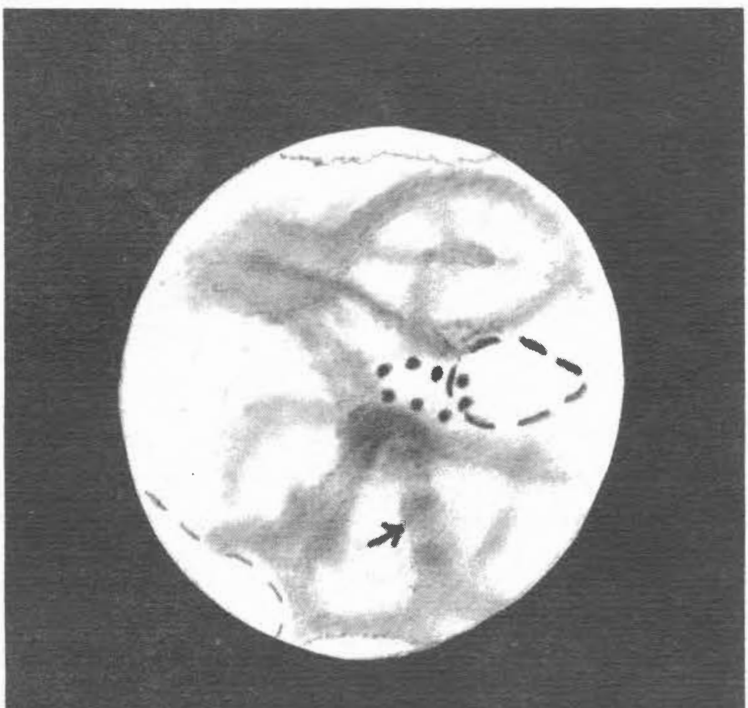
# The Strolling Astronomer

The Journal Of
The Association Of Lunar
And Planetary Observers

Volume 22, Numbers 7-8 Published August, 1970



Drawing of Mars by C. F. Capen on September 5, 1969 at 4 hrs., O mins., Universal Time. 16-inch Cassegrain, 500X. Martian Date 3 November. CM= 51°. The arrow points to a new dark development along the Issedon canal. Note the clouds and frost patches (dashed outlines). See text on pg. 138, and compare to drawing by T. Osawa on pg. 139.

THE STROLLING ASTRONOMER
Box 3AZ
University Park, New Mexico
88001

Residence telephone 524-2786 (Area Code 505)
in Las Cruces, New Mexico

ASSOCIATION OF LUNAR & PLANETARY OBSERVERS

Founded In 1947

**IN THIS ISSUE**

## LUNAR NOTES

By: John E. Westfall, Harry D. Jamieson, Charles L. Ricker, and Kenneth J. Delano, A.L.P.O. Lunar Recorders

### I. Partial Lunar Eclipse: August 17, 1970 (U.T.)

By: John E. Westfall

On the night of August 16/17 (local time), 1970, a partial lunar eclipse will occur, generally visible over the United States except that western observers will be able to see only the latter phases. Although this is only a partial eclipse, with magnitude 0.413, several useful forms of observations can be made:

1. Timing (to ± 0.1 mins.) first and last umbral contacts.

2. Timing (to ± 0.1 mins.) entering and leaving umbral contacts for the following craters: Aristarchus, Copernicus, Pytheas, Timocharis, Plato, Aristoteles, Eudoxus, Manilius, Menelaus, Plinius, Taruntius, and Proclus. Copernicus and Taruntius will be very near the border of the earth's shadow so that their timings, if possible, will be quite useful. Crater timing reports should be mailed to: Sky and Telescope, 49-50-51 Bay State Road, Cambridge, Massachusetts 02138.

3. Observing selected lunar features both immediately before and immediately after their immersion in the umbra in order to detect possible eclipse-induced Transient Lunar Phenomena. Some suggested features are Aristarchus, Eratosthenes, Conon, Plato, Linné, Ross D, and Atlas.

4. General descriptions and sketches of umbral and penumbral shading, color, and visibility, including descriptions of the sharpness and ellipticity of the edge of the umbra.

Except for crater timings, reports on this eclipse may be sent to the writer. More detailed information on lunar eclipse observing may be found in the A.L.P.O.'s Lunar Observer's Manual, available from the Lunar Recorders.

Lunar Eclipse Schedule: August 16/17, 1970

| | U.T. | EDT | CDT | MDT | PDT |
|---|---|---|---|---|---|
| Moon enters Penumbra | 01:06* | 21:06 | 20:06 | 19:06 | 18:06 |
| Moon enters Umbra | 02:17* | 22:17 | 21:17 | 20:17 | 19:17 |
| Middle of Eclipse | 03:23* | 23:23 | 22:23 | 21:23 | 20:23 |
| Moon leaves Umbra | 04:30* | 00:30* | 23:30 | 22:30 | 21:30 |
| Moon leaves Penumbra | 05:40* | 01:40* | 00:40* | 23:40 | 22:40 |

*August 17th; August 16th otherwise.

### II. Activities of the Selected Areas Program

By: Charles L. Ricker

As of this date (May), observing activity has remained rather low, but a few observers are continuing to observe regularly. Since the last "Lunar Notes", observations have been received from the following observers: Christopher Vaucher, Inez Beck, William Richrath, Chet Eppert, Harry Jamieson, and H. W. Kelsey. Inez Beck has made an uninterrupted series of observations of Eratosthenes for a number of months, which will prove extremely valuable in view of the fact that most observers shy away from this difficult formation. Christopher Vaucher makes a habit of supplementing his drawings and intensity estimates with extensive written notes, thereby greatly enhancing their value. William Richrath has submitted regular monthly observations for several years. These observers are to be commended for their extraordinary efforts and may feel confident that this extra effort greatly increases the scientific value of their observations.

Lunar Recorder Harry Jamieson has done an analysis with all the observations on file of crater Messier of the shadow lengths as measured from drawings of various observers. His aim is to derive a vertical profile for this formation, as well as for the other selected areas eventually. While the observations on file were not made with this aim in mind, and therefore the scatter between individual observations is quite high, still the method shows a great deal of promise; and if all observers will concentrate on carefully drawing in the shadow, and recording the corresponding time, the results could be very good.

No TLP (Transient Lunar Phenomena) have been reported by our observers during this period even though coverage of the selected areas, which include several active TLP formations, has been fairly good.

In recent self-critical discussions among the Lunar Recorders as to the fate of the TLP selected areas survey, several far-reaching decisions have been reached which will drastically change the goals and objectives of this program. Briefly the changes are:

1. Officially change the name of the program to the "Selected Areas Program".
2. De-emphasize the TLP aspect of the program. It is the consensus of opinion that TLP are far too subjective to lend themselves readily to detection by visual methods.
3. The major goals of the program will be: a. To identify and, if possible, explain the "seasonal" changes which have been detected in these areas in the past. b. To construct tonal charts which can serve as a base for future studies. c. To gather data on the vertical profiles of these formations as completely as visual methods will allow.
4. Drop the following formations from the program: Alphonsus, Plato, Messier-Pickering, and Kepler. Extensive files of observations exist for these formations, and it is time to go on to new ones.
5. Add Atlas, Ross D, Colombo, and Pico to the program. Future notes will describe these in detail, but suffice it to say now that they are all rich in history of unusual aspects which are as yet to be explained.
6. Change the selected areas at least every two years since this interval should be sufficient time to realize the above goals on any given formation.
7. Continue the practice of making a major report on each formation, but in addition publish frequent interim reports on <u>all</u> the formations.

The Recorders feel that the above program will be an interesting and useful study, and of course will only be successful if a number of observers stop waiting for the other fellow to do it. As in all ALPO programs, we must have observer support! See p. 131*

### III. A Miniature Schröter's Valley Near Delambre

By: Harry D. Jamieson

While making observations for the new A.L.P.O. High Sun Study, Mrs. Inez N. Beck found a miniature sinuous rille of the Schröter's Valley type curving about one-quarter of the way around the (IAU) SW outer rim of Delambre. The snake-like "body" and "Cobra-head" are most striking, as are the brightness changes which the head especially appears to undergo. Under low illumination, the feature is not outstandingly bright; but as the sun rises, brightness increases until, at local noon, the head seems to shine with diamond brilliance, and the entire body is outlined in white.

A sketch of Delambre with the sinuous valley by Mrs. Beck is shown in Figure 1, giving a view under late morning lighting. For comparison, Figure 2 is a Ranger-VIII photograph of the same region, under afternoon lighting, also showing the valley.

Studies of this feature, which is centered at rectangular coördinates +291 -046, are continuing; and it is hoped that more information about it can be obtained. This is yet another example of how many features of interest still remain to be discovered; for, to this writer's knowledge at least, this formation has never been reported before. Other observers who have subsequently observed this intriguing rille so far include H. W. Kelsey and the writer. Readers are heartily invited to join in this study.

*****

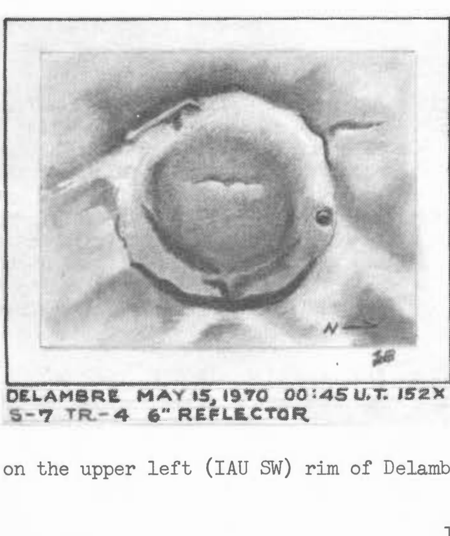



Figure 1. Drawing of Delambre by Inez Beck on May 15, 1970, 00:45 U.T., with a 6-inch reflector. Colong. = 20°.4. North is to the right, and the sinuous valley reported is on the upper left (IAU SW) rim of Delambre.

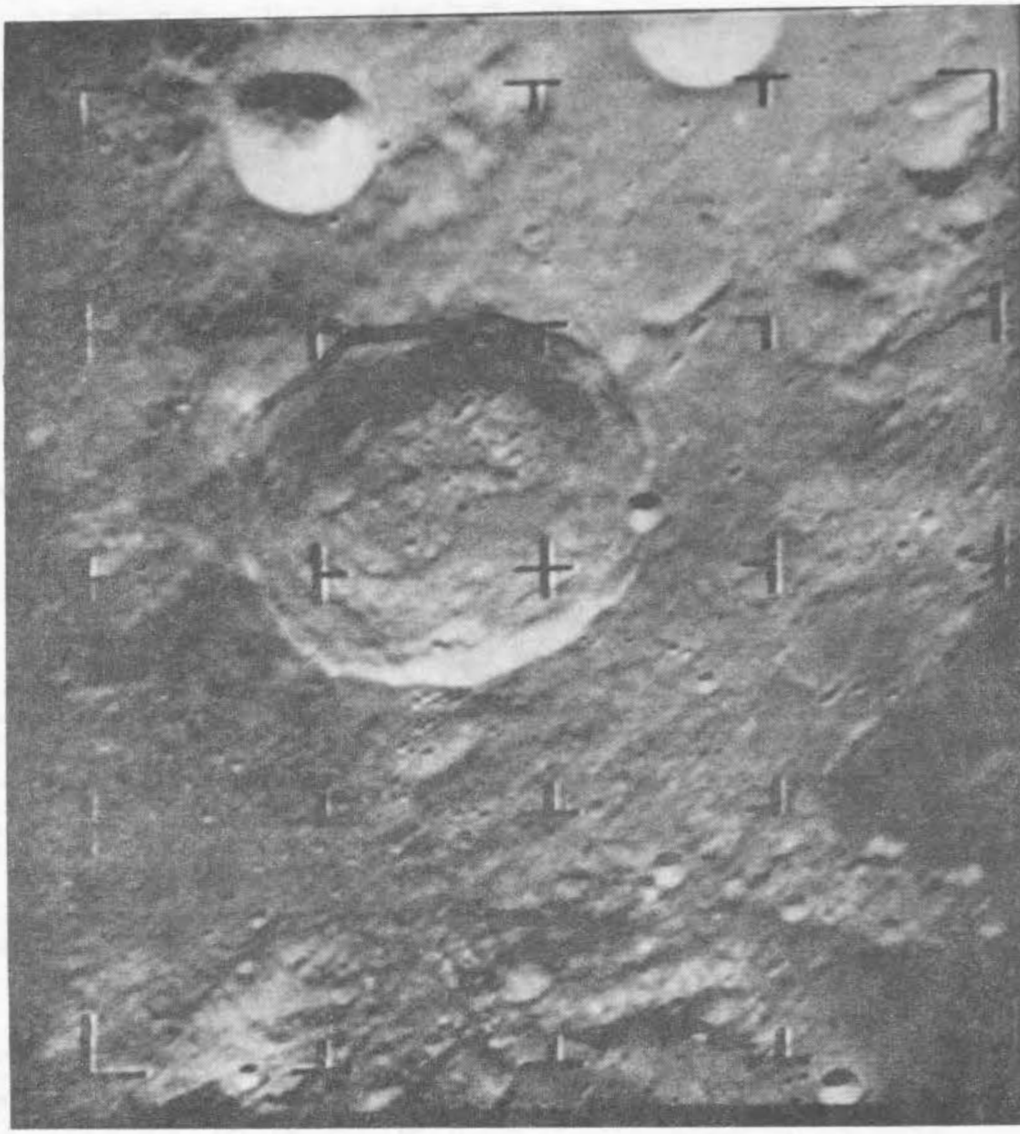


Figure 2. Delambre and its sinuous valley as photographed by Ranger-VIII on February 20, 1965 at colongitude 140°.4. North is to the right to correspond with Figure 1 so that the shadow-filled sinuous valley appears on the upper left rim of Delambre.

## IV. A Request For Observations of Lunar Saucers

By: Kenneth J. Delano

In an effort to interest more people in observing the Moon, the Lunar Dome Program is expanding in order to include other low-light features such as saucers and ghost craters. The very first step is to determine whether or not a sufficient number of ALPO members can readily distinguish saucers from ghost craters and are willing to send in reports of their observations of these low-light features. In contrast with the low-walled ghost craters, saucers can have no elevated rims at all, being only round depressions in the lunar surface.

A good place to begin observing lunar saucers is the huge Crater Ptolemaeus, which contains numerous saucers, according to H. P. Wilkins and Patrick Moore in their book, The Moon (p. 62). They write: "Immediately to the north of Lyot [a crater identified as Ptolemaeus 'A' on some more recent maps: it is the most distinct crater on Ptolemaeus' floor] is a low-rimmed object, a, the largest and the best marked of many shallow, saucer-like depressions scattered over the interior. Filling up the space between Lyot and the northern border of Ptolemaeus, in addition to a, are two objects of similar nature, b and c... . Of the other shallow depressions, which vary greatly in size, some are not by any means easy to see, except when near the terminator. The largest lies to the south-east of Lyot."

ALPO observers are asked to make a sketch of Ptolemaeus' floor, indicating on it the positions and diameters of any saucers seen by them. Additional comments concerning the appearance of any reported saucers will be most valuable, as will also be any negative reports of attempts to locate saucers. In particular, should the large 10-mile-diameter saucer a, which is adjacent to the northern wall of Lyot, be considered a genuine saucer; or is it better described as a ghost crater comparable to Stadius, which lies between Copernicus and Eratosthenes?

ALPO members are asked to look for the Ptolemaeus saucers at First Quarter and for a day or two afterwards, and also during the 1 or 2 days before Last Quarter, and to submit the results of their observations to the Lunar Dome Recorder so that they can be included in a report to be made later this year. Reports of any saucers found elsewhere on the Moon should also be submitted during this same period.

## THE AREAS OF THE LUNAR LOWLANDS

By: John E. Westfall, A.L.P.O. Lunar Recorder

### Introduction

In recent decades, statistical studies of the distributions of lunar features have become increasingly frequent. Many such investigations require accurate areas for the regions studied, and so it is surprising that the boundaries and areas of such important physiographic divisions as the lunar lowlands are usually given only vaguely. Often an area figure is given without any source, hint of the method used to obtain it, or precise definition of the area to which it applies. Despite its own accuracy limitations, this study is intended to present reasonably accurate area values for precisely defined lunar regions which may be used in statistical studies and in selenologic studies where the total area of the lunar lowlands is needed.

The term, "lunar lowlands," is here used in the same sense as by the United States Geological Survey (USGS)[1]: the lunar *maria* (including features named *sinus*, *lacus*, *palus*, and *oceanus*), including *terra* units enclaved within them.

### Method of Measurement

Sources.--The most important source used to define and measure the lunar lowlands was the USGS Engineer Special Study of the Surface of the Moon (1961)[2], as modified slightly in 1962.[1] In that report, sheet 3, "Physiographic Divisions of the Moon," shows the boundaries of the divisions on an orthographic photomosaic base at a stated scale of approximately 1/3,800,000 (measured scale = 1/3,822,000).

The USGS map shows the earthside only, and even here the limb areas are foreshortened. For this reason, limb and farside lowlands were plotted on the United States Air Force Lunar Farside Chart (LFC-1),[3] on a Mercator Projection at an equatorial scale of 1/5,774,000, enlarged to 1/2,900,000. *Maria* are indicated only vaguely on LFC-1, and more accurate boundaries were drawn upon it based on Orbiter and Apollo photographs.[4]

A third source was used for Mare Australe because this *mare* was not completely shown on either the USGS or the USAF maps. Fortunately, Orbiter-IV Photograph 67-H-745 (in the A.L.P.O. Lunar Photograph Library)[5] shows the entire *mare* and was used to measure the area of this feature.

When possible, the USGS map was used for the definitions of *maria* boundaries (i.e., for units IIA1 - A12, B1 - B3, C1 - C3, C6, and E1 on Figure 3). Based on Orbiter and Apollo photography, the writer defined the boundaries of the limb and farside units (i.e., IIC4, C5, D1, E2 - E4, F1, and F2). Figure 3 shows the earthside units for which the USGS map was used. Figures 4-6 show the limb units, and Figure 7, the farside units, as defined by the writer. Figures 4, 5, and 7 are reductions from USAF LFC-1, and Figure 6 is an enlargement from Orbiter-IV 67-H-745.

