notable feature, however, is the remarkable display of cracks or chasms which may be seen to the west side of it. Several of these cracks obviously diverge from near the west external bank of the great crater and they sub-divide or branch out as they extend from the apparent point of divergence, while they are crossed or intersected by others. These cracks or chasms are nearly one mile wide at their widest part and after extending for fully 100 miles taper away till they become invisible.

THEOPHILUS. 97. CYRILLUS. 96. CATHARINA. 95. These three magnificent craters form a conspicuous group. Their diameters and depths are as follows: Theophilus, diameter, 64 miles; depth of interior plateau from summit of crater wall, 16,000 feet; central cone, 5200 feet high; Cyrillus, diameter, 60 miles; depth of interior plateau from summit of crater wall, 15,000 feet; central cone, 5800 feet high; Catharina, diameter, 65 miles; depth of interior plateau from summit of crater wall, 13,000 feet; center of plateau occupied by a confused group of minor craters and debris. Each of these craters is full of interesting details presenting in every variety the characteristic features of the lunar volcanoes and giving unmistakable evidence of the tremendous energy which at some remote period piled up such gigantic formations. The intrusion of Theophilus within Cyrillus shows that it is of more recent formation than the latter. The flanks of Theophilus, especially on the west side, are studded with apparently minute craters. These would be considered of great size but for the enormous crater so near.

PTOLEMY. 111. ALPHONS. 110. ARZACHAEL. 84. The portion of the moon's surface which includes these features, being near the center of the lunar disc, is exceptionally well placed for observation. Within this area may be seen every variety of volcanic craters and a number of other interesting forms. Ptolemy belongs to the class of walled plains, its ramparts enclosing a plain 86 miles in diameter. Alphons and

Arzachael are respectively 60 and 55 miles in diameter. They have all the distinctive features of lunar craters, viz:—central cones, lofty, ragged ramparts, manifestations of landslip formations in the great segmental terraces within their ramparts and minor craters interpolated within their plateaus. A notable object near Alphons is an enormous straight cliff traversing the diameter of a low, ridged, circular formation. This great cliff is 60 miles long and from 1000 to 2000 feet high. It is a well known object to lunar observers and has been termed "The Railway" on account of its straightness. The existence of this remarkable cliff appears to be due either to an upheaval or a down-sinking of a portion of the surface of the circular area across whose diameter it extends.

TYCHO. 30. This magnificent crater is 54 miles in diameter and upwards of 16,000 feet deep from the highest ridge of the rampart to the surface of the plateau. It is one of the most conspicuous of lunar craters, not so much on account of its dimensions as from its occupying the great focus of disruption from whence diverge those remarkable bright streaks many of which may be traced over 1000 miles of the moon's surface. The interior of the crater presents striking examples of the concentric, terrace-like formations that are regarded as formed by landslips.

WARGENTIN. 26. SCHICKARD. 28. Wargentin is an object quite unique of its kind—a crater about 52 miles across, that to all appearance has been filled to the brim with lava that has been left to consolidate. There are evidences of the remains of a rampart, especially on the southwest portion of the rim. The general aspect of Wargentin has been compared to that of a "thin cheese." The terraced and rutted exterior of the rampart has all the details of a true crater. The surface of the high plateau is marked by a few ridges branching from a point nearly in the center.

Schickard is one of the finest examples of a walled plain. It is 153 miles in diameter. Within its rampart are 16 smaller craters and without, numberless others.

The following are the names of topographic features of the Moon which can be located by the corresponding numbers on the accompanying chart.

