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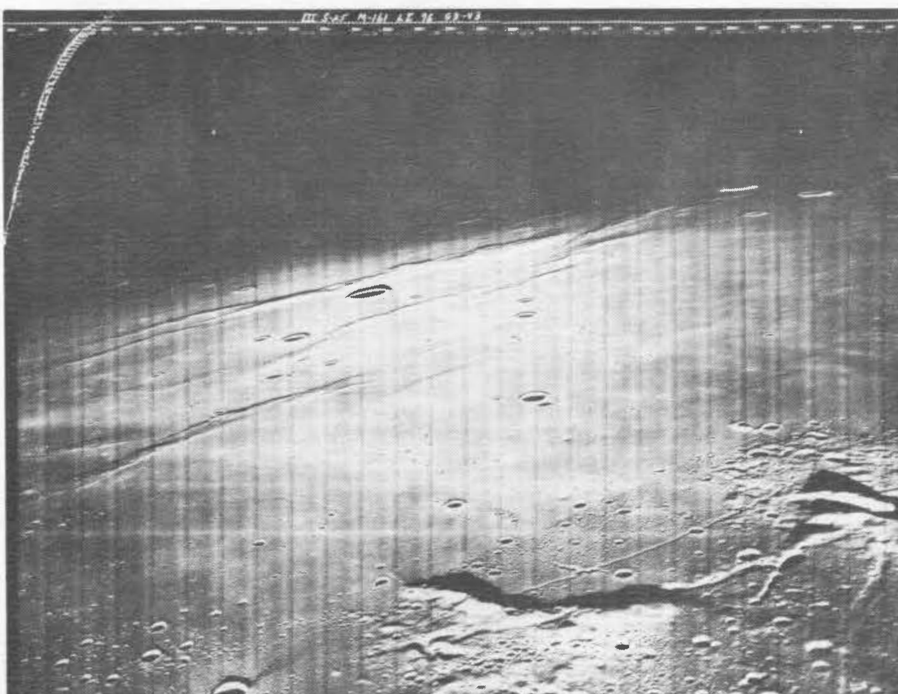

A wide-angle oblique view by Lunar Orbiter-III, looking west **(IAU sense)** toward the terminator (north is to the right). Area shown lies in Oceanus Procellarum. The partial ring Maestlin R is in the lower right; the triangle of craters in the upper right consists of Suess, Suess D, and Suess H. The length of the horizon shown is about 280 kms. (175 miles). Photograph 67-H-325, available for loan in the A.L.P.O. Lunar Photograph Library.

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IN THIS ISSUE

COMET IKEYA-SEKI 1967n MAGNITUDES

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

Observers will recall that Comet Ikeya-Seki 1967n was a binocular object near Polaris in March and April of 1968. Previous articles on this comet have appeared in the November-December, 1966 and January-February, 1967 issues of The Strolling Astronomer. These reports covered observations from discovery on December 28, 1967 through mid-April, 1968. After this time 1967n continued to fade as it headed for conjunction with the sun.

On April 28th, 1968 both Charles L. Ricker and Karl Simmons saw a short tail. In his 10-inch reflector Ricker spotted a stellar nucleus displaced to the northwest of the coma's center. Simmons had transparency near Sonoita, Arizona, that enabled him to see a star of magnitude 6.5 with the naked eye. Through a telescope he saw a fan-shaped tail 8' long. Most observers did not see any tail as the comet faded. By May 21st John Bortle could see little coma condensation, and the last pre-conjunction report was by Simmons on June 8th. After he located the comet only 15° above the horizon, the magnitude was 9.5 in his 8-inch, in agreement with brightness by Marsden on I.A.U. Circular 2054.

First to pick up the comet in the morning sky was Simmons on September 22nd, while Bortle found it at magnitude 12.5 on September 29th. Again using a 22-inch Maksutov, Bortle saw a 14th-magnitude stellar nucleus on October 22nd and 28th.

The original visual magnitude estimates from January 5th to May 26th are in the accompanying table on pg. 110. A late report from Darrell Conger, Elizabeth, West Virginia, gives these magnitudes: March 18.14, 7.1; March 25.11, 8.5; March 27.12, 8.2; March 28.08, 8.3; March 31.15, 8.2. Dates are in U.T. He used the SAO Catalog. The first estimate is with 7x50 binoculars; the others are with a 2.4-inch refractor.