Scale Factor.--None of the sources used shows the moon on an equivalent (equal-area) projection. This writer knows of only one lunar map on an equivalent projection, the National Geographic Society's The Earth's Moon,[6] on a Lambert Azimuthal Equivalent Projection at a mean scale of 1/11,620,000. Unfortunately, this scale is inconveniently small for area measurement, and also the borders of the *maria* are shown indistinctly on it.

The use of non-equivalent projections meant that the areal scale factor had to be calculated for each unit measured. (The areal scale factor is the ratio: (areal scale at center of map)/(areal scale at the point being measured).) In the case of the orthographic USGS map, the scale factor equalled secant $\Theta$, where $\Theta$ is the selenocentric angular distance from the center of the disc. With the USAF map, on the Mercator Projection, the areal scale factor was cosine$^2$ B, where $B$ is the selenographic latitude. Calculation of the areal scale factor was more complex in the case of the Orbiter photograph (used for

**FIGURE 3.** **LUNAR NEARSIDE LOWLANDS**

**(After USGS)**

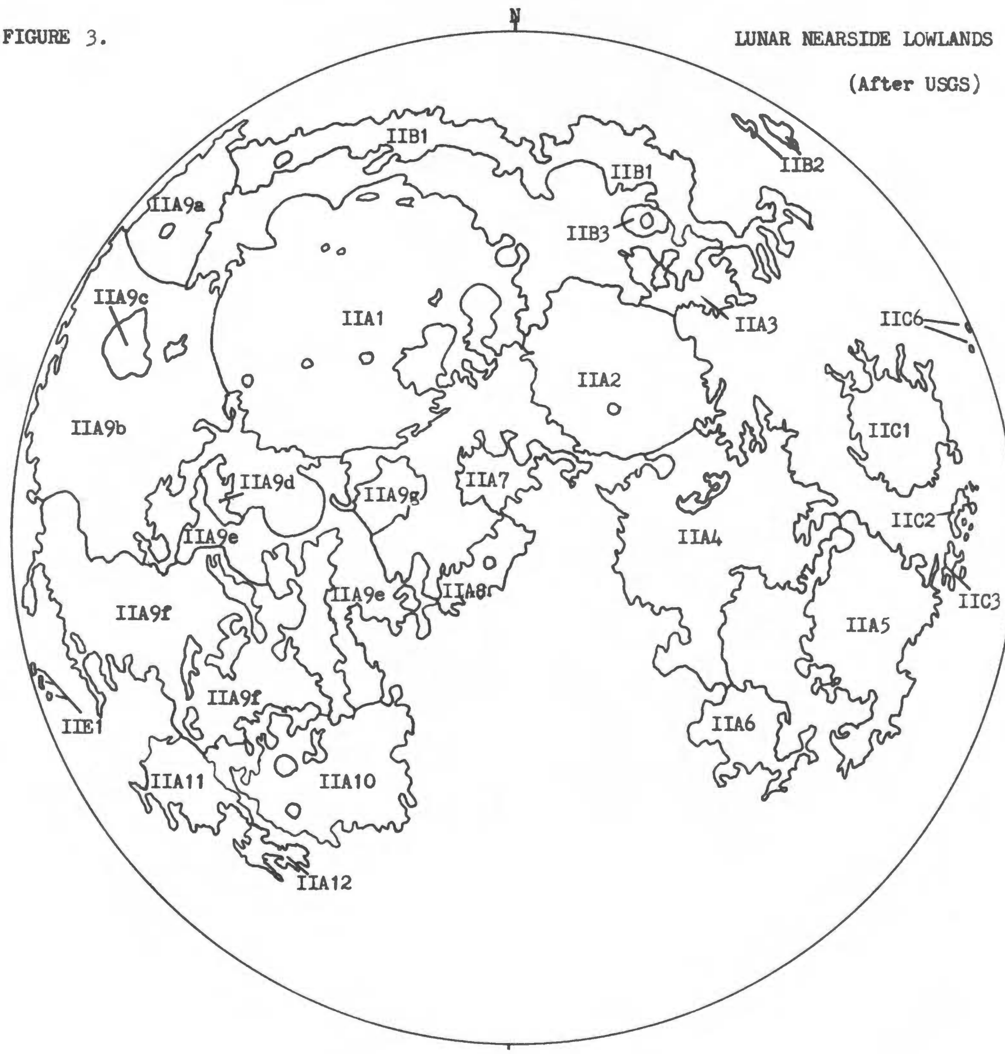



Figure 3. Orthographic projection of lunar earthside hemisphere, showing lowland units which were measured using the boundaries of the U.S. Geological Survey (References 1 and 2). North at top. Figures 3-7 are further discussed in the text of "The Areas of the Lunar Lowlands".

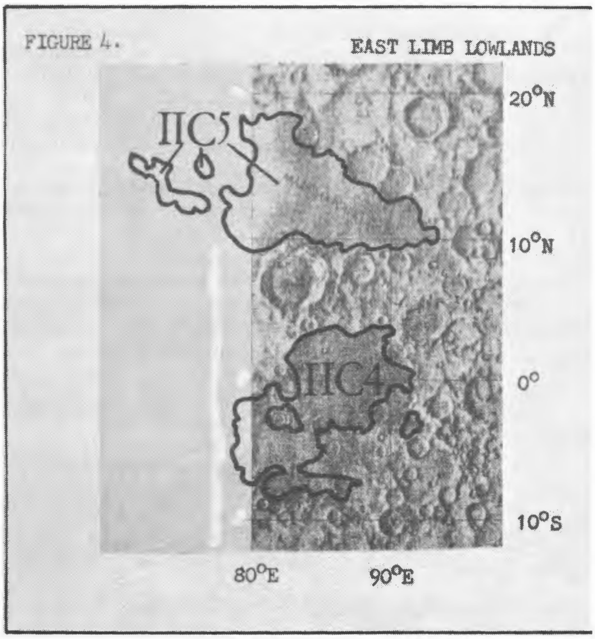



Figure 4. Lowland units IIC4 and C5 on the (IAU) East Limb of the moon, plotted on a reduction of the U. S. Air Force map, LFC-1. North at top.

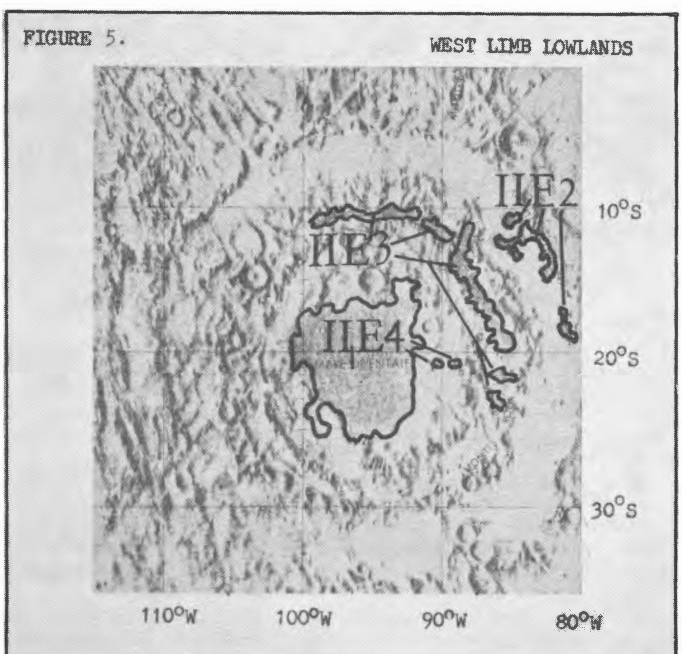



Figure 5. Lowland units within the Mare Orientale Basin (IAU West Limb) plotted on a reduction of LFC-1. North at top.

unit IID1) because not only the angle of view, but also the distance from the spacecraft, varied with distance from the apparent center of the disc.

FIGURE 6.

MARE AUSTRALE

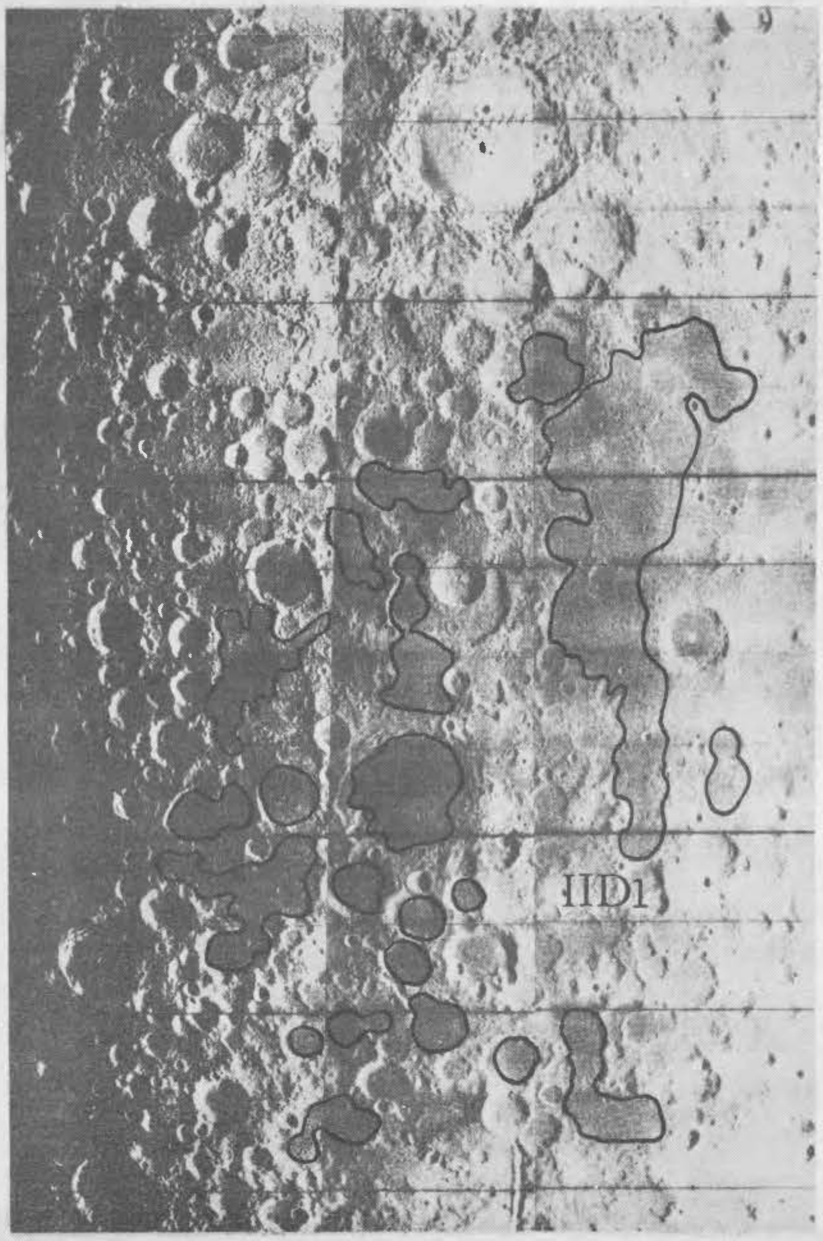



Figure 6. An enlargement of Orbiter-IV wide-angle frame No. 11 (A.L.P.O. Lunar Photograph Library print No. 67-H-745), showing the 21 portions of Mare Australe, as defined by the writer. The large crater near top center is Wilhelm Humboldt. North at top.

******

Method of Measurement.--For all units except IID1, map areas were measured with a polar planimeter. For IID1, because it consisted of many separate portions, a dot grid planimeter was used. The dot grid planimeter was also used to measure enclaved terra units within the maria. All map areas were measured to 0.01 square inches and were converted to lunar areas in square kilometers assuming a spherical moon with a radius of 1738.0 kms.

Each lowland unit was measured in segments, each segment having a constant areal scale factor. On the orthographic USGS map and the Orbiter photograph, segments were concentric circular bands parallel to the limb. On LFC-1, segments were latitudinal bands. A total of 548 segments were measured for the 34 lowland units considered.

## Area Results

The results of the areas measured, expressed in thousands of square kilometers, are summarized in Table 1.

Table 1. Areas of Lunar Physiographic Units.
(NOTE: Items may not total due to rounding.)

| Unit Designation and Name | Area (thousands of sq. kms.) Mare | Enclaved Terrae | Total Lowland | Notes |
|---|---|---|---|---|
| II. LUNAR LOWLANDS (TOTAL) | 5872.5 | 245.9 | 6118.5 | |
| IIA. MID LUNAR LOWLANDS | 4686.5 | 229.0 | 4915.6 | |
| A1. Mare Imbrium | 835.4 | 25.3 | 860.7 | a, b |
| A2. Mare Serenitatis | 311.7 | 1.1 | 312.8 | b |
| A3. Lacus Somniorum | 66.4 | 1.6 | 68.0 | b |
| A4. Mare Tranquillitatis | 407.6 | 30.4 | 437.9 | b |
| A5. Mare Fecunditatis | 334.0 | 3.3 | 337.3 | b |
| A6. Mare Nectaris | 98.8 | 1.7 | 100.5 | b |
| A7. Mare Vaporum | 53.3 | 0.4 | 53.6 | b |
| A8. Sinus Medii | 48.9 | 1.6 | 50.5 | b |
| A9. Oceanus Procellarum | 2146.7 | 136.6 | 2283.3 | b |
| A9a. Sinus Roris | 291.0 | 7.8 | 298.8 | b, c |
| A9b. Northern Section | 962.7 | 31.2 | 993.9 | b |
| A9c. Aristarchus Hills | 51.0 | 0.0 | 51.0 | b, d |
| A9d. Milichius Dome Field | 22.8 | 0.3 | 23.1 | b |
| A9e. Intermaria Section | 218.7 | 7.1 | 225.7 | b |
| A9f. Riphaeus Section | 557.8 | 90.2 | 648.0 | b, e |
| A9g. Sinus Aestuum | 42.8 | 0.0 | 42.8 | b |
| A10. Mare Nubium | 239.6 | 24.5 | 264.1 | b |
| A11. Mare Humorum | 115.4 | 1.8 | 117.2 | b |
| A12. Palus Epidemiarum | 28.8 | 0.9 | 29.7 | b |
| IIB. NORTHERN LOWLANDS | 475.2 | 10.2 | 485.4 | |
| B1. Mare Frigoris | 433.4 | 6.4 | 439.8 | b |
| B2. Mare Humboldtianum | 27.6 | 0.0 | 27.6 | b, f |
| B3. Lacus Mortis | 14.2 | 3.8 | 18.0 | g, h |
| IIC. MARGINAL LOWLANDS | 402.7 | 4.5 | 407.2 | |
| C1. Mare Crisium | 197.3 | 2.2 | 199.5 | b, i |
| C2. Mare Undarum | 18.6 | 0.0 | 18.6 | b, j |
| C3. Mare Spumans | 14.2 | 0.0 | 14.2 | b, k |
| C4. Mare Smythii | 77.2 | 2.3 | 79.5 | L |
| C5. Mare Marginis | 81.9 | 0.0 | 81.9 | m |
| C6. Mare Novum | 13.5 | 0.0 | 13.5 | b, n |
| IID. AUSTRALE LOWLANDS | 148.4 | 0.0 | 148.4 | |
| D1. Mare Australe | 148.4 | 0.0 | 148.4 | p |
| IIE. AESTATIS LOWLANDS | 83.6 | 0.0 | 83.6 | |
| E1. Mare Aestatis | 3.7 | 0.0 | 3.7 | b |
| E2. Mare Autumni | 4.0 | 0.0 | 4.0 | q, r |
| E3. Mare Veris | 16.2 | 0.0 | 16.2 | q, s |

FIGURE 7. FARSIDE LOWLANDS

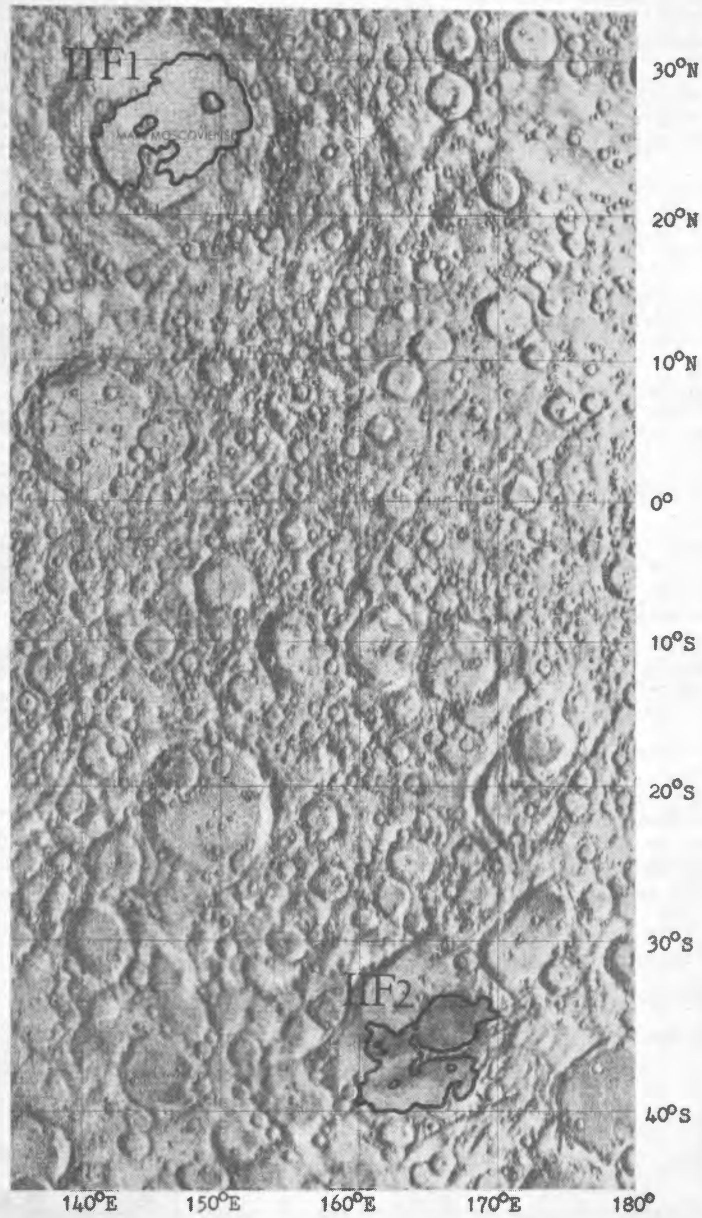



Figure 7. The two lunar farside units, IIF1 and F2, plotted on a reduction of LFC-1. North at top.