1. Newton.
2. Short.
3. Simpelius.
4. Manzinus.
5. Moretus.
6. Gruemberger.
7. Casatus.
8. Klaproth.
9. Wilson.
10. Kircher.
11. Bettinus.
12. Blancanus.
13. Clavius.
14. Scheiner.
15. Zuchius.
16. Segner.
17. Bacon.
18. Nearchus.
19. Vlacq.
20. Hommel.
21. Licetus.
22. Maginus.
23. Longomontanus.
24. Schiller.
25. Phocylides.
26. Wargentin.
27. Inghirami.
28. Schickard.
29. Wilhelm I.
30. Tycho.
31. Saussure.
32. Stoefler.
33. Maurolycus.
34. Barocius.
35. Fabricius.
36. Metius.
37. Fernelius.
38. Heinsius.
39. Hainzel.
40. Bouvard.
41. Piazzi.
42. Ramsden.
43. Capuanus.
44. Cichus.
45. Wurzelbauer.
46. Gauricus.
47. Hell.
48. Walter.
49. Nonius.
50. Riccius.
51. Rheita.
52. Furnerius.
53. Stevinus.
54. Hase.
55. Snell.
56. Borda.
57. Neander.
58. Piccolomini.
59. Pontanus.
60. Poisson.
61. Aliacensis.
62. Werner.
63. Pitatus.
64. Hesiodus.
65. Mercator.
66. Vitello.
67. Fourier.
68. Lagrange.
69. Vieta.
70. Doppelmayer.
71. Campanus.
72. Kies.
73. Purbach.
74. La Caille.
75. Playfair.
76. Azophi.
77. Sacrobosco.
78. Fracastorius.
79. Santbech.
80. Petavius.
81. Wilhelm Humboldt.
82. Polybius.
83. Geber.
84. Arzachael.
85. Thebit.
86. Bullialdus.
87. Hippalus.
88. Cavendish.
89. Mersenius.
90. Gassendi.
91. Lubiniezky.
92. Alpetragius.
93. Airy.
94. Almanon.
95. Catharina.
96. Cyrillus.
97. Theophilus.
98. Colombo.
99. Vendelinus.
100. Langreen.
101. Goclenius.
102. Guttemberg.
103. Isidorus.
104. Capella.
105. Kant.
106. Descartes.
107. Abulfeda.
108. Parrot.
109. Albategnius.
110. Alphons.
111. Ptolemy.
112. Herschel.
113. Davy.
114. Guerike.
116. Bonpland.

117. Lalande.
118. Reaumur.
120. Letronne.
121. Billy.
122. Fontana.
123. Hansteen.
124. Damoiseau.
125. Grimaldi.
126. Flamsteed.
127. Landsberg.
128. Moesting.
129. Deambrel.
130. Taylor.
131. Messier.
132. Maskelyne.
133. Sabine.
134. Ritter.
135. Godin.
136. Soemmering.
137. Schroeter.
138. Gambart.
139. Reinhold.
140. Encke.
141. Hevelius.
142. Riccioli.
143. Lohrman.
144. Cavalerius.
145. Reiner.
146. Kepler.
147. Copernicus.
148. Stadius.
149. Pallas.
150. Triesnecker.
151. Agrippa.
152. Arago.
153. Taruntius.
154. Apollonius.
155. Schubert.
156. Firmicus.
157. Silberschlag.
158. Hyginus.
159. Ukert.
160. Boscovich.
161. Ross.
162. Proclus.
163. Picard.
164. Condorcet.
165. Pliny or Menelaus.
167. Manilius.
168. Erastothenes.
169. Gay Lussac.
170. Tobias Mayer.
171. Marius.
172. Olbers.
173. Vasco de Gama.
174. Seleucus.
175. Herodotus.
176. Aristarchus.
177. La Hire.
178. Pytheas.
179. Bessel.
180. Vitruvius.
181. Maraldi.
182. Macrobius.
183. Cleomides.
184. Roemer.
185. Littrow.
186. Posidonius.
187. Geminus.
188. Linnaeus.
189. Autolycus.
190. Aristillus.
191. Archimedes.
192. Timocharis.
193. Lambert.
194. Diophantus.
195. Delisle.
196. Briggs.
197. Lichtenberg.
199. Calippus.
200. Cassini.
201. Gauss.
202. Messala.
203. Struve.
204. Mason.
205. Plana.
206. Burg.
207. Baily.
208. Eudoxus.
209. Aristotle.
210. Plato.
211. Pico.
212. Helicon.
213. Maupertuis.
214. Condamine.
215. Bianchini.
216. Sharp.
217. Mairan.
218. Gerard.
219. Repsold.
220. Pythagoras.
221. Fontenelle.
222. Timaeus.
223. Epigenes.
224. Gartner.
225. Thales.
226. Strabo.
227. Endymion.
228. Atlas.
229. Hercules.