For our graph (Figure 1) the tabulated magnitudes were corrected to a standard aperture of 2.67 inches in accordance with N. T. Bobrovnikoff's finding in the 1940's that a comet appears 0.17 magnitudes fainter per inch of increasing aperture. Then the daily averages were plotted by R. B. Minton at New Mexico State University Observatory.

The conclusion drawn from this graph (Figure 1) is that the light from Ikeya-Seki decreased from prediction in late March and continued about a magnitude faint for at least a month. The scatter in the graph is not very pretty. In order to obtain the most consistent magnitude estimates, I urge observers to set up telescopes at the darkest sky location possible. Although this circumpolar comet gave an excellent opportunity for all-night monitoring for short-period magnitude changes, none were reported. Visual magnitudes from these observers were used for the graph:

Carl Anderson, 40 Magnolia Rd., Manchester, New Hampshire 03104.
John Bortle, 642 Locust St., Mount Vernon, New York 10552.
Robert Buecher, SUPO 10462, Tucson, Arizona.
Charles Capen, Box 367, Wrightwood, California 92397.
Kenneth Delano, 22 Ingell St., Taunton, Massachusetts 02780.

Edgar Everhart, Mt. Hope Road, Mansfield Center, Connecticut 06250.
Forster*.
Bill Grady, 745 Willey St., Morgantown, West Virginia 26505.
Heiser*.
Kasten*.

Randy Lambert, 2532 Mark Dr., Mesquite, Texas 75149.
Leitmeier*.
Lukas*.
Russell Maag, 1601 Blackwell Rd., St. Joseph, Missouri 64505.
Vic Matchett, Box 14, North Brisbane, Queensland 4000, Australia.

Michael McCants, 1007 W. 26th, Apt. 110, Austin, Texas 78705.
Richard McClowry, 177 Beale Rd., Sarver, Pennsylvania 16055.
Tom Middlebrook, 815 Norma St., Nacogdoches, Texas 75961.
Martin Miller, 43294 Road 120, Orosi, California 93647.
Dennis Milon, 378 Broadway, Cambridge, Massachusetts 02139.

R. B. Minton, P. O. Box 443, Mesilla Park, New Mexico 88047.
Thomas P. O'Hara, 1924 Beechwood Ave., Fullerton, California 92631.