Table 1.--Continued.

| Unit Designation and Name | Area (thousands of sq. kms.) Mare | Enclaved Terrae | Total Lowland | Notes |
|---|---|---|---|---|
| E4. Mare Orientale | 59.7 | 0.0 | 59.7 | h, t |
| IIF. FARSIDE LOWLANDS | 76.1 | 2.2 | 78.3 | h |

Table 1.--Continued.

| Unit Designation and Name | Area (thousands of sq. kms.) Mare | Enclaved Terrae | Total Lowland | Notes |
|---|---|---|---|---|
| F1. Mare Moscoviense | 49.2 | 1.8 | 51.0 | h, u |
| F2. Mare Ingeni | 26.9 | 0.3 | 27.2 | h, v |
| CONTIGUOUS LOWLANDS | 5134.1 | 239.2 | 5373.4 | w |

Table 1.--Notes.

[a]Includes Palus Putredinis and Sinus Iridum.
[b]USGS designation and boundary.
[c]"Enclaved Terrae" includes Rümker formation (5900 sq. kms. area).
[d]Partly terra.
[e]Includes Mare Cognitum.
[f]Includes outlier to West (5000 sq. kms. area).
[g]USGS boundary but no USGS designation.
[h]Designation of writer.
[i]Includes Mare Anguis.
[j]Includes six outliers to northeast and southeast (4700 sq. kms. total area).
[k]Includes outlier to East (2000 sq. kms. area).
[L]USGS designation, but area measured on USAF LFC-1, based on Apollo-8 frame AS8-18-2845. Includes outlier to southeast (800 sq. kms. area).
[m]USGS designation, but area measured on USAF LFC-1, based on Apollo-8 frame AS8-18-2885. Includes two outliers to West (8900 sq. kms. total area).
[n]In two portions.
[p]USGS designation, but area measured from A.L.P.O. Lunar Photograph Library print No. 67-H-745 (Orbiter-IV wide-angle frame No. 11). In 21 portions.
[q]USGS designation, but area measured on USAF LFC-1, based on Orbiter-IV wide-angle frame No. 187.
[r]In three portions.
[s]In five portions.
[t]Includes two outliers to East (400 sq. kms. area). Area measured on USAF LFC-1, based on Orbiter-IV wide-angle frame No. 187.
[u]Area measured on USAF LFC-1, based on Orbiter-V wide-angle frames Nos. 103 and 124.
[v]Area measured on USAF LFC-1, based on Orbiter-II wide-angle frame No. 75.
[w]Units IIA, B1, and B3.

In terms of the total surface of the moon (37,958,500 sq. kms.), the Lunar Lowland areas are as shown in Table 2.

Table 2. Lunar Lowland Areas in Percent of Lunar Surface.

| | All Lowlands Relative to Moon | Contiguous Lowlands Only: Relative to Moon | Relative to Lowlands |
|---|---|---|---|
| Maria | 15.47% | 13.53% | 87.43% |
| Enclaved Terrae | 0.65 | 0.63 | 97.28 |
| Total | 16.12 | 14.16 | 87.82 |

## Accuracy

Sources of Error.--Assessing the accuracy of the above area measurements is difficult because there are four possible sources of error--lowland delimitation, cartographic, areal scale factor, and measurement--only the last two of which can be estimated reasonably.

In terms of the delimitation of the lowlands, the areas given here can be considered either as precise or as debatable. They are precise in the sense that they refer to precisely-defined portions of the moon--either on the USGS map[2] or on Figures 4, 5, 6, or 7 accompanying this paper. Thus, for statistical purposes, such as crater-counting, the units used here may be strictly adhered to. In another sense, though, the lowland boundaries are not accurate. For example, the "real" area of Mare Nubium is unobtainable because there is as yet no "real" Mare Nubium; there is no general agreement as to the boundaries between maria. Likewise, no two selenographers will draw a terra-mare boundary in the same place (particularly in a palus area), nor similarly define enclaved terra units within maria. An inescapable question is what constitutes a mare; in particular, what the dividing line is between a small mare and a large, dark-floored, crater. Because most dark-floored craters, and many small lunabase patches, have been ignored in this study, the total "mare" area heading Table 1 is a definite understatement of the total area of lunabase.

"Cartographic" errors refer to errors in the areas given in Table 1 caused by positional errors in the maps used for measurement, either due to misplacements of individual features, an error in the assumed lunar radius, or to the deviation of the actual lunar surface from the hypothetical sphere. This writer feels that the last two sources of error are negligible, causing errors well under 1 percent. Unfortunately, though, the positions of many limb farside features are still uncertain by several degrees, so that the areas of units C4, C5, C6, D1, E1-E4, F1, and F2 may be somewhat in error because of this uncertainty.

Scale Factor and Measurement Error.--As mentioned above, no measurements were made from equivalent-projection maps so that areal scale factor corrections had to be applied. These corrections were large only in the case of units measured from the USGS map, and hence it is felt that this possible error is significant only in these cases (i.e., units IIA, B, C1-C3, C6, and E1). Because the areal scale factor is a function of distance from the apparent disc center, the possible areal scale factor error is dependent on any error in measuring this distance. It is reasonable to assume that the maximum radial distance error involved in measurements from the USGS map is 2 millimeters, and this assumption is the basis of the estimates of areal scale factor error given in the second column of Table 3.

"Measurement errors" refers to those errors made in measuring (either with the polar, or the dot grid, planimeter) the map areas of lowland units. For medium-sized and large units, this error was estimated by comparing the measured area of the unit as a whole with the area found by summing the areas of the segments comprising the unit. The estimated error of measurement is given in the third column of Table 3.

The total estimated error, the root-mean-square product of the areal scale factor error and the measurement error, is given in the right-hand column of Table 3.

Table 3. Estimated Errors of Lunar Lowland Areas.

(NOTE: Excluding Unit Delimitation and Cartographic Errors.)

| | Estimated Error (Percent) | | | | Estimated Error (Percent) | | |
|---|---|---|---|---|---|---|---|
| Unit | Scale Factor | Measurement | Total | Unit | Scale Factor | Measurement | Total |
| A1 | 0.4% | 1.3% | 1.3% | A12 | 0.9% | 0.6% | 1.1% |
| A2 | 0.2 | 0.8 | 0.8 | B1 | 1.1 | 0.4 | 1.2 |
| A3 | 0.4 | 0.6 | 0.7 | B2 | 6.6 | 5.1 | 8.4 |
| A4 | 0.2 | 0.3 | 0.4 | B3 | 0.6 | 2.4 | 2.5 |
| A5 | 0.8 | 0.2 | 0.8 | C1 | 1.1 | 0.5 | 1.2 |
| A6 | 0.4 | 0.9 | 1.0 | C2 | 2.1 | 1.2 | 2.4 |
| A7 | 0.1 | 1.0 | 1.0 | C3 | 1.7 | 3.0 | 3.5 |
| A8 | 0.04 | 0.5 | 0.5 | C4 | ---[b] | 0.2 | 0.2 |
| A9a | 3.3 | 0.6 | 3.4 | C5 | ---[b] | 0.1 | 0.1 |
| A9b | 1.7[a] | 0.1[a] | 1.7[a] | C6 | 175. | ---[c] | >175. |
| A9c | 1.4 | 0.2 | 1.4 | D1 | ---[d] | ---[d] | 3.[d] |
| A9d | 0.4 | 1.9 | 2.0 | E1 | 10.6 | ---[c] | >10.6 |
| A9e | 0.2 | 0.6 | 0.7 | E2 | ---[b] | 3.8 | 3.8 |
| A9f | 0.7 | 0.00 | 0.7 | E3 | ---[b] | 1.5 | 1.5 |
| A9g | 0.1 | 0.9 | 0.9 | E4 | ---[b] | 0.2 | 0.2 |
| A10 | 0.4 | 0.2 | 0.4 | F1 | ---[b] | 0.1 | 0.1 |
| A11 | 1.1 | 0.4 | 1.1 | F2 | ---[b] | 0.5 | 0.5 |

[a]Represents combined area of A9b and A9c (enclaved within A9b).
[b]Measured from USAF LFC-1; scale factor error probably very small.

[c]Measurement error not estimated, but probably quite high because of small size of unit.
[d]Error difficult to assess because of many separate portions of unit. 3% is the stated error of the dot grid planimeter used.

---

Although some units have large estimated errors, these units are relatively small in area so that the total lowland area is probably fairly accurate, as is shown in Table 4.

Table 4. Absolute and Proportional Areas of Units by Size of Estimated Error.

| Estimated Error | Units | Area: Sq. Kms. | Area: Percentage of Total Lowlands |
|---|---|---|---|
| under 1% | A2, A3, A4, A5, A6, A8, A9e, A9f, A9g, A10, C4, C5, E4, F1, F2. | 2,786,900 | 45.5% |
| 1 - 2% | A1, A7, A9b, A9c, A9d, A11, A12, B1, C1, E3. | 2,784,700 | 45.5% |
| 2 - 5% | A9a, B3, C2, C3, D1, E2. | 502,000 | 8.2% |
| 5 - 10% | B2. | 27,600 | 0.5% |
| over 10% | C6, E1. | 17,200 | 0.3% |

Thus, about 91 percent of the lunar lowlands were measured with an estimated areal error of under 2 percent, and less than 1 percent with an estimated error exceeding 5 percent.

It is also of interest to compare the writer's area measures with those made by others since this comparison will give a rough indication of errors due to differing delimitations of mare units. Table 5 compares this paper's areas with those of Beer and Mädler[7] and Baldwin.[8]

Table 5. Area Comparisons.

| | | Area Comparisons (in thousands of sq. kms.) | | | | |
|---|---|---|---|---|---|---|
| Unit | Name | (A) Westfall | (B) Beer & Mädler[a] | (C) Baldwin | (A) vs. (B)[b] | (A) vs. (C)[c] |
| A1 | M. Imbrium | 860.7 | 881.1 | 864. | + 2.4% | + 0.4% |
| A2 | M. Serenitatis[d] | 312.8 | 322.2 | 318. | + 3.0 | + 1.7 |
| A3 | L. Somniorum | 68.0 | ----- | 64.5 | ------ | - 5.2 |
| A4 | M. Tranquillitatis | 437.9 | 413.0 | 402. | - 5.7 | - 8.2 |
| A5 | M. Fecunditatis | 337.3 | 414.4[e] | 311. | + 22.9 | - 7.8 |
| A6 | M. Nectaris | 100.5 | ----- | 96.4 | ------ | - 4.1 |
| A8 | S. Medii | 50.5 | 33.0 | ----- | - 34.7 | ------ |
| A9 | O. Procellarum | 2283.3 | 4956.4 | ----- | +117.1 | ------ |
| A9g | S. Aestuum | 42.8 | 35.8 | ----- | - 16.4 | ------ |
| A10 | M. Nubium | 264.1 | ----- | 261. | ------ | - 1.2 |
| A11 | M. Humorum | 117.2 | 131.1 | 107. | + 11.9 | - 8.7 |
| A12 | P. Epidemarium | 29.7 | ----- | 288. | ------ | +869.7 |
| B1 | M. Frigoris | 439.8 | ----- | 439. | ------ | - 0.2 |
| B2 | M. Humboldtianum | 27.6 | 99.1 | ----- | +259.1 | ------ |
| B3 | L. Mortis | 18.0 | 41.3 | ----- | +129.4 | ------ |
| C1 | M. Crisium | 199.5 | 170.7[f] | 165. | - 14.4 | - 17.3 |

[a]Converted from Quadratmeilen to sq. kms. and adjusted to the adopted lunar radius of 1738.0 kms. Original areas given to 1 - 3 significant figures.
[b]I.e., (B/A - 1) X 100.
[c]I.e., (C/A - 1) X 100.
[d]An area of 340,000 sq. kms. (uncorrected for libration) is given by: Dodd, R. T., Jr.; Salisbury, J. W.; Smalley, V. G., "Crater Frequency and the Interpretation of Lunar History," Icarus, 2 (1963), 468.

[e]Area given by Nevill (converted to sq. kms.) since Beer & Mädler give no area: Nevill, Edmund (Edmund Neison, pseudonym), The Moon and the Conditions and Configurations of its Surface (London: Longmans, Green, and Co., 1876). In the other units (except C1), Nevill's areas (still quoted in the literature) agree with Beer and Mädler's and are evidently derived from theirs.

[f]Nevill's area, equivalent to 202,000 sq. kms., is, however, more comparable to this writer's. It is not clear whether or not Baldwin and Beer and Mädler included Mare Anguis.

---

Although some numerical areas (particularly those of Baldwin) agree reasonably well with this writer's, others do not. Much of the difference is probably due to varying definitions of the units measured; this is undoubtedly the case with Palus Epidemarium and Oceanus Procellarum.

References Cited in Text

1. Mason, Arnold C. and Hackman, Robert J., "Photogeologic Study of the Moon." In: Kopal, Zdeněk and Mikhailov, Zdenka Kadla (eds.). The Moon (London and New York: Academic Press, 1962), pp. 301-315.

2. Hackman, Robert J. and Mason, Arnold C. Engineer Special Study of the Surface of the Moon. U. S. Geological Survey, Miscellaneous Geologic Investigations, Map I-351 (Washington, D.C.: U. S. Geological Survey, 1961). 1/3,800,000 approximate stated scale; 1/3,822,000 measured scale.

3. United States. Department of the Air Force. Air Chart and Information Center. Lunar Farside Chart (LFC-1). 2nd Ed. (St. Louis: USAF-ACIC, 1967). 1/5,000,000 scale at 30° N-S; 1/5,774,000 equatorial scale.

4. For specific frames, see notes for Table 1.

5. Orbiter-IV wide-angle frame No. 11.

6. National Geographical Society. The Earth's Moon. (Washington, D.C.: National Geographical Society, 1969). 1/11,620,000 mean scale.

7. Beer, Wilhelm and Mädler, Johann Heinrich. Der Mond. (Berlin: Simon Schropp and Co., 1837).

8. Baldwin, Ralph B., "Lunar Crater Counts," Astron. J., 69 (1964), 380.

## A 1967 PHOTOVISUAL CHART OF MARS

By: C. F. Capen, A.L.P.O. Mars Recorder

The photovisual map of Mars for 1967 appearing on page 122 depicts the Martian surface during northern hemisphere summer and southern winter. The initial base map was constructed from the Mercator format of De Mottoni's International Astronomical Union chart of Mars 1941-1952, with areographic coördinates by Camichel (Ref. 1) and de Vaucouleurs' 1958 Mars map (Ref. 2). Key surface feature areographic positions were obtained from de Vaucouleurs' areographic coördinates (Refs. 2 & 3). The new map was compiled from homogeneous measurements of more than 300 photographs and drawings in green, orange, and red light, inclusive, during one Martian season. Photographic measurements were performed on the Lowell Observatory IAU Planetary Research Center's projection image reader. The contrasts of weak features have been increased on the map relative to the dark contrast features in order to aid reproduction. Unfortunately, there is always a certain amount of artistic license present in every hand-drawn chart, especially noteworthy in the fine detail. The areographic coördinate grid is presented in two systems for astronomical and astronautical orientation. This 1967 Chart of Mars is a contemporary reference map, and it serves as a data-link between 1965 maps and the 1969 apparition data yet to be published (Ref. 4).

References

1. Ashbrook, J., "The New IAU Nomenclature For Mars," Sky and Telescope, Vol. XVIII, No. 1, pp. 23-25, 1958.

2. de Vaucouleurs, G., "Charting The Martian Surface," Sky and Telescope, Vol. XXX, No. 4, pp. 196-201, 1965.

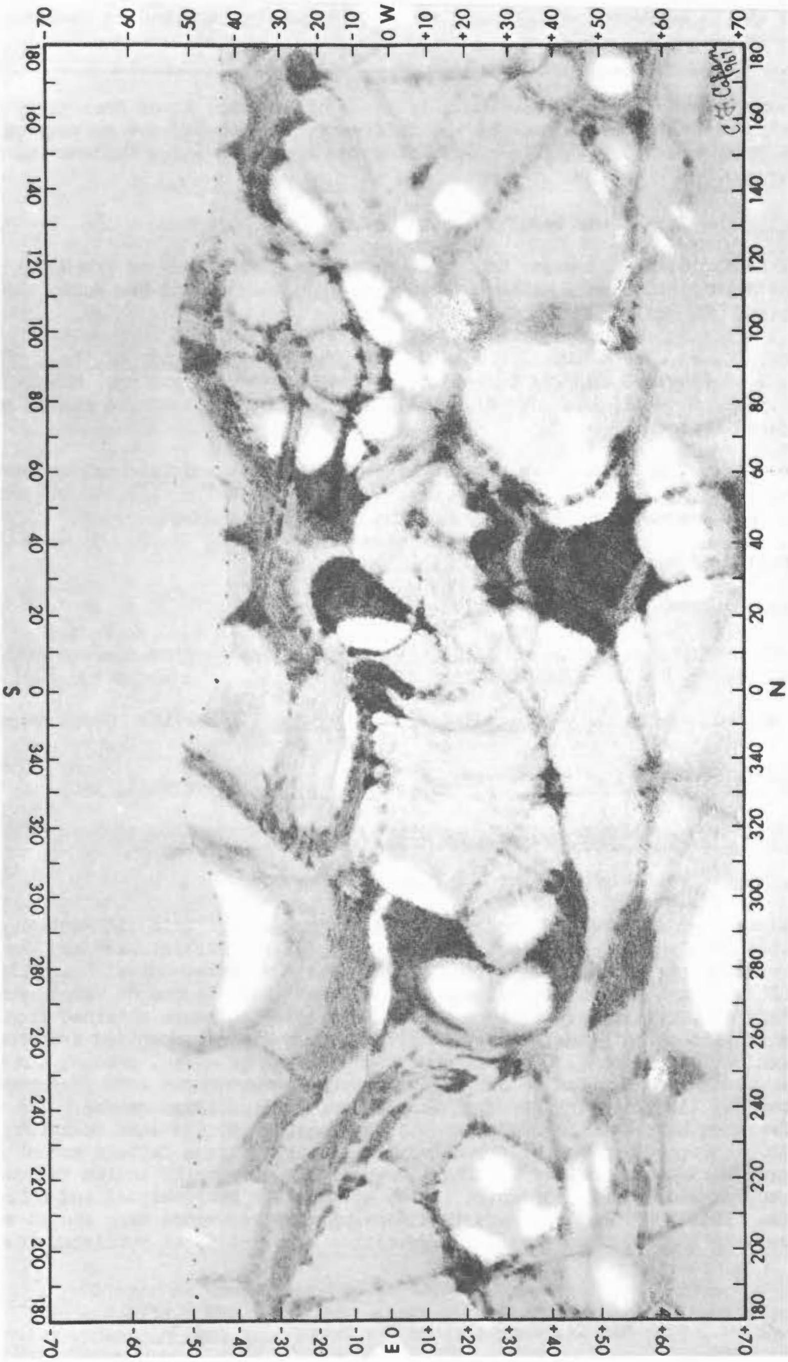



Figure 8. Chart of Mars in 1967. Drawn by C. F. Capen. Described in text on pages 121 and 123.