OLIVER C. FARRINGTON.

SOURCES OF ADDITIONAL INFORMATION ABOUT THE MOON

A number of textbooks and popular works on astronomy deal more or less fully with the Moon. Among them the following may be mentioned.

MOULTON, FOREST RAY—Introduction to Astronomy. Macmillan & Co., New York. 1916. 577 pp.

YOUNG, CHARLES A.—A Textbook of General Astronomy. Ginn & Co., Boston. 1898. 630 pp.

TODD, DAVID P.—Stars and Telescopes. Little, Brown & Co., Boston. 1899. 419 pp.

The following are some works which treat exclusively of the Moon.

NASMYTH, JAMES AND CARPENTER, JAMES—The Moon. John Murray, London. 1885. 213 pp. 25 "Woodburytype" plates and several text figures.

PICKERING, WILLIAM H.—The Moon. Doubleday, Page & Co., New York. 1903. Quarto. 103 pp. and many full-sized plates.

PROCTOR, RICHARD A.—The Moon. Longmans, Green & Co., London. 1898. 314 pp.

GILBERT, GROVE K.—The Moon's Face. Bulletin of the Philosophical Society of Washington, 1892-93. Vol. 12, pp. 241-292.

SHALER, NATHANIEL S.—A Comparison of the Features of the Earth and the Moon. Smithsonian Contributions to Knowledge. 1907. Vol. 34, pp. 1-79. 25 plates.

The figures

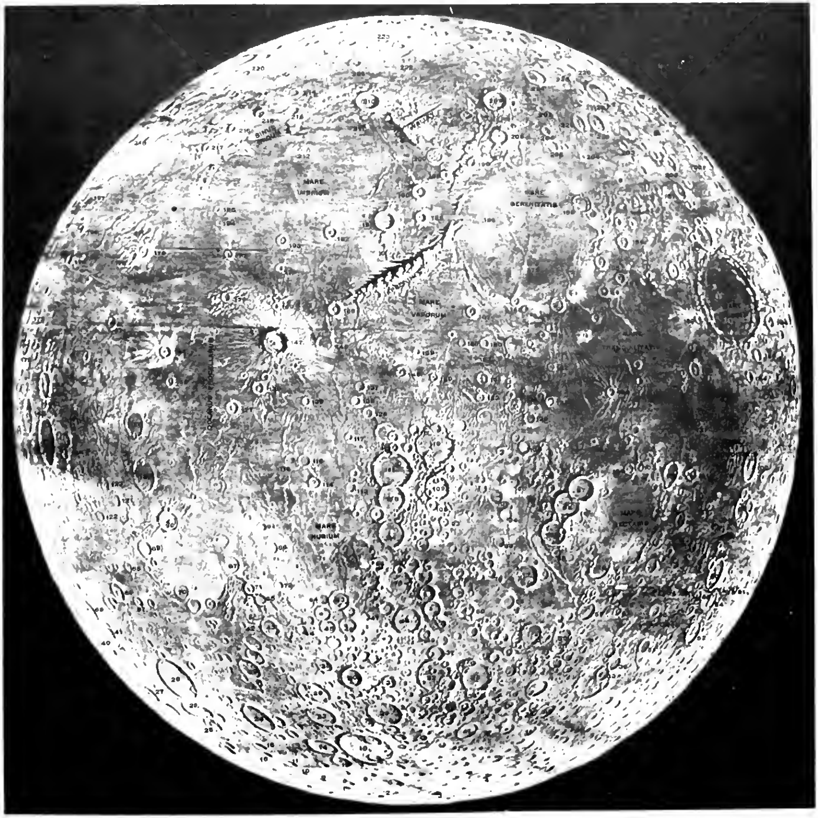


CHART OF THE MOON'S SURFACE. AFTER NASMYTH.

The figures refer to the names given on pp. 11 and 12 and the use of this chart with the model will enable the reader to name the different features of the moon.

PRINTED BY FIELD MUSEUM PRESS