Comet Ikeya-Seki 1967n Visual Magnitudes

1968 UT	Date	Observer	Aperture	Mag.	
Jan.	5.45	Everhart	11"2	9.5	
	6.46	Bortle	6"	8.8	a
	6.69	Capen	2	9	
	7.07	Pacholka	8	9.5	b
	9.45	Bortle	6	8.5	a
	12.46	Bortle	6	8.6	a
	12.53	Minton	8	9.0	c
	13.49	Middlebrook	8	9.5	b
	13.51	McCants	10	9.1	c
	14.48	Rimes	6	8.5	e
	14.52	Pacholka	8	8.5	a
	14.58	Capen	2	8	
	17.49	Maag	6	9.1	
	18.56	Buecher	4.2	8.6	c
	18.58	Pacholka	8	8.4	c
	19.45	Bortle	6	8.5	a
	20.50	Maag	6	8.7	
	21.50	Maag	8	8.3	
	22.40	Anderson	10	8.1	d
	22.41	Smith	6	8.4	a
	22.45	Bortle	2	7.7	a
	24.66	Pacholka	8	8.5	c
	25.47	McCants	10	8.8	c
	25.55	Simmons	4.2	8.6	c
	25.56	Buecher	4.2	8.4	c
	26.48	Rimes	6	8.4	e
	26.49	Middlebrook	8	8.1	a
	27.35	Smith	6	8.5	a
	27.38	Anderson	10	8.0	d
	27.45	Bortle	2	7.7	a
	31.55	Simmons	4.2	8.5	c
	31.56	Buecher	4.2	8.3	c
Feb.	1.22	Leitmeier	3.1	8.3	
	1.55	Buecher	4.2	8.3	c
	2.20	Ruhnow	2.5	7.5	
	2.47	Middlebrook	8	8.2	a
	2.48	Rimes	4.2	8.3	e
	2.54	Buecher	4.2	8.1	c
	3.22	Ruhnow	2.5	7.8	
	3.33	Ranson	8	7.7	e
	3.46	Middlebrook	8	8.0	a
	3.48	Rimes	4.2	8.3	e
	3.54	Simmons	4.2	8.3	c
	4.38	Wooten	2	7.3	e
	5.45	Bortle	2	7.7	a
	6.46	Middlebrook	8	7.8	a
	7.24	Matchett	12	8.8	c
	7.44	Bortle	2	7.7	a
	7.35	Grady	2.4	8.3	c
	8.19	Ruhnow	2.5	8.7	
	8.21	Lukas	2	8.7	
	8.48	Rimes	4.2	8.1	e
	8.56	Buecher	4.2	7.9	c
	9.21	Leitmeier	2	7.3	
	9.48	Rimes	4.2	7.9	e
	16.44	Bortle	2	7.6	a
	17.17	Ruhnow	2.5	8.0	
	19.20	Leitmeier	3.1	7.5	
	20.46	Rimes	4.2	7.6	e
	20.48	Buecher	4.2	7.4	c
	20.52	Simmons	4.2	7.5	c
	21.15	Ruhnow	2.5	8.0	
	23.42	Delano	1.6	7.5	a
	24.36	Simmons	12.5	7.3	c
	24.46	Rimes	4.2	7.5	e
	25.46	Rimes	4.2	7.5	e
	26.17	Ruhnow	2.5	7.8	
	26.18	Lukas	2	7.0	
	26.24	Anderson	10	7.5	f
	26.41	Delano	1.6	7.5	a
	26.44	Bortle	2	7.5	a
	26.46	Rimes	4.2	7.4	e
	26.99	Kasten	3.1	7.5	
	27.44	Rimes	4.2	7.4	e
March	1.17	Ruhnow	2.5	7.4	
	1.17	Lucas	2	8.0	
	1.42	Rimes	4.2	7.2	e
	1.99	Kasten	3.1	7.5	
	2.99	Kasten	3.1	7.5	
	3.02	Wedel	12	8.3	
	3.10	Schumacher	5	6.7	
	3.16	Heiser	2	7.0	
	3.22	Lucas	12	7.7	
	3.22	Wedel	12	8.0	
	3.33	O'Hara	6	6.9	e
	4.41	Delano	1.6	7.6	a
	4.42	Bortle	2	7.3	a
	6.40	Buecher	4.2	7.2	c