It will be noted that Mr. Capen has set up the latitude and longitude scales on his map so that they are conveniently useful both for those who like the astronomical orientation (south at top) and for those who prefer the more modern astronautical orientation (north at top).

3. de Vaucouleurs, G., "Areographic Coördinates for 1958," Harvard College Obs., Science Report No. 4, ARDC Contract AF19(604)-7461, AFCRL 818, 1961.

4. Brasch, K. R., "Report on the 1964-65 Apparition of Mars - Part II," The Strolling Astronomer, Vol. 21, Nos. 7-8, April, 1969.

## RECENT OBSERVATIONS OF WATER VAPOR ON MARS

By: Fred Jay Lazor, Astronomy Department, University of Texas at Austin, Austin, Texas

Mankind has long wondered if life exists somewhere else in the universe. The planet Mars has especially been considered as a possible abode of life. One of the most necessary ingredients for life as we know it is water. Therefore, astronomers have recently been trying to observe water on Mars and to calculate the amount, if any, that is present.

### Early Suggestions and Results

From the observed shrinking and expansion of the Martian polar caps, it has long been widely assumed that water does exist on Mars. However, it has remained for more sophisticated methods and more sensitive materials to be developed to obtain proof of the existence of water on Mars.

It was not until 1963 that water was positively detected on Mars. Dollfus observed water absorption at 1.4 microns, using a wide band-pass filter and a spectrophotometer flown by ballon to an altitude of 14 kilometers. His results suggest 20 milligrams of water vapor per square centimeter of Martian surface area, which is quite a bit more than de Vaucouleurs had determined by empirical means in 1960.

In March of 1963, Danielson and Schwarzschild used the same method as Dollfus in conjunction with the 36-inch telescope of the Stratoscope II. Their result of 10 microns was similar to the predictions of de Vaucouleurs; but because of various uncertainties in their data, the Stratoscope team announced 40 microns of precipitable water vapor in the atmosphere of Mars.

Spinrad, Munch, and Kaplan waited until May of 1963 so that the relative velocities of the Earth and Mars would produce the maximum Doppler shift in water vapor absorption spectra. This team used the Mt. Wilson 100-inch telescope to obtain high dispersion spectrograms in the near infrared where the water absorption lines are the strongest. Shifted the predicted 0.42 angstroms to the red of the terrestrial water lines were eleven faint lines due to water vapor on Mars. By comparing the intensities of the Martian water lines to absorption tube spectra obtained by Rank, Spinrad, Munch, and Kaplan calculated $14\pm7$ microns of precipitable water vapor on Mars.

### Recent Observations and Results

In February and March of 1969, Shorn, Barker, Little, and Capen made observations of the Doppler shifted lines of Martian water vapor with the 82-inch Struve reflector of the McDonald Observatory. This group, like the Mt. Wilson team, observed absorption lines in the near infrared 8200 angstrom band. They used ammonia hyper-sensitized II-N plates in conjunction with the new, extremely powerful, "B" Coudé grating spectrograph to obtain several spectrograms superior to any that had been previously made.

Shorn, Barker, Little, and Capen made microdensitometer tracings of their spectrograms, dividing the planet into five zones of latitude: the two poles, the temperate regions, and the equator. This was done in order to determine the distribution of water vapor with latitude on Mars. On the best spectorgrams, as many as twenty-two water absorption features originating in the Martian atmosphere were identified. The abundance of water vapor was determined from the equivalent widths of the respective Martian water vapor absorption lines. Figure 9 on pg. 124 is a sample tracing.

The results give 25 to 45 microns of precipitable water vapor above the north polar cap of Mars in early summer, but only 5 to 30 microns of water above the south polar cap. In Martian mid-summer there was found to be 25 to 30 microns of water vapor distributed uniformly over the disc of Mars. And in early autumn, there was less than 20 microns of precipitable water vapor detected over the Martian disc. These results indicate that during the Martian summer, water vapor tends to "migrate" from one pole toward the other and that during the cold seasons on Mars, most of the water vapor is frozen out of the Martian atmosphere.

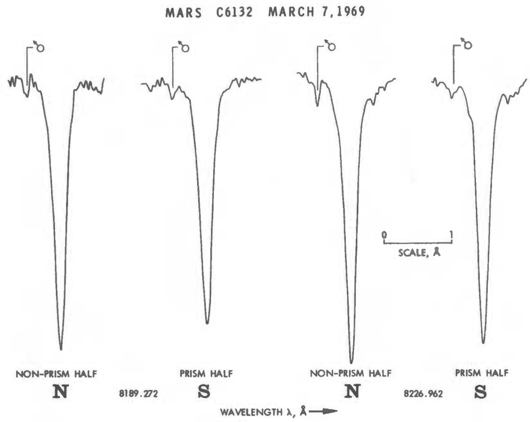



Figure 9. Sample microdensitometer tracing of the water vapor absorption lines at 8189.272 (left) and 8226.962 (right) angstroms. The tracing clearly shows the presence of absorption features caused by water vapor in the atmosphere of Mars and the distribution of water vapor with latitude. See text of article by Mr. Fred Jay Lazor on pg. 123. Illustration furnished by Mr. C. F. Capen. The deeper valleys of these representative water vapor lines indicate more water vapor in the northern hemisphere (N) at this time than in the southern (S).

## PHOTOGRAPHS AND DRAWINGS OF COMET HONDA 1968c

By: Dennis Milon, A.L.P.O. Comets Recorder

Minuro Honda discovered his 11th comet on July 6.7, 1968, Universal Time. From Tokyo Observatory a telegram relayed the information to Brian Marsden at the Smithsonian Astrophysical Observatory in Cambridge, Mass. Marsden requested confirmation from the ALPO, and three members (John Bortle, Dennis Milon, and Karl Simmons) spotted the new comet less than 12 hours after Honda's discovery. Comet 1968c was then moving slowly due north in Auriga in the morning sky, but by August of 1968 it had become a circumpolar object visible in binoculars. Late in that month it passed the north celestial pole, moving about 3° per day. When it was first seen, its motion was hardly discernible in a day.

ALPO Comets Section members have submitted over 200 reports on this comet. Presented in this issue and the preceding one is a selection of drawings and photographs. (See also Str. A., Vol. 22, Nos. 5-6, pp. 106-108.)

## PLANETARY PHOTOGRAPHY*

By: Tom Pope

Good planetary photographs are the result of correctly handling many factors. These factors can be categorized as good astronomical seeing, instrumentation, camera set-up, and the right focal ratio-film combination.

### Good Seeing

Anyone who has looked for any length of time through a telescope quickly becomes aware that the image looks at times sharper and steadier than at other times. This blurring and movement of the image is caused by masses of air at different temperatures-densities. Since the refractive index of air is a function of its density, light will be refracted in a non-harmonious manner through a mass of air that contains mixed cells of different densities. These cells or turbulent masses of air are constantly streaming across the telescope light path. Air near the ground, in and about the instrument, and air at higher altitudes can all contribute to adverse seeing effects. To improve the high altitude conditions, the telescope itself must be placed in a favorable part of the world, the Southwestern part of the United States, etc.

Some of the ground effects, as well as seeing effects in and about the tube, can be minimized. The telescope tube, if metal, should be coated, especially on the inside with an insulating material such as cork or polyurethane. Fiberglass and wooden tubes are also effective. If a dome or other shelter is used, it should be equipped with a fan that will exhaust air out near ground level. This measure will keep some of the warmed air from streaming out the slit and into the light path. The telescope should be placed on as high ground as possible because on quiet nights cool air flows to the lower ground and this mixing of warmer and cooler air will cause bad seeing.

Great patience is required in planetary photography since one must spend many hours at the telescope in order to catch a few moments of good seeing. Almost all parts of the



*Contributed by Mr. Paul K. Mackal, A.L.P.O. Jupiter Recorder.

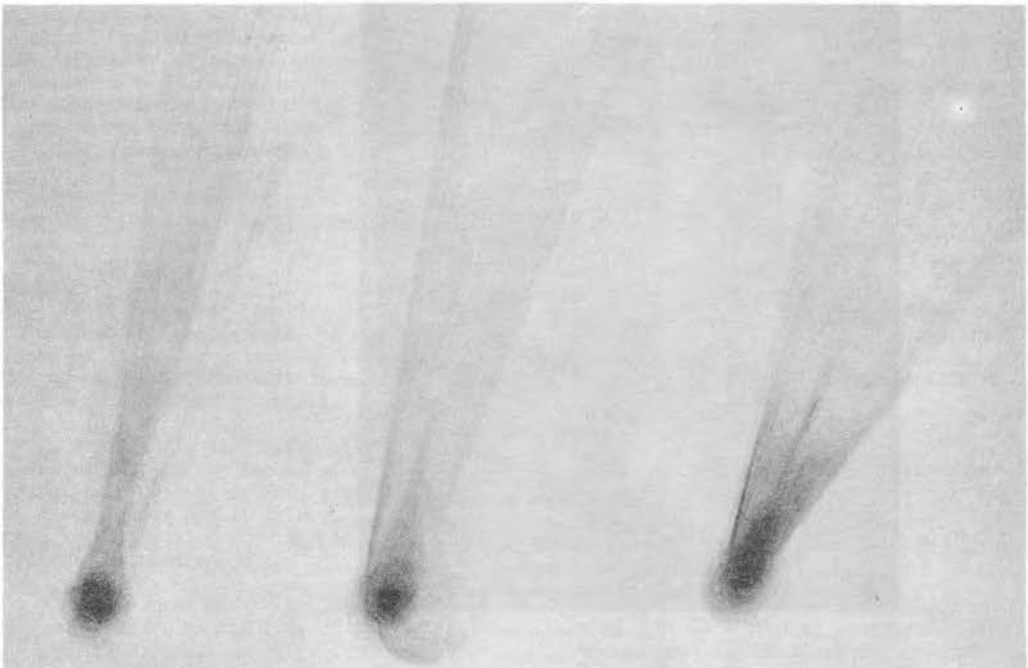


Figure 10. Drawings of Comet Honda 1968c by G. E. D. Alcock of Peterborough, England, with 15 x 80 and 25 x 105 binoculars. Left drawing: August 11.90, 1968, U.T., coma diameter 3'. Center: August 18.98, showing the diffuse area to the right of the coma as well as a cone-shaped brightening above the coma. Right drawing: August 22.97, 1968, U.T.. Negative shading.

Figure 11. Photograph of Comet Honda 1968c by James W. Young, Wrightwood, California on September 16.24, 1968, U.T. 103 a-O emulsion. Exposure 84 minutes. Note the thin tail and the diffuse area to the right of the coma, features also shown on Figures 12 and 13.

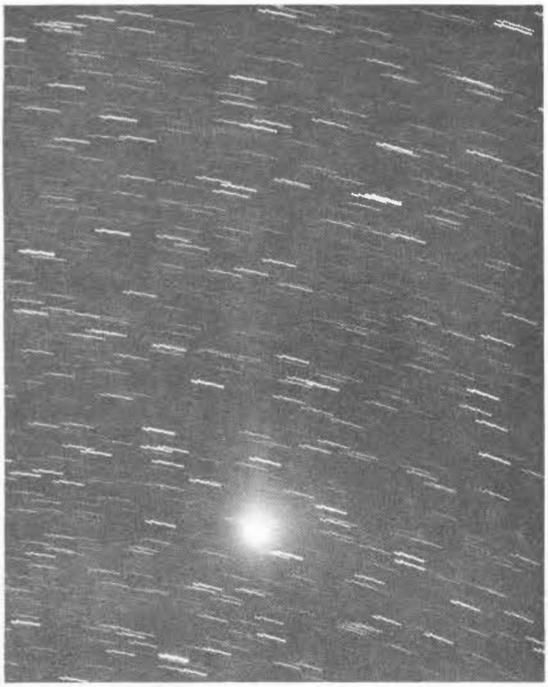


Figure 12. Photograph of Comet Honda 1968c by John Bortle and Charles Scovil on August 27.17, 1968, U.T. 22-inch telescope at Stamford Observatory, Connecticut. Tail 3/4 degrees long on original photograph.

Figure 13. Photograph of Comet Honda 1968c by James W. Young, Wrightwood, California, on August 28.43, 1968. 103 a-O emulsion (blue sensitive). 6-inch f/10 refractor. Exposure 30 minutes (guided on comet so that stars trailed). South is toward the top.

world have good seeing at times. Just at sunset and sunrise are times which are often favorable and hence should be given special attention. Seeing can vary from excellent to poor many times in one night. Sometimes early in the evening it is better than late at night, and vice versa. However, watch for patterns of good and bad seeing that may last for several days or even weeks. In this way you can concentrate on the times that appear more favorable in your locale or in different seasons.

Seeing is usually very bad just after a cold or warm front has moved through your locale, and it may take anywhere from one day to a week to improve. It is obvious that if you carefully watch weather reports, you will save yourself much time that would otherwise be wasted.

If you are lucky enough to have good seeing, take a number of photographs at what you think are the optimum moments for as long as the good seeing lasts. After you have developed and studied these photographs, you will usually find one or two that are better than the others; and, of course, these are the ones you will use for further study, etc.

## Telescope and Mounting

Both refractor (lens) and reflector (mirror) type telescopes are capable of taking fine planetary photographs. A reflecting type telescope has a very great advantage: the light of all colors comes to the same focus. A 6-inch f/15 commercial Achromat I have tested has a difference in focus between red and blue light of almost ½-inch, and I think this amount is fairly typical.

A perfectly achromatic mirror system not only means a more accurate focus; but because no filters are needed to cut out unfocused light, the entire visible spectrum contributes to the photograph, resulting in shorter exposures. Size for size, reflectors are in general less costly to buy, mount, and house. A refractor has the advantage that it is kept in collimation more easily, and is less costly in upkeep. A refractor also has no central obstruction.

A Newtonian reflector requires a diagonal secondary to reflect the light to the eyepiece or camera on the side of the tube. This diagonal acts as a central obstruction and because of diffraction effects throws light out of the central diffraction disk and into the surrounding rings of a point source of light. This reduces the contrast and resolution of planetary images. Because of this effect the diagonal should be kept as small as possible. It is very common for amateur telescopes to be equipped with a diagonal too large for high resolution uses.

The secondary mirror is supported by thin pieces of flat metal and is called a secondary spider. It is strongly recommended that a four-vein spider be used. A three-vein spider will produce six diffraction spikes; and the once popular curved spider support is usually very thick and scatters light all about the diffraction image, reducing contrast. Formulas for computing the proper diagonal size can be found in References 1 and 2.

The aperture (diameter) of the mirror or lens determines how much detail can be seen or photographed through the telescope. In general, if telescopes are of equal quality and care is taken to keep environmental seeing effects to a minimum, a larger telescope will do better than a smaller one.

Since the earth rotates, a telescope must constantly be moved westward in order to keep the celestial object in the field of view. This can best be done with a combination of motor and gears on the polar axis of an equatorial mounting. If a drive is not used, a star or planet will move through the field of view at a rate of 15 seconds of arc in 1 second of time at the celestial equator. It can be seen that a photographic image would be smeared by 15 seconds of arc if a 1 second exposure were to be taken through an undriven telescope at the celestial equator. As most planetary exposures are one or more seconds in length, a drive mechanism of some sort is more or less a must.

The slightest wind hitting a telescope tube can ruin a photograph. For this reason the tube and mounting should be as compact and heavy as is practical. It is urged that as heavy duty a mounting as you can afford to build or purchase be used. Most commercial mountings designed for a 12-inch telescope are actually none too large for a 6-inch telescope.

## Good Camera Set-Up

In order to have a reasonably large image of Jupiter to measure and study and also for ease in printing, it will be necessary to enlarge the primary image before photographing it. A-12 inch f/7 telescope has a focal length of 84 inches, which will produce an image of Jupiter only about 1/60 of an inch in diameter. If, with eyepiece projection, the primary image is enlarged ten times, Jupiter would be about 1/6 of an inch in diameter, and much easier to work with. Of course, you will be photographing with an effective focal ratio of f/70; but in planetary photography that is not too great at all.

In eyepiece projection, an eyepiece or other good quality lens, usually about 1/2 or 1 inch in focal length, is placed between the primary telescope image and the film plane. This procedure will increase the effective focal length of your system and consequently will increase the focal ratio. These relationships are found by the following formulas:

$$EFR = \left(\frac{D}{f} - 1\right) \times FR$$

$$EFL = \frac{EFR}{FR} \times F, \text{ where:}$$

EFR = Effective focal ratio.

EFL = Effective focal length.

D = Distance of eyepiece from film plane.

F = Focal length of telescope.

f = Focal length of eyepiece.

FR = Focal ratio of telescope.

A 35-mm. single lens reflex camera is perhaps the easiest type to use in conjunction with eyepiece projection. Cameras from the expensive Nikons and Leicas to the much less expensive Exactas and Mirandas, and the very cheap Exas (not all Exa models have removable pentaprisms) are all very satisfactory. The current photographic magazines have advertisers who sell many of these cameras at far lower prices than your local camera dealer. These ads should be seriously and carefully examined before you decide to purchase a camera. Camera companies do not manufacture different quality cameras or lenses for different markets. These cameras are usually fully guaranteed; and, of course, this should be clearly spelled out by the mail order house before purchasing.

No matter what camera you choose, it should have interchangeable pentaprisms and a focusing screen. The ground glass focusing screen is almost useless in planetary photography. You simply cannot see sharply enough to focus. Some method should be found to replace the ground glass with a clear glass equipped with cross-hair lines. A very low power eyepiece, about 1-1/2 inches to 2 inches in focal length, is then focused on the cross-hairs. The camera will then be in focus when the planetary image is focused sharply through this eyepiece also. The Exacta and Exa have a special adaptor whereby the ordinary 50-mm. taking lens can be mounted in place of the pentaprism and used for this very purpose. I do not know of any other camera that has such a device made by the manufacturer.

In order to focus the planetary image in the same plane as the cross hairs, the entire camera and projection eyepiece must be movable with a rack and pinion, etc. If an adaptor is made or purchased that will screw into the camera on one end, and slide into a 1-1/4 inch tube on the other end, the telescope's regular focusing device can be used. This adaptor will have to be 5 to 10 inches long in order to have sufficient projection length. Adaptors similar to this are available commercially; one of sufficient length is available from Reference 3 for about $35.00. Another method, but much more expensive, is to use a microscope adaptor system made for such cameras as Nikon and Leica. These systems usually contain a beam splitting system and a leaf type shutter.

Because the mirror and shutter in a single lens reflex camera produce a significant amount of vibration, their use for the actual exposures is not recommended. Instead, a black card flicked in and out of a slot between the telescope and camera or in front of the telescope tube is recommended. A leaf type shutter can be placed between the projection eyepiece and the camera and be used for the actual exposure also. These shutters cause less vibration than focal plane shutters, but will be more expensive to incorporate into the system. The camera can be set on time or bulb; and the shutter can be held open while the actual exposure is accomplished with the black card, leaf type shutter, etc.

## Film and Focal Ratio Combination

The relationship between aperture, focal length and plate scale is such that the focal ratio alone determines how much a telescope can resolve on 1 millimeter of film. In other words, all telescopes, no matter of what aperture, will resolve the same amount of detail on 1 millimeter of film as long as the focal ratios are the same. Of course, if one telescope is twice as large in focal leng   as another telescope, it will have an image twice as large and could therefore resolve twice as much detail. A film that is well suited for a 6-inch f/10 telescope will be just as well suited for a 60-inch f/10 telescope.

An optical system of f/1 can resolve almost 1,800 high contrast, equally spaced, black and white lines per millimeter. At f/10 this becomes 180, and at f/100, 18 lines per millimeter.

Although there are films that could resolve all the detail in a perfect f/1 system, they are extremely slow and are not practical for planetary photography. Also, because it is easier to measure or make a useful print from a larger image, it is advised that a focal ratio of f/70 or 80 be used. As explained earlier, this will require magnifying the image in the telescope and projecting it upon the film. Most films will not resolve as much low-contrast detail as they can high-contrast detail. Since Jupiter is a very low contrast subject, a film that resolves three to four times what the effective focal ratio of the telescope would indicate should be used. This means that with an effective focal ratio of f/80, a film similar to Panatomic X is indicated.

The film used should also be capable of high contrast and should be developed in a high contrast developer, such as Kodak's D-19. Claims of super speed and super fine grain are made for developers today as they always have been, but I would personally use D-19. If you wish to try a newer developer, by all means compare it fairly with D-19; and if you feel that it is better and still gives the needed contrast, then use it. Otherwise, stay with D-19.

I have found Adox's KB 14 and Kodak's Panatomic X very useful films. Kodak also makes special spectroscopic films, but they are quite expensive. A 100 foot roll of 35-mm. IV F (fine grain, high contrast, panchromatic) film costs $22.55. Unfortunately, a minimum order is three rolls. Although the expense is considerable, this film is far better for planetary work than is off-the-shelf film. A 100 foot roll will give you about 700 exposures. A group of people could, of course, buy the film and thus share the cost. For planetary use these films are of a high enough contrast to use developers such as UFG, etc.

If you are going to use films such as Panatomic X, KB 14, etc., you should buy these in 50 or 100 foot rolls since it is about 1/3 as expensive as buying 36-exposure rolls. You can easily load your own 36-exposure rolls with reusable cassets sold by Kodak.

Color film can, of course, be used in planetary photography, and I recommend Kodachrome X or Agfachrome. A good test of any color film is the moon. If your lunar shots do not come out with the almost neutral gray that they should have, there is false color being added. Color films should also be processed by their respective manufacturers to insure best results.

Reference 1. Amateur Telescope Making, Book I.
Reference 2. Standard Handbook for Telescope Making "by Howard".
Reference 3. Peterson-Young Research, 18589 Main St., Huntington Beach, Calif. 92646.

## BOOK REVIEWS

An Advanced Observer's Handbook for Jupiter Observers. Edited by Paul K. Mackal, A.L.P.O. Jupiter Recorder. 47 pages. Available from the Jupiter Recorder at $1.50.

Reviewed by Richard E. Wend, former A.L.P.O. Jupiter Recorder.

The original A.L.P.O. Jupiter Handbook was written in 1961 by Elmer Reese, who was then on the staff. The rapid changes in planetary astronomy have necessitated the writing of a new handbook, which would encompass both the classical methods and newer techniques of planetary observing. The present Jupiter Recorder has enlisted the help of several skilled observers of the Giant Planet in compiling the present monograph.

This Handbook comprises eleven papers by the two Jupiter Recorders, three ALPO Jupiter observers, and a BAA Jupiter staff member. The contents include advice on sketching the planet, measuring latitudes, and recording central meridian transits. The visual use of color filters is discussed for both the planet and the satellites. The paper on planetary photography gives valuable pointers, stressing the great care and patience needed for good results. (Mars and Saturn observers can also benefit by this section).

The Recorders explain how the observers' contributions are used in creating the qualitative and quantitative reports for each apparition. Perhaps this subject has not been sufficiently explained to contributors in the past; this part will be gratifying to observers who contribute over a period of time. What the Recorders are seeking in the drawings and descriptions that are sent in is carefully outlined; this discussion should aid in improving the quality of future contributions.

In the foreword, Mr. Mackal lists the purposes of the Jupiter Section of the A.L.P.O.: first, to provide "a more scientific presentation and reduction of the primary data so that better secondary data may be generated from it", and second, to provide an educational and recreational pastime. The eleven papers touch clearly and concisely on the varied problems of Jupiter observing.

The last paper in the Handbook is of special interest. This is "A List of Research Hypotheses that can be Tested by Amateurs." Mr. Mackal poses a number of provocative questions, and then suggests possible answers, each one of which would be an interesting project for the Jupiter Section. The methods employed in this paper could inspire serious amateur observers to come up with additional projects, not on the list.

Note the word "Advanced" in the title. Beginners will have a little difficulty with some of the language, but a dictionary and correspondence with the Recorders can clear this up. The Wildt mechanism and the Rice mechanisms are mentioned, but not defined. This is left for additional reading in textbooks or in the Journals mentioned on the last page.

The Handbook will be helpful to Jupiter observers both as a technical aid, and as a morale booster for those who are discouraged about the role of the serious amateur in planetary astronomy. Our friends in the A.A.V.S.O. have an enviable record of observational activity; perhaps this success is due in part to a clear understanding of the methods and purposes of their variable star programs. The new Jupiter Handbook should go a long way toward promoting a similar understanding of the goals of the A.L.P.O. Jupiter Section.

*********

<u>Mysteries of the Universe</u>, by William R. Corliss. Published by Thomas Y. Crowell Company, New York, N. Y., 1967. 216 pages, price $5.95.

Reviewed by Gene Lonak

In this work the author has attempted to answer some current and fascinating questions in cosmology and general astronomy, especially matters pertaining to structures, sizes, ages, and origins. He leads the reader down a natural path extending from the farthest reaches of the known universe to our own celestial neighbor - the moon. The book ends with a chapter on the search for extraterrestrial life. I believe that in his effective attempts to erase some perplexing question marks in the astronomical sciences, the author has raised additional intriguing queries.

Of the eleven chapters contained in this book, the first three aim at some of the mysteries of cosmology. Was there a beginning, and is there an end? What are quasars, and are they located at the brink of infinity? How do we measure the age of the universe? In a thorough discussion of the Big-Bang and Steady-State theories of the universe and the consequences derived from both models, partial solutions are presented; but Mr. Corliss opens the door to further speculations and questions. What is the size of the universe, and how is matter distributed? Do the physical laws we have verified "locally" hold true billions of light years away? The reasons for our present leanings toward the Big-Bang system are explained, along with the methods employed to determine certain sizes and relative ages in the universe.

Focusing on quasars and the part radio astronomy has played recently, the author further advances our journey. The known facts are played against the variables, and once again we see that our knowledge is limited in certain areas. Taking the particular case of 3C 273, one of the brightest quasars, Mr. Corliss outlines the difficulties of observation and interpretation of data received. After pausing to explain the Doppler effects in quasar observations and what they may mean, the author stops to explain various types of "astronomical clocks" and how we use time to decipher the codes brought to us on beams of feeble starlight. The different types of "clocks" used as we go farther back in time and the accuracy attainable with each of them are discussed in an extremely interesting manner.

With a stop to "check out Einstein", and to explain some of the facets of the theory of relativity, we next travel to the interior of a star and learn the mechanics by which this type of object, such as our sun, can "burn" 600 million tons of hydrogen fuel each second and continue to radiate energy for billions of years. We examine the Hertzsprung-Russell Diagram closely and follow a typical sun from its birth to its death. Certain questions are raised as we go along but may not be answered until new data can be received from observatories located outside our own limiting atmosphere.

The terminal point in our astronomical journey in this book is our own Solar System. If we eliminate everything discussed so far, we still have enough mysteries presented to fill a lifetime. Is our sun-planet system tied together by a giant spring which coils and recoils in a regular eleven-year cycle? How do the sunspots affect the earth and every other member of the system? For that matter - what are sunspots and what are their life histories? Knowing that we feel the effects of the cycle through radio transmissions and phenomena in our upper atmosphere, can we observe other cyclic changes on other planets? With improved astronomical observational techniques we have noticed the Red Spot of Jupiter undergoing changes along with other idiosyncracies in its upper strata; the radio transmissions received and linked in some manner with its satellite Io appear to fluctuate in cycles, possibly reflecting the sunspot cycle back to the earth. In our own vicinity, transient phenomena on the moon appear to vary in accordance with the cycle; the varied types of observations are explained and a simple question is asked - what are those lights on the moon?

Closing with chapters on the always interesting "Canal Question" of Mars, the "missing" planet of the asteroid belt, and finally the search for life beyond the earth, the author has left the reader with a better understanding of the known facts, the speculations, and the still unanswered questions in our present position in astronomy.

**********

Atlas of the Heavens, Deluxe Edition, by Antonin Becvar. Available from Sky Publishing Corp., 49-50-51 Bay State Road, Cambridge, Massachusetts 02138. $12.50.

Reviewed by Michael Rogers, Lansing Astronomical Society

One of the most valuable tools of any amateur astronomer is a good star atlas. It is vital for finding deep sky objects; and it is also useful for marking the paths of asteroids, comets, and meteor radiants, as well as for keying photographs and for identification of constellations. One of the best atlases available is Atlas of the Heavens by Antonin Becvar.

The Atlas of the Heavens is a 16-page volume covering the entire sky to a limit of magnitude 7.75. The cover is blue, spiral bound plastic (12 3/4" x 16 1/2"). On the first page is an interesting introduction by Zdenek Kopal. Dr. Kopal gives a short history of star atlases and describes some of the work that went into developing this atlas. On the next page is a list of sources, a key to the atlas, and an extremely handy index to the constellations. To help locate objects, a thin plastic overlay grid is included. Another aid is the separate symbol key sheet, which illustrates all the symbols used in the atlas for easy reference.

The biggest advantage to this new atlas is its ease of use. It is much smaller than the impossibly bulky old edition, and it can be easily stored. Since it is spiral bound, it can be folded back to open to a particular chart; and it is durable enough to use at the telescope. The clear markings show up plainly under a red light; and the color-keyed clusters, nebulae, and galaxies make identification of glowing blobs swift and sure. About the only faults with this atlas are the flimsy overlay and the absence of magnitude identifications for the deep sky objects.

Overall, Atlas of the Heavens is probably the best set of charts available. Its reduced size, spiral binding, and six colors make it extremely easy to use. After struggling with the old edition on a dark night, any reader would find this new volume a refreshing change.

*********

*New observing forms may be obtained from Charles L. Ricker, who will be happy to answer any questions you may have concerning the program. New observers as well as experienced ones are invited to participate. (This footnote follows text in "Lunar Notes" on pg. 110.)

MARS 1969 APPARITION - ALPO REPORT I

By: C. F. Capen and T. R. Cave, A.L.P.O. Mars Recorders

## Introduction

The Martian 1969 apparition was the first of the current three near-perihelic approaches of the planet. The 1969 opposition occurred four days earlier than the mean synodic period, on May 31 at an orbital heliocentric position of 335°, which was only 86° from the perihelion position; and consequently, this apparition was considered perihelic. Mars presented to the observer a favorable planetary disk diameter of 19".2 at a distance of 44.6 million miles on the night of opposition. The closest approach occurred on June 10 with a disk diameter of 19".5 because of the eccentricities of the orbits of Mars and Earth. Mars had a useful disk diameter greater than 6" of arc for a period of 11 months from mid-January through December, 1969. The range of the axial tilt allowed observation into both hemispheres equally well. At the beginning of the apparition the northern hemisphere was tilted toward the Earth during the early Martian summer season. The equatorial region was well placed for observation during Martian summer and autumn. The sub-Earth point crossed the Martian equator on September 19, 1969. Throughout the remainder of the apparition the south pole was tilted toward the Earth, allowing early spring observations of the South Polar Cap and related antarctic phenomena (Refs. 1 and 2).

Mars was relatively low on the horizon during the entire apparition because of its large southern declination. This aspect made the seeing below average and observation difficult at most observatories. Even so, many quality observations were received; and Mars was well observed over a long period.

## ALPO Observers and Data

This report is based on 415 recorded observations and 645 drawings of Mars by 30 A.L.P.O. observers covering the 1969 apparition from 31 August 1968 to 31 January 1970. These observations included ten Martian northern hemisphere seasonal months from April (Martian Date) to January (MD). Many quality and systematic observations were received in the form of drawings in restricted colors (defined pass-bands), color drawings, contrast intensity estimates, color data, clouds and whitening phenomena, and polar cap measurements. These data make possible statistical tables and charts of meteorological phenomena and surface seasonal and secular changes. Many quality observations were received from observers located in Germany and Japan. Observations from foreign locations are extremely important to the data record because they give simultaneous information about Martian longitudes located on the other side of Mars. The ALPO observers employed telescopes with 3.5- to 82-inches of aperture using 140X to 1000X ocular powers. The most often used apertures were 6-inches to 16-inches. Visual and photographic observations were made with the aid of violet (W47), blue (38A), blue-green (W64), yellow-green (W57 and 58), yellow (W12, 15, and 21), orange (W23 and 106), red (W25), infrared (RG-10 or W87 photo), and magenta (30 and 32) filters. The Mars Recorders desire to take this opportunity to thank all those who contributed observational data for the 1969 apparition. The following is a list of active ALPO Mars Section observers and contributors, the telescopes and ocular powers employed, and the number of observational contributions:

| Observer | Station | Telescope (Power) | Observations |
|---|---|---|---|
| J. C. Bartlett | Baltimore, Md. | 5-in. Refl. (142X, 437X) | 74 obs.<br>1 color drawing |
| K. R. Brasch | Ottawa, Canada | 5-in. Refr. (250X) | 8 b&w drawings* |
| C. F. Capen | Table Mt., Calif. | 16-in. Refl.<br>24-in. Refl. | 123 b&w drawings<br>20 color drawings |
| | Flagstaff, Ariz.<br>Mt. Locke, Texas | 30-in. Refl.<br>82-in. Refl.<br>(395X, 1000X) | 200 observations |
| V. W. Capen | Table Mt., Calif.<br>Flagstaff, Ariz. | 24-in. Refl.<br>30-in. Refl.<br>(450X, 825X) | 28 obs. |
| D. Cave | Long Beach, Calif. | 12.5-in. Refl.<br>24-in. Refl.<br>(500X, 625X) | 17 drawings |
| T. R. Cave | Long Beach, Calif. | 12.5-in. Refl. | 33 drawings |

*black and white drawings.

| Observer | Station | Telescope (Power) | Observations |
|---|---|---|---|
| T. R. Cave | Long Beach, Calif. | 24-in. Refl. (380X, 625X) | |
| E. W. Cross | Las Cruces, N. M. | 6-in. Refr. (260X, 170X, 400X) | 34 obs. 41 drawings |
| K. J. Delano | Taunton, Mass. | 12.5 in. Refl. (300X) | 22 drawings |
| M. Eales | San Jose, Calif. | 8-in. Refl. 6-in. Refr. (250X) | 5 drawings |
| R. Gordon | Pen Argyl, Pa. | 3.5-in. Refl. (200X) | 8 drawings |
| R. C. Hartman | Saugus, Calif. | 82-in. Refl. (900X) | 2 drawings 2 photos |
| W. H. Haas | Univ. Park, N. M. | 12.5-in. Refl. (305X) | 2 drawings |
| A. W. Heath | Nottingham, England | 12-in. Refl. (190X) | 5 b&w drawings |
| H. Heuseler | Berlin, Germany | 12-in. Refl. (250X, 400X) | 12 b&w drawings Many obs. |
| K. Krisciunas | Naperville, Ill. | 6-in. Refl. (138X, 183X) | 18 b&w drawings |
| H. Lines R. Lines | Phoenix, Ariz. | 16-in. Refl. (200X, 500X) | 9 drawings |
| D. Louderback | South Bend, Wash. | 8-in. Refl. (360X) | 2 drawings |
| C. R. Mallett | Parsippany, N. J. | 6-in. Refl. (210X, 400X) | 6 drawings |
| C. H. Mayer | Barberton, Ohio | 6-in. Refl. (150X, 220X, 300X) | 18 b&w drawings 19 color drawings |
| R. McClowry | Sarver, Pa. | 6-in. Refr. (180X, 360X) | 18 drawings |
| J. L. Mitchell | Cairo, Ga. | 6-in. Refl. 12.5-in. Refl. (300X, 490X, 636X) | 41 b&w drawings 1 photo 1 color drawing |
| T. Osawa | Hyogo-ken, Japan | 8-in. Refl. (286X, 500X) | 96 b&w drawings 42 obs. |
| R. Rhoads | Scottsdale, Ariz. | 6-in. Refl. (300X) | 14 drawings |
| B. Salmon | Oklahoma City, Okla. | 10-in. Refl. 8-in. Refl. 12.5-in. Refl. (375X, 550X) | 39 color drawings |
| K. Simmons | Jacksonville, Fla. | 6-in. Refl. 8-in. Refl. 10-in. Refl. (192X, 220X) | 18 drawings |
| H. A. Smith | Willimantic, Conn. | 6-in. Refl. (210X) | 14 drawings |
| J. E. Westfall | San Francisco, Calif. | 10-in. Refl. (200X, 330X) | 12 drawings |
| T. R. Williams | Darien, Conn. | 10-in. Refl. 22-in. Refl. (160X, 264X, 477X) | 4 drawings |
| W. Wooten | De Funiak Springs, Fla. | 8-in. Refl. (250X, 350X) | 12 drawings |

The Mars Recorders received many letters during the apparition from ALPO members requesting information about a Mars observing program, the use of filters, and observing techniques. A Mars observing kit was prepared and mailed to correspondents in order to efficiently answer most of the questions. The observing kit consisted of a standard reply form, CM rotation tables, "Filter Techniques for Planetary and Lunar Observations" (a reprint), "Mars - A Dynamic World" (reprint, introduction to Mars), "The Planet Mars in 1969" (reprint), the 1954 ALPO Map of Mars, several other working maps of Mars depending upon availability (De Mottoni IAU Maps, Antoniadi-Ebisawa Map, etc.), and Mars observing forms. Due to the increased costs of printing, the Mars Observing Kits and ALPO observing forms will be available in the future at cost and postage.