	6.52	Minton	4.2	7.2	c
	7.22	Delano	1.6	7.5	a
	7.93	Forster	3	7.0	
	8.43	Bortle	2	7.1	a
	12.33	Delano	1.6	7.6	a
	14.42	Bortle	2	7.0	a
	15.17	Delano	1.6	7.5	a
	18.32	Buecher	4.2	7.2	c
	19.25	Minton	4.2	7.4	c
	20.05	Bortle	2	7.0	a
	20.13	Wooten	2	7.2	c
	22.31	Buecher	4.2	7.1	c
	23.29	Simmons	4.2	7.5	c
	23.30	Buecher	2	7.5	c
	24.17	Bortle	2	7.2	g
	24.17	Ranson	8	7.5	c
	24.19	Lambert	6	7.4	e
	24.21	Simmons	2	7.6	c
	25.02	Delano	1.6	8.0	a
	25.04	Milon	4	8.5	c
	25.16	Buecher	4.2	8.7	c
	25.17	Bortle	2	7.3	g
	25.06	Delano	1.6	7.9	a
	26.15	Bortle	2	7.5	g
	26.18	Simmons	4.2	8.8	c
	26.67	Buecher	4.2	8.5	c
	27.22	Simmons	4.2	8.8	g
	28.04	Delano	1.6	7.9	a
	28.10	Milon	4	8.7	g
	28.16	Bortle	2	7.6	g
	28.22	Simmons	4.2	8.7	g
	29.23	Simmons	4.2	9.8	g
	30.23	Simmons	4.2	10.3	g
	31.05	Delano	1.6	7.9	a
	31.12	Milon	1.4	7.4	g
	31.14	Simmons	4.2	8.2	g
	31.15	Milon	6	8.1	g
	31.18	Bortle	2	7.7	a
	31.26	Milon	1.4	7.4	g
April	2.07	Smith	2	8.1	g
	2.08	Delano	1.6	7.9	a
	2.17	Bortle	2	7.7	g
	2.20	Simmons	4.2	9.4	g
	2.24	Minton	4.2	8.5	c
	3.14	Milon	4	9.0	g
	4.05	Bortle	2	7.7	g
	4.17	Simmons	4.2	9.9	g
	5.16	Simmons	4.2	8.8	g
	6.16	Simmons	4.2	9.2	c
	6.17	Delano	1.6	8.0	a
	6.21	Milon	4	8.9	g
	6.25	Simmons	4.2	9.5	c
	7.12	Simmons	4.2	9.4	g
	8.06	Bortle	6	8.6	g
	8.25	Simmons	4.2	9.1	g
	9.20	Simmons	4.2	9.8	c
	10.05	Bortle	2	7.7	g
	10.05	Bortle	6	8.2	g
	13.20	Bortle	2	8.0	g
	13.20	Smith	6	8.9	g
	13.22	Millar	6	7.5	c
	13.24	Milon	4	9.2	c
	15.08	Bortle	2	8.1	g
	15.19	Simmons	4.2	9.3	c
	18.10	Delano	1.6	8.3	a
	18.17	Simmons	4.2	9.4	c
	19.31	Simmons	4.2	9.3	c
	20.14	Simmons	4.2	9.4	c
	22.12	Simmons	4.2	9.1	c
	23.13	McClowry	6	8.5	
	24.14	Simmons	4.2	9.8	c
	24.31	Simmons	4.2	9.6	a
	25.14	Simmons	4.2	10.0	a
	26.06	Delano	1.6	8.4	a
	26.15	Simmons	4.2	10.0	a
	28.14	Ricker	4.2	8.9	a
	28.14	Simmons	2	8.5	a
	29.06	Delano	1.6	8.4	a
	29.14	Simmons	4.2	9.8	a
May	4.15	Simmons	4.2	10.2	a
	7.08	Bortle	2	8.8	a
	16.16	Delano	12.5	9.5	a
	19.18	McCants	10	10.2	c
	20.20	Miller	6	8.7	c
	21.08	Bortle	6	9.5	a
	22.17	Simmons	4.2	10.2	a
	23.16	Simmons	4.2	9.2	a
	24.16	Simmons	4.2	10.2	a
	26.15	Simmons	4.2	9.2	a