Future papers in this journal concerned with a Mars observing program and visual observing suggestions are planned to assist the student of Mars in observing the important and favorable 1971 and 1973 apparitions.

## Martian Nomenclature

The current ALPO Mars Section Reports will be similar in format and tradition to those followed by Mars Recorders D. P. Avigliano and K. R. Brasch. They will be based on the nomenclature shown in the 1954 ALPO Map of Mars (Refs. 3, 4). Names of fine surface features are found on the Mars map drawn by S. Ebisawa in 1956, which is an updated version of Antoniadi's 1929 map (Refs. 5 and 6). The understanding and use of Martian terms is important to the Mars observer.

1. Drawings, photographs, maps, and observation descriptions are orientated to an inverted telescopic Martian disk, where the top is south, the bottom is north, the right side is the following or morning limb, and the left side is the preceding or evening limb, in accordance with astronomical convention.

2. The planetary rotation is from west to east, or from right to left.

3. The terminator is the line where the daylight ends and the darkness of night begins. The terminator phase (defect of illumination) is given in degrees to define how much of the geometrical visual Martian disk is in darkness. The evening or sunset terminator appears on the preceding limb of the disk before opposition. Close to the date of opposition there is no apparent phase; and consequently, there is then no terminator seen by the terrestrial observer. After opposition the terminator becomes the morning or sunrise line on the following limb of the Martian disk.

4. The Central Meridian (CM) is an imaginary line passing through the planetary poles that bisects the planetary disk, and is used by the astronomer to define what longitudes are present on the planetary disk during an observation. The CM is the areographic longitude that is on the central meridian of the disk, as seen from Earth at a given Universal Time. The areographic longitude at any time of observation can be calculated by allowing $14\overset{\circ}{.}6$ per hour for the rotation of Mars. Since the rotation period of Mars is about 40 minutes longer than the Earth's, Mars furns through only about 350° while the Earth completes one full rotation. Hence, any particular Martian surface marking will arrive at the central meridian about 40 minutes later each night. After the lapse of 36 days, this 10° lag will add up to a full retrograde rotation of the planet, and all parts of its surface will have come under view. During the 36 days, any given Martian region is observable for from 8 to 10 nights.

5. The declination of the planet Earth ($D_E$) as seen from Mars defines the axial tilt of the Martian globe relative to the Earth. This $D_E$ is also equal to the aerographic latitude of the center of the Martian disk, which is known as the subearth point. The subearth point is + if the north pole is tilted toward the Earth and - if the south pole is tilted toward the Earth.

6. Quantity TD indicates the terrestrial date. The terrestrial date begins at $0^h$ Universal Time, which corresponds to a day earlier in the United States, at 7 p.m. standard time in the Eastern zone, 6 p.m. Central Time, and 4 p.m. on the Pacific Coast. The terrestrial date is written with a day number following the month name; e.g., April 1 TD, in order to avoid confusion with the Martian seasonal date in the text.

7. Quantity MD indicates the Martian date. The Martian seasonal date for the northern hemisphere of the planet is by analogy with terrestrial seasons. Martian "March 21st" occurs when the sun crosses the planet's equator from south to north; "June 22nd" and "December 22nd" come at the Martian solstices, when the subsolar point is in latitudes +24° and -24° respectively. Each Martian date as thus defined lasts two or sometimes three Earth days. The Martian date is written with the day number preceding the month name, e.g., 20 March MD, in order to differentiate the Martian seasonal date from the terrestrial observation date.

8. The color aspects or appearance of objects are described in terms of hue, lightness, and saturation. The color definitions are as follows: color specifically applies to one of the 6 or 7 pure or fully saturated primary spectral colors. Hue implies some modification of a finer discrimination of a primary color. It is a multiple color as contrasted with black, white, or gray, and is formed from the overlapping of basic spectral colors. Tint applies to a color modified toward white. Tinge suggests an interfusion or overlying or mixture of one color with another background intrinsic color. Shade applies

to a color modified toward black by the addition of gray, or to different off-whites or grays tending toward black. Descriptive colorimetry defines blue-green as a different hue from green-blue. In the former case blue-green has a blue tint, while in the latter green-blue is stronger in the green. This method of describing hues is followed by the authors.

9. The areographic descriptive terms are similar to the selenographic descriptive terms that originated in the eighteenth and nineteenth centuries when nothing was known about the actual surface physical conditions. Therefore, they should not be taken literally but rather as referring to a characteristic surface feature. This is also true of descriptions of Martian atmospheric meteorology, where clouds, hazes, and whitenings are referred to in the classical sense. The following abbreviations are in standard use on maps of Mars:

C, canal - Canali or canal-lineament feature. A canal is a fine linear surface feature that is composed of smaller dark fragments, e.g. triangular, circular, or irregular, each fragment close to or below the telescopic resolution.

D, desert - A light ocher surface area.

D - Depressio, a depression.

F - Fons, a spring or oasis, usually a small circular dark area located at a junction of canals.

FR - Fretum, a strait.

I, IN - Insula, an island or small ocher area.

L - Lacus (Lucus), a lake usually found at an oasis position.

M - Mare, a sea or gross dark surface feature.

N - Nodus, node, nodule, knot, swelling, a concentration similar to a Lacus.

Nix - Frost, snow, or a white area.

oases - A dark surface feature roughly circular in outline and usually located at canal junctions. It is sometimes composed of several smaller circular features, each called a fons.

P - Palus, a swamp, medium-size dark area.

PO - Portus, harbor, caret.

PR - Promontorium, a cape, caret.

R - Regio, a light ocher desert region.

S - Sinus, a gulf or dark surface feature.

region - Several surface areas or a gross area, e.g., Tempe-Arcadia-Amazonis region.

area - A surface area or a small surface feature, e.g., the Nix Tanaica area.

ca. - Center-of-area position for circular frost or cloud formations, used to define a position of a feature when its boundary is symmetrical or fairly circular.

PH - Polar haze or hood.
NPC - North Polar Cap.
SPC - South Polar Cap.

MC - Morning cloud.
EC - Evening cloud.
CB - Cloud band.

MBL - Morning bright limb or sunrise haze.

EBL - Evening bright limb or sunset haze.

10. IAU nomenclature is used for identification of drawings and photographs, where M 69 07 04 DB 0515 UT. CM 339° 6" Newt 200X 27 Sept MD is: Mars, year, month, day, drawing-filter color (photo color), time, longitude on CM, telescope, power, Martian date.

Clouds are indicated by dashed lines, frosts by dotted lines, and unidentified patches by dash-dots.

cloud - A well-defined white patch that is recorded best in blue or violet light, is topographically orientated, and rotates with the planet. It is possibly an atmospheric aerosol next to or above the surface of Mars.

yellow cloud- A light hazy area recorded best in yellow or red light that is topographically orientated, rotates with the planet, and has a definite morphological history.

haze - A nebulous white or blue-white area on the sunrise or sunset limbs. It is sometimes called limb brightening. The misty brightening has little preference for light or dark regions. It dissipates about Martian 8 or 9 o'clock in the morning and does not rotate with the planet. Haze is possibly a frozen crystal-fog contiguous to the surface, or frost on the surface, or a combination of both. It is best seen in blue light and blue-green light.

frost - A bright, white patch with a well defined border in green, orange, or red light that rotates with the planet. Frost patches usually appear only on light surface areas.

The syllabus of reporting observational data regarding Mars is similar to that employed at the telescope, e.g., the polar regions, clouds (aerosols, dust), frosts (whitenings), gross surface features (maria, deserts), and fine surface details (oases, canal-lineaments). The areographic map coördinates (long., lat.) are usually given with new features, rarely used names of features, or multiply named features.

Summary of Observed Events

Polar Regions. The North Polar Cap was free of its winter haze hood at the commencement of observations in 1969 since it was already Martian April; however, temporary hazes were observed in the arctic region at times throughout the apparition. Visual micrometer measurements of the retreating spring-summer North Cap produced a graph that showed a normal regression curve when compared to similar seasonal curves obtained during the 1963, 1965, and 1967 apparitions. ALPO observations showed that the north polar hood suddenly reappeared as a large and dense entity about June 4, 1969 TD or 27 Sept. MD. The dull, gray-white north hood had a poorly defined periphery, and at certain times it was larger than the spring South Polar Cap. The reformation of the North Cap was observed to be irregular beneath the variable density of its polar hood.

The South Polar Cap first became free of its polar hood about the last week of May, but it was covered once again during most of June, 1969. Visual micrometer and photographic measurements near the time of the southern hemisphere spring equinox showed the South Cap edge to be at -46° to -48° latitude, or gave a cap diameter of about 86°. This is slightly larger than the average cap diameter of 80° at -50° latitude found by E. Slipher. Several cap extensions and hazes were observed as far north as -34° latitude over the southern light areas.

Clouds. Good seeing and a large apparent disk diameter are not requirements to detect the presence of clouds and limb brightenings or to determine their positions relative to the planetary disk center. Violet, blue, and blue-green filter observations made by ALPO members recorded many interesting and remarkable white clouds. The usual seasonal cloud activity was present over the Libya-Crocea-Oenotria region (285° long., -03° lat.) on the southern border of the Syrtis Major. This phenomenon has been termed a "seasonal cloud," in the classical sense, because it has occurred each Martian July and August since before 1911. Afternoon recurrent white W-cloud formations were again seen over the Great Martian Desert (50° to 170° long., -10° to +50° lat.). There appeared to be fewer equatorial cloud bands reported during this apparition. An equatorial cloud band was present from 20° through 240° long. during most of June TD. Northern hemisphere evening limb haze from the equator to the North Pole was prevalent during most of June TD. Dense, bright morning clouds and possible surface frosts were present over the Isidis R.-Neith R.-Meroe In. region during June TD, and they dissipated during July TD. A large, bright wedge-shaped cloud was observed in blue and green light by R. Rhoads over the Dioscuria-Cydonia region (290° - 20° long., +50° lat.), and its presence was immediately telephoned to the Mars Recorders. Refer to Fig. 14. Several good drawings and photographs were obtained of its behavior in June and July. This cloud was curiously contained by the Protonilus-Deuteronilus Canal on the south and the Pierius-Callirrhoe Canal on the north from June 30 to July 16 TD. More will be said about the interesting diurnal behavior of this cloud

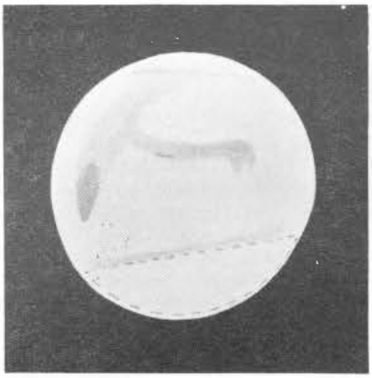


Figure 14 (left). M 69 07 04 D 0515 UT. CM 339° 6" Newt 300X 27 Sept MD. R. Rhoads. The coding used here is explained in the Mars Report by Messrs. Capen and Cave and applies to the other illustrations in their Report.

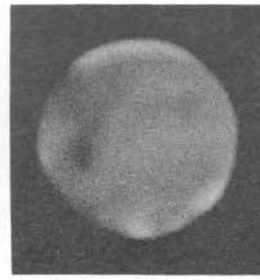


Figure 15 (above). M 69 05 29 V 0658 UT. CM 324° McD 82" coudé 6 Sept MD. C. Capen. Blue-clearing. A violet light photograph with the McDonald 82-inch reflector.

in a future report. The M. Acidalium was covered with dense and bright morning limb mists during July TD. Morning and evening clouds were reported over the Elysium plateau at times during the apparition.

Yellow cloud. A southern hemisphere bright, white streak was first noted visually and was located on infrared, red, and green light photographs. This salient feature was not recorded on blue or violet light photos. This curious white-ocher streak was first interpreted as surface frost or fog, but its motion equatorward and its appearance in multicolor photos put it in the yellow cloud class. It extended from the edge of the South Cap and wound northward through the east side of the Noachis, cut across the Charis, and followed the Hellespontus into the Iapygia area. This yellow type cloud stayed confined to this region and did not break out and become planet-wide as did a similar cloud in the same location during 1956.

Weak to moderate periods of blue-clearing were observed in violet light (W47) as far away as 247 days from opposition. A strong clearing period was noted around the time of opposition on May 31. In comparison, no strong to moderate blue-clearings were recorded during the date of the 1967 opposition on April 15 TD. Refer to the violet light photo of Fig. 15.

White areas. Morning frosts or bright fogs were prevalent over the Elysium, Neith Regio, Isidis Regio, Meroe Insulae, Nymphaeum, Edom, Aram, Eos, Nix Tanaica, and along the north border of the Sabaeus-Meridiani Sinus on the Deucalionis Regio.

The Hellas plateau (285° long., -45° lat.) was only partly covered with a white extension from the South Cap, while its north two-thirds appeared a dark ocher hue during the first half of the apparition. Later, the Hellas was covered with white cloud and probably with frost during July TD, a condition that appeared and disappeared unpredictably throughout the Martian spring-summer season of the southern hemisphere.

Surface features. ALPO observers obtained many useful and detailed drawings that showed seasonal and secular changes. The data show that observers experienced fairly good seeing at most places around the time of opposition regardless of the low altitude of Mars. According to the size of telescopes employed the resolution at the sub-earth point on Mars ranged from 320 miles (1.5 arc seconds) to 20 miles (0.1 arc second).

Seasonal contrasts of dark surface features appeared darker than normal when newly uncovered from beneath the rapidly retreating North Cap (Ls* 40° - 90°). Dark maria are usually next to or surrounded by light desert areas that exhibit seasonal whitening during maximum regression of the North Cap in late spring and summer. The relative contrast between the dark and light areas is consequently increased. Observations showing detailed contrast changes in selected regions are important because the mechanism which causes the apparent contrast changes is not understood. Features showing seasonal changes during Martian spring were: the northern part of the M. Acidalium, M. Boreum, Baltia, Copais P., Cecropia, Propontis complex, Acidalius F., Ascuria L., Maotis Palus, Heliconius C, Pierius C, Callirrhoe C, Tanais C, Eurotus C, and Midas C.

The seasonal changes were more widespread toward the equatorial region during the summer season ($L_s$ 90° - 180°). The M. Acidalium displayed the most intrinsic surface seasonal changes of all observed features. The Baltia-M. Boreum region, on the NW border of the



*$L_s$ is the areocentric longitude of the sun, measured so as to be 0° at the vernal equinox of the northern hemisphere of Mars.

M. Acidalium, faded back to its previous normal boundary and light ocher shade, leaving exposed the two boundary canals - the Laxartes C. (30°, +65°) and Silis C. (50°, +60°). The Niliacus Lacus became a detached entity from the south border of the Acidalium. A darkening wave appeared to move up the Nilokeras I and II Canals, filling in the light region between them. The Lunae L., Oleaster L. (58°, +13°), Clytraemnestra L. (47°, +12°), Jamuna C, Hydraotes C, and Lysis C (55°, +15°) were intensified in late Martian summer. The Umbra-Utopia-Casius region showed similar darkening. The Propontis complex has appeared darkened and enlarged in summer during the 1967 and 1969 apparitions. An enlarged dark structure was seen visually and photographed in the Fatigium Aryn (0°, +05°) connecting the two promontories of the Meridiani Sinus. This feature was recorded by the Mariner VI and VII spacecraft. The third fork of Meridiani S. and its connecting Brangaena C. (13°, +05°) were resolved only with good seeing.

The secular changes and newly found fine structure were the unique events of the 1969 apparition. Secular changes of dark features in the vicinity of Syrtis Major, Sabaeus S., and Margaritifer S. during Martian summer and within the Great Martian Desert in autumn were obvious from ALPO visual and photographic observations.

Around the time of opposition on the nights of May 29 through June 2 TD, inclusive, the excellent astronomical seeing made possible high quality resolution of surface detail of less than 20 miles within the Syrtis Major-Aeria-Sabaeus S. region with the 82-inch McDonald reflector. The maria were composed of various geometric shapes, the oases appeared to be a composite of small triangular and circular objects, and some of the canal-lineaments were resolved into dark gray, irregular, circular, and parallel filaments. The general appearance of the Martian disk during the moments of best seeing was that of a dark gray spider web dropped over an ocher sphere. The shade and texture of the fine structure were analogous to iron-filings in appearance. Several new features were found on the following or west side of the Syrtis Major that have not been found to date in the literature. There was more fine surface detail present than could be drawn (Refs. 7, 8). A detailed description and map of this region will be forthcoming. Telescopes from 12-inches to 24-inches in aperture could have defined most of these features, given equally excellent seeing.