a. AAVSO charts
b. Atlas Eclipticalis
c. SAO Catalog
d. Compared to M10, M12
e. Skalnate Pleso Atlas
f. Compared to M13, M92
g. Magnitudes and Colors of Stars North of +80° by Seares, Ross, and Joyner

Table of A.L.P.O. visual estimates of integrated stellar magnitude of Comet Ikeya-Seki 1967n. See also text of accompanying article by Dennis Milon. These tabulated values are plotted in Figure 1, corrected for an aperture effect.

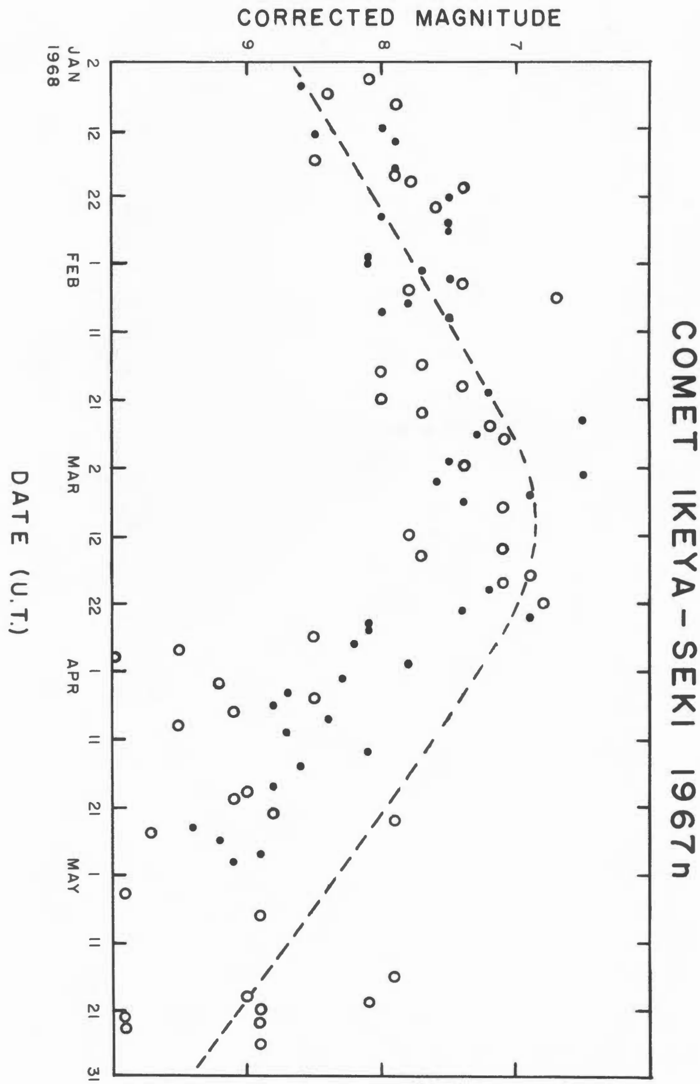

Figure 1. Graph of A.L.P.O. visual magnitude estimates of Comet Ikeya-Seki 1967n. Graph drawn by R. B. Minton of New Mexico State University Observatory. All magnitudes have been corrected to a standard aperture of 2.67 inches. The plotted points are daily averages, with an open circle for a single observation and filled dark circles for means of two or more observations. The dashed curve is the predicted magnitude given by Brian Marsden on I.A.U. Circular 2054. The observations show a fading of the comet in late March, 1968.

Walter Pacholka, 4836 Pimenta, Lakewood, California 90712.
Chris Ranson, 1706 W. Davis, Apt. A, Dallas, Texas 75208.
Charles L. Ricker, 403 West Park St., Marquette, Michigan 49855.
Logan Rimes, 2007 La Monte, Houston, Texas 77018.
Ruhnow*.

Schumacher*.
Karl Simmons, 4238 Springwood Rd., Jacksonville, Florida 32207.
Douglas Smith, Rt. 2, Box 275, Vinton, Virginia 24179.
Bernhard Wedel*.
Wayne Wooten, Rt. 4, Box 90, De Funiak Springs, Florida 32433.

*Sent by A. Kunert, Wilhelm Foerster Observatory, 1 Berlin 41, Munsterdamm 90, West Germany.

Reference

N. T. Bobrovnikoff, "Observation of the Brightness of Comets", Popular Astronomy,

Figure 2. Photograph of Comet Ikeya-Seki 1967n on February 25, 1968 at 12^h0^m, Universal Time by J. D. Wiseman, Jr. of Portland, Oregon. North is at the top. A tail about 25' long curves to the right. The comet lay between 69 Herculis (left) and Pi Herculis (lower right) and had a total magnitude of $7\frac{1}{2}$. Mr. Wiseman used a cooled emulsion camera and Tri-X film for this 9-minute exposure with his 10-inch, F:4.6 reflector. Photograph courtesy Sky and Telescope magazine.

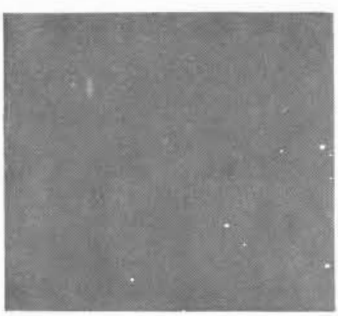

Figure 3. Photograph of Comet Ikeya-Seki 1967n by Eric Thiede of Madison, Wisconsin on March 4, 1968 with a 15.5-inch, F:15.5 refractor. The motion of the comet is evident on this 5-minute exposure.

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Vol. 49, No. 467, 1941.

Other Bobrovnikoff papers upon the aperture effect in brightness estimates of comets were cited by Dennis Milon in Str. A., Vol. 20, Nos. 11-12, pg. 206, lines 4-5, 1966.