Probably the most salient events of the 1969 apparition were the secular changes that were recorded by ALPO observers. The Aethiopis-Laocoöntis-Aetheria region (250°, +20°) has been active and observed with interest since 1954. The Aethiopis-Laocoöntis region, to the north, has displayed secular change since 1964 (Refs. 9, 10). Multicolor photographs showed the Laocoöntis to be one of the most color saturated structures on the Martian disk and moving southward along the Adamas and Aethiops canals in 1967. This enlarged dark area reported at 245° long. by Dr. G. de Vaucouleurs (Ref. 8) was verified as a vague entity on ALPO visual drawings and photos. The Antigones Fons (Astaborae F., 300°, +20°) on the NW border of the Syrtis has shown an increase in definition and intensity during the 1967 and 1969 apparitions. Likewise, Propontis I has been enlarging southward along the Hades Canal. A most interesting darkening was observed in the Chryse Desert continguous to the following or west border of the Margaritifer S. (30°, 0°) before opposition. This newly darkened area was recorded on Mariner '69 TV photos, and it apparently persisted throughout the remainder of the apparition. Whether this was a bona-fide secular change or will prove to be a seasonal change is to be seen during the next several apparitions. An observational surprise awaited those persistent observers who continued studying Mars three to five months after opposition. A new large and dark gray-brown feature was independently discovered in the obscure Great Martian Desert region by T. Osawa and C. Capen. This usually vague and insipid Martian region displayed intense seasonal and possible secular contrast changes from early August to mid-October TD. A homogeneous series of observations showed that a gross dark feature had germinated within a few days time during Martian September in the Tempe Desert along the Issedon and Nilus canals joining the Ascuris Lacus to the Lunae Lacus. T. Osawa immediately sent a detailed description and four beautiful disk drawings of the unusual happening to the Mars Recorder. One of Mr. Osawa's excellent drawings of this feature is shown in Fig. 16. Unfortunately, this event happened after the brief passage of the Mariner 1969 spacecrafts, and therefore did not show in the TV pictures. The front cover drawing by one of the authors shows this same part of Mars one terrestrial month later. ALPO observing data concerning this darkening phenomenon are currently under study.

This brief summary of atmospheric and surface phenomena will be discussed in detail in individual ALPO Mars Reports in the future. At the time of this writing it is not too late to send in Martian observational data and drawings to the Mars Recorders for analysis.

References

1. Capen, C. F., and Capen, V. W., "The Planet Mars in 1969", Sky and Telescope, Vol. 37,

Figure 16. M 69 08 09 D 1100 UT. CM 89° 8" refl. 286X 30 Sept MD T. Osawa. The Solis L., Ganges, and new darkening (arrow) in the Tempe D. are clearly seen. The M. Acidalium and Nilokeras C. are covered by dense aerosols.

This drawing may be compared to the front cover drawing, which shows the same portion of Mars. See also text of Mars Report, pg. 138.

No. 3, March, 1969.

2. Capen, C. F., "The Observer and Mars in 1969", J.A.L.P.O., Vol. 21, Nos. 7-8, April, 1969.

3. Avigliano, D. P., "Note on The 1954 A.L.P.O. Map of Mars", J.A.L.P.O., Vol. 8, Nos. 11 and 12, Nov.-Dec., 1954.

4. Ashbrook, J., "ALPO Map of Mars", Sky and Telescope, Vol. 15, No. 11, Sept., 1956.

5. Ebisawa, S., "A Map of Mars for 1907-1957", J.A.L.P.O., Vol. 14, Nos. 9-10, October, 1960.

6. Vaucouleurs, G. de, "Charting the Martian Surface", Sky and Telescope, Vol. XXX, No. 4, Oct., 1965.

7. Capen, C. F., "Current Notes on Mars in 1969", J.A.L.P.O., Vol. 21, Nos. 9-10, July, 1969.

8. Editorial, "Some Highlights of the Current Apparition of Mars", Sky and Telescope, Vol. 38, No. 2, Aug., 1969.

9. Brasch, K. R., "Report on the 1964-1965 Apparition of Mars - Part I", J.A.L.P.O., Vol. 20, Nos. 1-2, January, 1967.

10. Brasch, K. R., "Report on the 1964-65 Apparition of Mars - Part II", J.A.L.P.O., Vol. 21, Nos. 7-8, April, 1969.

## SOME ASPECTS OF RING DIKES, CALDERAS, AND MOON CRATERS

By: William Seager*

Until recently ring dike complexes have received little attention in spite of Sir Harold Jeffrey's suggestion that they resembled large lunar craters. The origin of ring dike complexes, such as those in New Hampshire and in the Precambrian shield terrain of Canada and Scandinavia, was largely unknown because it was difficult to reconstruct their pre-erosion morphology. Field work by several individuals is beginning to show that ring dike complexes are the roots of volcanos or volcanic centers which have undergone volcano-tectonic collapse. The structure and igneous activity of the Jemez caldera and Mogollon Plateau caldera of New Mexico suggest that these features are the surface expressions of deeper ring dike complexes. Further, these calderas exhibit most of the features of many large lunar craters.

A succession of eruptions of ash-flow tuffs in the Jemez Mountain area in Pleistocene time led to the formation of the Jemez caldera. The tremendous volume of lava, known now as the Bandelier Tuff, issued from vents in the Jemez region and flowed as nuée ardentes down surfaces inclined gently away in all directions. Collapse of the magma chamber along a ring fracture 18 miles in diameter produced the Jemez caldera, the rims and floor of which are composed largely of the Bandelier Tuff. The ring fracture was subsequently

*Contributed by Eugene W. Cross, Jr. in 1968(?) when he was a student at New Mexico State University. Dr. Seager is an Associate Professor of Geology at N.M.S.U.

invaded by viscous rhyolite which, where it reached the surface, gave rise to a series of volcanic domes, present now as a relatively undissected group of hills encircling the caldera just inside the rim. Locally, small craters and associated flows also formed along the ring fracture. Nearly contemporaneous with intrusion of the ring fracture was doming of the caldera floor, probably by resurgence of new magma from below. This dome forms a central peak which rises 1,000 to 2,000 feet above the encircling rim and rhyolite domes.

Like the Jemez caldera, the much larger Mogollon caldera (75 miles in diameter) consists of a centrally depressed area surrounded by a raised rim, both of which are formed from a complex volcanic sequence characterized by thick piles of ash-flow tuffs. A peripheral belt of arcuate, discontinuous bodies of rhyolite intrusions in the form of domes, dikes, and fan-shaped bodies, corresponds to the peripheral domes of the Jemez caldera and presumably rose along a ring fracture zone. Structural relief between highest parts of the rim and the central depressed area, as measured on equivalent beds, is about 7,000 to 8,000 feet. The Mogollon caldera differs from the Jemez caldera in the following aspects: a) its greater size, b) the greater volume of volcanic rock erupted before collapse (more than twice as much as in the Jemez region), c) no resurgent doming of the central floor (a prominent central peak in the Mogollon caldera is formed by a complex of basaltic intrusions), d) its greater age, greater complexity, and longer period of development (at least three major ash-flow eruptions in post-Cretaceous to pre-Pliocene time were each followed by collapse), e) the superposition of numerous smaller and younger calderas, including the Plains of St. Augustine volcano-tectonic collapsed area, upon the main structure, f) and the modification of the caldera rims by younger basin and range faulting, which produced a series of semi-peripheral mountain ranges and a pronounced ring graben.

In many respects the Mogollon and Jemez calderas resemble moon craters. They exhibit well-defined, though somewhat eroded rims and inner crater walls, which, in the case of the Mogollon caldera, approach 5,000 feet in height. Locally, inner "crater" walls of the Mogollon "crater" are terraced by young normal faults, which produces a resemblance to the "landslip" features of many lunar crater walls. A central crater floor, depressed by movement along ring fractures, is similar to lunar counterparts; and the floor of the Mogollon crater would be depressed beneath the level of the outer "plains" were it not for infilling of the Gila Conglomerate. The list of large-scale terrestrial volcanic calderas which exhibit central peaks is becoming impressive. Well-defined central peaks of different origins are present in both the Jemez and Mogollon calderas as well as in the Creede, Silverton, Newberry, and Crater Lake calderas, in the Aguachile collapse structure, and in the explosion craters of the Pinacates and Zuni Salt Lake. Three types of central peak are generally recognized: 1) broad domes, faulted or unfaulted, characterized by the Jemez caldera, with lunar counterparts in the craters of Bullialdus, Alpetragius, Argelander, Arzachel (?), and probably others; 2) complex or simple intrusives of basic or near basic composition, found in the Mogollon crater and Aguachile collapse structure and represented on the moon in Langrenus, Cleomedes, Alphonsus, and many others; 3) cinder cones, represented by those in the Pinacates, Crater Lake, Zuni Salt Lake, and Potrillo craters, and having possible lunar analogs in Rheinhold, Yerkes, Picard, and others. The areas of rhyolite intrusions that occupy the ring fractures of the Jemez and Mogollon calderas also appear to have lunar analogies. Many of the large lunar craters exhibit rings of craters superimposed on rims (Byrgius, Apollonius, Firmicus, Condorcet, Purbach, and LaCaille), and a few (Bullialdus) show arcs of craterlets within the crater at the base of rims. The rings of explosion craterlets in lunar craters and arcs of rhyolite intrusions in terrestrial calderas have their origin in the ring fractures and owe their existence, therefore, to volcano-tectonic collapse. The Mogollon caldera also shows features which heretofore have not been recognized in terrestrial volcanic regions but which are common in most large lunar craters. These are large and small volcanic craters superimposed more or less randomly on the major caldera, that is, on the rims, caldera margins, and floor; several of these have central peaks. The apparent random distribution of small craters across large ones on the moon is well-known, excellent examples being Clavius and Schickard.

With few exceptions the large volcano-tectonic calderas on earth are associated with tremendous piles of rhyolitic and latitic ash-flow tuffs. Indeed, it is becoming increasingly more apparent that eruption of ash-flow tuffs is normally followed by collapse and that the resulting ring fractures become sites for subsequent volcanic activity ranging in scope from acidic to basic intrusions and extrusions, gaseous explosions, and thermal tivity. If many of the large lunar craters are interpreted, therefore, as volcano-tectonic in origin, as is suggested by the Jemez and Mogollon calderas and others, one should expect great volumes of rhyolitic to latitic material on the moon, forming crater walls and floors and perhaps much of the upland areas. Part of these hypothetical rocks have doubtless been covered by younger outpourings of basalt, especially rocks of the crater floors and Maria regions. These masking flows presumably rose along late fractures in a manner similar to the young basic lavas of the western United States.

The main points of this discussion are two-fold. First, a reasonable interpretation of many large lunar craters as volcano-tectonic in origin is based on their morphological and geological analogy with known terrestrial volcanic calderas. An increasing amount of field data is showing that volcano-tectonic calderas are formed typically by collapse within a ring fracture following expulsion of acidic ash-flow tuffs, and that calderas thus formed normally are sites for subsequent igneous activity, especially in their centers and along ring fractures. With an understanding of the origin and behavior of terrestrial calderas, then, many of the lunar features, such as central peaks, arcs and rings of craterlets, terraced inner walls, and the craters themselves are logically explained as volcanic in origin. Secondly, the relation between ring dike systems in basement rocks of various ages and volcano-tectonic collapse appears assured. The ring dikes are the roots of magma-filled ring fractures, along which volcano-tectonic collapse occurred. At the surface, peripheral ring fault-controlled rhyolitic domes and dikes are manifest; but at low levels of erosion only granitic ring dike roots bear witness to a volcano's former existence. It should be added, however, that several ring dike complexes have preserved in their centers the remnants of ash-flow tuff lavas. Ring dike complexes are not uncommon in the basement rocks of Canada, Scandinavia, New England, and elsewhere. Inasmuch as large parts of the continental shield areas of the world are unknown geologically, it is likely that many more ring dikes will be found by careful mapping and that perhaps thousands, buried by younger rocks, will never come to light. If one could presume a volcano or volcanic complex for every ring dike system now known or postulated within the basement rocks, the total number of calderas formed through the earth's history, all spared by erosion and taken collectively, may approach the density of craters we see now on the moon.

## ANNOUNCEMENTS

There follows a listing of our Sponsors and Sustaining Members as of August 10, 1970. Sponsors pay $25 per year; Sustaining Members, $10 per year. We are greatly indebted to these colleagues for their generous and most meaningful financial support of the A.L.P.O. Many of them have renewed at the special rates for several years and are also among our major contributors as observers, authors of papers, and speakers at A.L.P.O. Conventions. Their loyalty and support have been of the greatest value to our Association.

Sponsors. William O. Roberts, Grace A. Fox, David P. Barcroft, Philip and Virginia Glaser, Dr. John E. Westfall, Dr. James Q. Gant, Jr., Ken Thomson, Reverend Kenneth J. Delano, Richard E. Wend, Reverend Richard G. Hodgson, A. B. Clyde Marshall, Alan McClure, Walter Scott Houston, Frederick W. Jaeger, and Phillip W. Budine.

Sustaining Members. Sky Publishing Corporation, Charles F. Capen, Charles L. Ricker, Elmer J. Reese, Carl A. Anderson, Gordon D. Hall, Michael McCants, Dr. William K. Hartmann, William E. Kunkel, Ralph Scott, A. W. Mount, Charles B. Owens, Joseph P. Vitous, John E. Wilder, Clark R. Chapman, A. K. Parizek, B. Traucki, Nicholas Waitkus, Patrick S. McIntosh, Lyle T. Johnson, the Chicago Astronomical Society, H. W. Kelsey, Phillip Wyman, Harry Grimsley, Daniel W. Harris, the Junior Texas Astronomical Society, Dr. David Meisel, Daniel Vukobratovich, John Bally-Urban, W. King Monroe, Warner T. Crocker, James W. Young, Klaus R. Brasch, Inez N. Beck, Jimmy G. Snyder, Dr. George W. Rippen, Dr. Joel W. Goodman, William B. Chapman, and Harry D. Jamieson.

New Addresses for Staff Members. Our Assistant Jupiter Recorder has the following new address:
Phillip W. Budine
101 Somerset Drive
Willingboro, New Jersey 08064

Lunar Recorder Jamieson now has the following address:
Harry D. Jamieson
P. O. Box 30163
Cleveland, Ohio 44130

An Appeal for Book Reviews. We have received the following note from Mr. J. Russell Smith, our Book Review Editor: "We have many qualified book reviewers among our members, but the Book Review Section is always in need of good and up-to-date reviews. We'd like to encourage you to consider doing a book review for your journal - The Strolling Astronomer.

"When you get a new book or have a chance to read one from your library, I know our membership would appreciate your sharing it with them in a review."

"Please let me hear from you."

The Editor can only heartily endorse Mr. Smith's appeal. It is good to see the name of one new reviewer among the book reviews in this issue - we need more.

Omission in Last Issue. Mr. J. Russell Smith has pointed out that the review of The World of Mars on pp. 96-97 of Vol. 22, Nos. 5-6 of this journal was not properly credited. The reviewer was Reverend Kenneth J. Delano. We apologize to Father Delano and to our readers for this careless oversight.

New Price of Lunar Observer's Manual. Lunar Recorder Charles Ricker writes that it has been necessary to increase the price to A.L.P.O. members of the A.L.P.O. Lunar Observer's Manual to $1.00. The supply on hand is dwindling. Mr. Ricker can accept no orders at the old, lower price after this issue is published.

Publication of Proceedings of the Apollo 11 Lunar Science Conference. The following release from the Pergamon Press, Inc. should be self-explanatory. It arrived a number of months ago. The material described will surely be of great value to advanced lunar research workers:

"Pergamon Press, Inc., in cooperation with The Geochemical Society and The Meteoritical Society, is pleased to announce the forthcoming publication of the three-volume Proceedings of the Apollo 11 Lunar Science Conference on April 30, 1970.

"The Proceedings of the Apollo 11 Lunar Science Conference features papers written by the principle investigators who participated in the three-month lunar sample investigation. Their findings were given at the historic three-day Apollo 11 Lunar Science Conference, held in Houston, Texas from January 5th-8th, 1970. The vital information found in this exclusive set of volumes cannot be found as complete in any other form. Volume 1: details the mineralogy and petrology of the lunar samples; Volume 2: explores their chemical and isotope analyses; and Volume 3: elaborates the physical measurements and organic analyses of the specimens.

"Highlighted by color plates and halftones of the lunar samples, the fully bound, three-volume reference work will be an invaluable and accurate soucebook for all those engaged in the various fields of scientific endeavor, as well as interested laymen.

"The 2000 page monograph has a price of $30.00 for the entire set and may be ordered through Pergamon Press, Maxwell House, Fairview Park, Elmsford, New York 10523."

Flying Saucers, Pro and Con. The whole August, 1970 issue of The Griffith Observer is given to a discussion of the reality or otherwise of "flying saucers". The affirmative side is presented by Stanton T. Friedman, nuclear physicist with TRW Systems; and the negative side is handled by Ronald A. Oriti of the Griffith Observatory. While many of the arguments will necessarily now be long familiar, we recommend this discussion, which takes the form of a written debate, as highly interesting reading.

New Booklet in ALPO Library. Mr. Takeshi Sato of Hiroshima, Japan has kindly given to the ALPO Library the following reprint: "Contributions from the Institute of Astrophysics and Kwasan Observatory, University of Kyoto. No. 184. Meteorological Observations of Mars during the 1969 Opposition", by S. Miyamoto. More than 300 drawings of Mars are published and described, a tremendous mine of information to the student of the Red Planet. About 15 pairs of photographs of Mars in blue and yellow light, taken by S. Matsui with the 60-cm. Tsugami reflector at Hida Observatory, augment the evidence of the visual drawings. This report is part of a continuing meteorological study of Mars initiated at the Kwasan Observatory in 1956.

We thank Mr. Sato for this truly valuable addition to the A.L.P.O. Library.

## OBSERVATIONS AND COMMENTS

A Comparison of Methods of Determining Rotation-Periods on Jupiter. The classical method of determining rotation-periods of features on Jupiter has involved no explicit mathematics. Rather, on a chart where longitudes in System I or System II are plotted against time, there is fitted a drift-line by eye to the observed points. The slope of the line is the rate of change of longitude with time and hence gives the period of rotation. A more refined method, used extensively in recent years by professional students of Jupiter, is to fit a computed Least Squares Line to the observed points. Here one minimizes the sum of the squares of the residuals in longitude, which are the differences between the observed longitudes and the corresponding points on the Least Squares Line. The computed slope of the line determines the period of rotation.

In 1960 Elmer Reese compared the two methods, and his results should still be of interest to our readers. The feature used was his hypothetical "Source Gamma" of major South

Equatorial Belt Disturbances. The observed points were initial longitudes of such outbreaks. The "thread and graph" method gave the longitude of Source Gamma as 204° - 1°.171 (T-2434308), period equal to $9^h\ 54^m\ 52^s.60$. The time T is measured in Julian Days. The Least Squares Line gave 202°.9 - 1°.17141 (T-2434308), period equal to $9^h\ 54^m\ 52^s.58$.

Of course, one will hardly question the superiority of the Least Squares calculation. It is encouraging, though, that the graphical procedure as practiced by experienced persons is here in such good agreement. As is known, the main difficulties in computing rotation-periods on Jupiter are in the proper identification of the features, often very difficult in an active current of the Giant Planet.

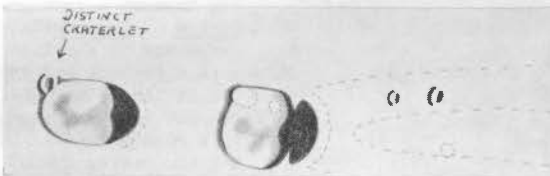



Figure 17. Drawing of Lunar Craters Messier and W. H. Pickering (or Messier A) by Elmer J. Reese on August 27, 1953 at $5^h$, U.T. 6-inch reflector, 350X. Seeing 5, transparency 4. Colong. = 120°.8, evening lighting. Inner east (IAU sense) wall of Pickering brighter than that of Messier.

*****

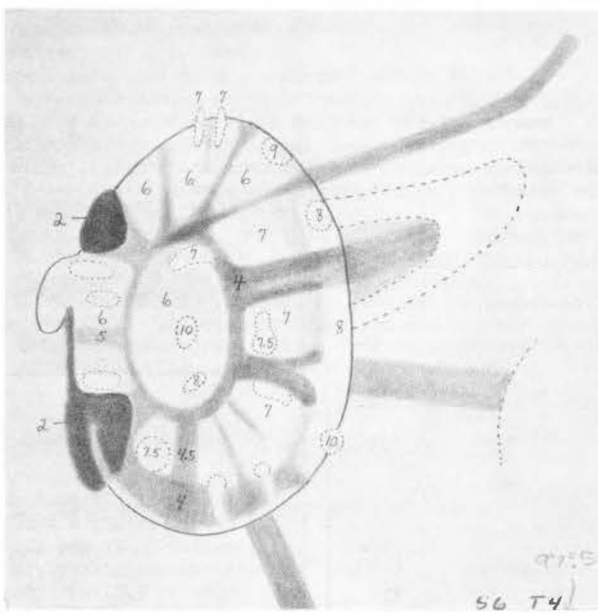



Figure 18. Drawing of Lunar Crater Aristarchus by Elmer J. Reese on December 18, 1956 at $3^h5^m$, U.T. 6-inch reflector, 240X. Seeing 6, transparency 5. Colong. = 97°.5. Dark wall bands and exterior bands well developed near Full Moon. The intensities marked on this drawing are on a numerical scale of 0 (shadows) to 10 (very brightest spots). The drawing is very similar to one Mr. Reese made on November 18, 1948 at colong. 111°.5.

*****

Lunar Eclipse of October 6, 1968. John E. Westfall observed this event from San Francisco and was apparently the only A.L.P.O. member to contribute a report. He estimated the eclipse luminosity to be 1 on the Danjon Scale - namely, "dark eclipse, gray or brownish coloration, details distinguishable only with difficulty". He employed the naked eye, binoculars, and a 4-inch refractor at 73X. Light winds somewhat handicapped the observations.

When observations began at $9^h37^m$, U.T., penumbral shading was definitely visible with eye, binoculars, and telescope. In the telescope first contact was estimated to occur at $9^h56^m$, U.T. A.E.N.A. gives $9^h55^m.2$, Ephemeris Time. A reddish tint developed on the Moon's west limb during the next 15 minutes; and Aristarchus remained visible as a pearly-white nebula-like spot after it entered the umbra. At $10^h36^m$, U.T. Dr. Westfall noted in the 4-inch refractor: "Aristarchus now only faintly visible, along with Tycho, Grimaldi, and the edge of O. Procellarum - no other umbral detail." A sketch at $11^h0^m$ shows the Moon to be dusky red in its approximate southeast half (east in I.A.U. sense), with a pearly-white zone about 12' wide between this region and the penumbrally illuminated northwest limb. Totality was observed to begin at $11^h9^m.7$, U.T.; A.E.N.A. gives $11^h 10^m.5$, E.T. At $11^h40^m$, near mid-totality, light clouds and dew condensations ended the observations.

Atmospheric Transparency and Colors in Nebulae. The following portion of a letter from Mr. William E. Crawley of Brownsburg, Indiana on July 26, 1970 may be of interest to

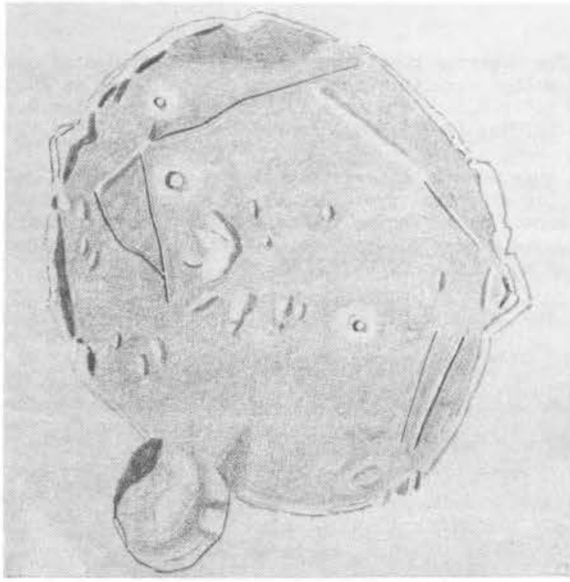


Figure 19. Drawing of Lunar Crater Gassendi by Alika K. Herring on December 15, 1956 at $5^h10^m$, U. T. 12.5-inch reflector, 220X. Seeing 6, transparency 3 to 0. Colong. = 62.°1. A morning view. Note two radial dark bands on the inner wall of Clarkson (or Gassendi A). Drawing incomplete because of failing transparency.

*****

many of our readers: "While leafing through a 1965 issue of The Review of Popular Astronomy I was surprised to see that someone with a 16-inch had reported colors in the Great Nebula of Orion, and the 'experts' had denied this observation as being impossible. During 1966-7 I regularly viewed a whole spectrum of colors (mostly maroons, lavenders, and violets) in this object from my lonely outpost in Texas where 11 members of the Pleiades could be seen with the unaided eye. The same 8-inch reflector revealed the arms of the Crab Nebula with startling clarity. Last year from the Ohio River Valley I could see neither of these phenomena with a 7.5-inch refractor at a time when only 6 members of the Pleiades could be detected with unaided vision. The 2.5-inch finder on the refractor showed the Ring Nebula with startling clarity, revealing both doughnut shape and gaseous center (very near the zenith), while a futile hour's search failed even to locate the object from the suburbs of Indianapolis with a 3-inch reflector."

New South Tropical Zone Disturbance. Mr. Elmer J. Reese of the staff of New Mexico State University Observatory has informed the Editor of the rapid development, in early August, 1970, of a large Disturbance in the STrZ of Jupiter. The longitude (II) was near 85° on August 14. Careful observations are strongly recommended. Mr. Reese would be particularly glad to learn their impressions of the new feature from experienced visual observers who studied STrZ Disturbances in the 1940's and 1950's. Such information can be a helpful supplement to intensive photography.

# *The Strolling Astronomer*

## SUBSCRIPTION RATES

| | |
|---|---|
| Single Issue (in stock) | $1.00 |
| 6 Months . . . . . . . . | 2.50 |
| 1 Year . . . . . . . . . . | 4.00 |
| 2 Years. . . . . . . . . . | 7.00 |

## SPECIAL MEMBERSHIPS

| | |
|---|---|
| Sustaining Members | $10 per year |
| Sponsors | $25 per year |

☆ ☆ ☆

## ADVERTISING RATES

| | |
|---|---|
| Full Page Display Ad.................. | $40.00 |
| Half Page Display Ad.................. | 22.50 |
| Quarter Page Display Ad........... | 15.00 |
| Classified or Listing (per col. in.) | 4.00 |

Discount of 10% on 3-time insertion.

☆ ☆ ☆

NOTICE: In order to facilitate the reproduction of drawings in future issues readers are requested to exaggerate contrasts on drawings submitted. Extremely faint marks cannot be reproduced. Outlines of planetary discs should be made dark and distinct. It is not feasible to reproduce drawings made in colors. Following these precepts will permit better reproductions.

## STAFF

EDITOR
Walter H. Haas
Box 3AZ
University Park, New Mexico 88001

SECRETARY
Atty. David P. Barcroft
Box 3AZ
University Park, New Mexico 88001

LIBRARIAN
Mrs. Walter H. Haas
2225 Thomas Drive
Las Cruces, New Mexico 88001

BOOK REVIEW EDITOR
J. Russell Smith
8930 Raven Drive
Waco, Texas 76710

MERCURY RECORDER
Richard G. Hodgson
Dordt College
Sioux Center, Iowa 51250

VENUS RECORDER
Dale P. Cruikshank
Institute for Astronomy
University of Hawaii
2840 Kolowalu St.
Honolulu, Hawaii 96822

MARS RECORDER
Charles F. Capen
223 W. Silver Spruce
Flagstaff, Arizona 86001

ASSISTANT MARS RECORDER
Thomas R. Cave
265 Roswell Ave.
Long Beach, California 90803

JUPITER RECORDER
Paul K. Mackal
7014 W. Mequon Road
112 North
Mequon, Wisconsin 53092

ASSISTANT JUPITER RECORDERS
Phillip W. Budine
101 Somerset Drive
Willingboro, New Jersey 08064

SATURN RECORDER
Thomas A. Cragg
Mount Wilson Observatory
Mount Wilson, California 91023

ASSISTANT SATURN RECORDER
Larry C. Bornhurst
Mount Wilson Observatory
Mount Wilson, California 91023

REMOTE PLANETS RECORDER
James W. Young
Table Mountain Observatory
P. O. Box 367
Wrightwood, California 92397

COMETS RECORDER
Dennis Milon
378 Broadway
Cambridge, Massachusetts 02139

LUNAR RECORDERS
Harry D. Jamieson
P. O. Box 30163
Cleveland, Ohio 44130

John E. Westfall
Department of Geography
San Francisco State College
1600 Holloway Avenue
San Francisco, California 94132

Clark R. Chapman
(Lunar Training Program)
Apt. 7, One Chauncy St.
Cambridge, Massachusetts 02138

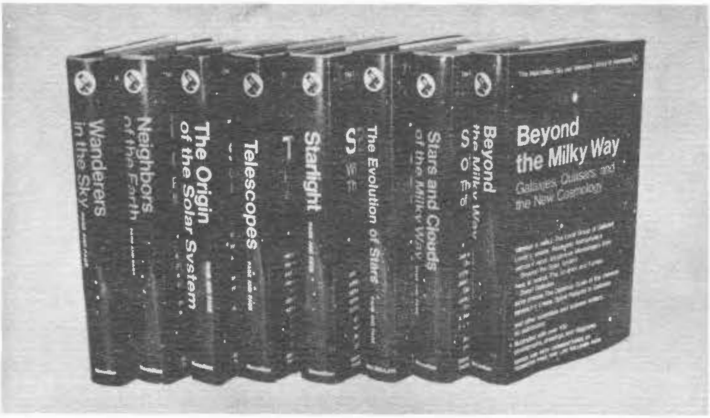
Kenneth J. Delano
(Lunar Dome Survey)
22 Ingell St.
Taunton, Massachusetts 02780

Charles L. Ricker
403 W. Park St.
Marquette, Michigan 49855

H. W. Kelsey
3439 Mono Drive
Riverside, California 92506

LUNAR LIBRATION CLOUD RECORDER
Walter J. Krumm
NASA, Office of Advanced Research and Technology
Mission Analysis Division
Moffett Field, California 94035

LUNAR & PLANETARY TRAINING PROGRAM
Clark R. Chapman
Apt. 7, One Chauncy St.
Cambridge, Massachusetts 02138




**Macmillan's *Sky and Telescope***

# Library of Astronomy

**Edited by Thornton Page and Lou Williams Page**

No effort has been spared to make these eight large volumes cogent to today's interests. Dr. and Mrs. Page have fashioned books that are truly hard to put aside.

Now you can own the complete Library of Astronomy. Fill in your set from this listing and have the most comprehensive coverage of modern astronomy. If you haven't started, the entire series of eight volumes is available at a special price, if ordered at the same time and sent to one address.

**Order B-M $57.50**

## BEYOND THE MILKY WAY: Galaxies, Quasars, and the New Cosmology.

More than 80 selections by 18 authors have been integrated into seven chapters that cover distances beyond the Milky Way; the structure and content of galaxies; evolution; peculiar galaxies; quasars; masses, luminosities, and models; cosmology. There are three appendixes, glossary, suggestions for further reading, and an index. 336 pages. 124 illustrations.

**Order B-8 $7.95**

## STARS AND CLOUDS OF THE MILKY WAY.

Over 40 articles explore our Milky Way galaxy. After an introduction, seven sections cover: 1, Stellar Distances; 2, Star Clusters and the Galaxy's Nucleus; 3, Rotation of the Galaxy; 4, Between the Stars; 5, Gas Clouds; 6, The Radio Galaxy; 7, Size and Structure of the Milky Way Galaxy. A special epilogue presents the late Otto Struve's "A Historic Debate About the Universe." The articles have been updated and connected with editors' commentaries to produce a unified whole. Popular yet thorough, this book also includes appendixes to help the reader: a brief chronology of astronomy through the ages, notes on the contributors, a glossary, and suggestions for further reading. 361 pages. 137 illustrations.

**Order B-7 $7.95**

## THE EVOLUTION OF STARS: How They Form, Age, and Die.

This popular volume in the Library of Astronomy contains articles by Bart J. Bok, Harlow Shapley, Otto Struve, G. P. Kuiper, Cecilia Payne-Gaposchkin, Donald H. Menzel, and 14 other authorities. In more than 80 articles (with about 100 illustrations) is told the life story of stars and how we have learned so much about them. A 27-page introduction sets the stage for eight sections: Inside the Sun and Stars; H-R and Color-Magnitude Diagrams; The Ages of Star Clusters; Star Formation; The History of Spinning Material; Stellar Explosions; Changes in Chemical Composition; Peculiarities in the Lives of the Stars. The editors' commentaries relate each entry to the overall picture of this important branch of astronomy. 334 pages.

**Order B-6 $7.95**

## STARLIGHT: What It Tells About the Stars.

Over 75 articles by Leo Goldberg, Annie J. Cannon, Gerard P. Kuiper, George Ellery Hale, Otto Struve, and other equally famous authors. In nine chapters we read how light brings us information about the sun and stars, their luminosities and spectra. Also discussed are variable stars and novae, magnetic and flare stars, doubles, clusters, the distribution of stars, and the galaxy. The editors have given essential connective explanations, selected 142 illustrations, and supplied a glossary, appendixes, a reading list, and an index. 337 pages.

**Order B-5 $7.95**

## TELESCOPES: How To Make Them and Use Them.

This 338-page volume answers the telescope maker's most important questions: What is the best telescope for me to build? How do I use it? What objects will it be most suited for? Covered in sequence are basic optical principles, early telescopes, making a reflector, mountings and drives, visual observations of the moon, planets, and stars, telescope accessories, and special-purpose instruments. The volume is rounded out with a tour of observatories and telescopes. 338 pages. 122 illustrations.

**Order B-4 $7.95**

## THE ORIGIN OF THE SOLAR SYSTEM: The Genesis of the Earth and Planets, and Life on Other Worlds.

Over 75 selections by 39 authors, arranged as follows: 1, Questions of Origin; 2, The Sun, Source of Energy and Control; 3, The Outer Layers of the Sun; 4, Our Earth as a Planet; 5, The Earth's Atmosphere — Viewed from Below and Above; 6, Evidence of the Origin; 7, The Growth of Cosmogony; 8, Other Life on Other Worlds. The appendixes are similar to those in other volumes. 336 pages. 115 illustrations.

**Order B-3 $7.95**

## NEIGHBORS OF THE EARTH: Planets, Comets, and the Debris of Space.

Some 100 selections by 38 contributors (including 10 by the late Otto Struve), arranged within the following chapters: 1, The Warmer Planets, Mercury and Venus; 2, Mars, Abode of Life?; 3, The Major Planets and Pluto; 4, Asteroids: Bits or Pieces?; 5, Comets, So Different from the Rest; 6, Meteors, Meteorites, and Meteoroids; 7, Atmospheres, Aurorae, and Exospheres; 8, The Debris of Interplanetary Space. There are over 130 illustrations in this timely volume. 336 pages.

**Order B-2 $7.95**

## WANDERERS IN THE SKY: The Motions of Planets and Space Probes.

More than 100 selections are arranged within the following chapters: 1, The Dawn of Understanding; 2, Newton's Mechanical System; 3, Recent Probing of Space; 4, The Hazards of Interplanetary Space; 5, Our Moon, a Big Satellite. The appendixes include a brief chronology of astronomy through the ages, notes on the contributors (43 in this volume), a glossary of astronomical terms, suggestions for further reading, and an index. 338 pages. Over 100 illustrations.

**Order B-1 $7.95**

All items sent postpaid. Please enclose your check or money order. Send for the Blue Book, a 32-page catalog describing SKY PUBLICATIONS.

SKY PUBLISHING CORPORATION
49-50-51 Bay State Road Cambridge, Massachusetts 02138