EVERHART'S STUDY OF COMET DISCOVERIES

By: John E. Bortle

Dr. Edgar Everhart is the author of "Comet Discoveries and Observational Selection", published in The Astronomical Journal, Vol. 72, No. 6, August, 1967. A professor of physics at the University of Connecticut, Everhart is known for his sweeping which has netted two comets in recent years. Pictures of his search telescopes are in The Strolling Astronomer, January-February, 1965, page 2, and November-December, 1966, pages 196 and 197. This article is a condensation of Dr. Everhart's report, usually direct quotations from The Astronomical Journal article, prepared for ALPO members. It is worth noting that professional astronomers think that comet searching is one of the most worthwhile activities for an amateur.

Recommended Equipment

By actual count, 98% of the 19th century long-period comets and 74% of those of the 20th century were found either visually with small telescopes, or with the naked eye. Of course, some of these discoveries were accidental; but a study of the word descriptions and a count of the men with several discoveries to their credit indicates that at least 204 comets of the 337 discovered were found by men actively engaged in comet sweeping with small visual telescopes. In the case of photographic discoveries, only 13 comets of those so found remained too faint ever to be seen visually in a comet seeker.

To be useful in visual comet sweeping, there is a practical maximum aperture and power. These limits are close to 10 inches and 40X. In order to provide maximum field and yet keep the exit pupil adapted to the observer's eye, the power must be about 4X the aperture in inches. Thus a 4-inch telescope should operate at 16X, a 10-inch at 40X, a 20-inch at 80X, etc. However, a 20-inch telescope at 80X would be completely impractical. From experience, the author estimates that such a 20-inch telescope cannot sweep a 15° sector of the sky and keep up with the diurnal motion. With a 10-inch at 40X it is possible to sweep a section of sky 45° by 45° in two and one-half hours of time, and with a 4-inch at 16X half the sky above the horizon can be examined in a few hours.

Being extended objects, comets are not so easily seen as are stars of the same magnitude. Their visibility in a telescope should depend on their magnitude, their apparent angular size after magnification, the brightness of the sky background as seen in the eyepiece field, the contrast threshold of the eye at that illumination level, and a factor depending on the rapidity with which the observer sweeps the field. Everhart has found that it is easier to see a 13.0-magnitude galaxy known to be in the center of the field of view than it is to notice an unexpected 12.0-magnitude galaxy which crosses the field in two seconds as the telescope is swept along.

Nonetheless, it is possible to be reasonably quantitative in predicting the minimum magnitude visible. Computations were made assuming an aperture of 10 inches and a magnification of 40X. (The computations are repeated for a 4-inch telescope at 16X.) Characteristically, the limit reaches about 13th magnitude where Δ (distance from earth) is large and the comet's image is small. When the comet is near earth, its angular size is larger and its light less concentrated. The limiting magnitude decreases, sometimes by several units for a comet passing near the earth.

The calculations of the limiting magnitude were repeated for a 4-inch telescope at 16X. The difference, compared with a 10-inch, 40X telescope, was about one magnitude, sometimes less. The faintest visible magnitude for extended objects does not vary with aperture in the same way as it does for stars. The surface brightness both of the comet and of the sky is the same as seen in a 10-inch telescope at 40X as it is in a 4-inch telescope at 16X. The reason that the 10-inch telescope is better by about a magnitude is that the image is larger: the eye can detect large images at lower contrasts than it can small images.

Where to Look

An important time in Everhart's study is that at which the comet was first discovered. Here 53% of the direct, and 69% of the retrograde comets were found in the morning sky. "This is not a selection effect", says Everhart. "I refuse to believe that the asymmetry occurs because the morning sky is more carefully swept than the evening sky. In the morning sky there is, moreover, a clustering of discovery positions near the sun, but no such effect in the evening sky."

Another critical time is ordinarily earlier than the discovery time. This is the time at which the comet first became "discoverable". It is the time when the stellar magnitude first equaled that of the faintest observable comet at the comet's position. Here is seen a startling preference for the morning sky (70% direct, and 81% retrograde).

Everhart's first thought to explain these facts was that perhaps the motion of the earth and of the average comet are such that the comet spends more time while observable in the morning sky than in the evening sky before perihelion. Analysis of the data showed only a slight effect, not nearly large enough to account for the observed percentages.

Next, a visual inspection was made of the many plots; and this step suggested an explanation: the magnitude curve rises less steeply before perihelion when the comet is in the evening sky and more steeply when the comet is in the morning sky. In the morning sky

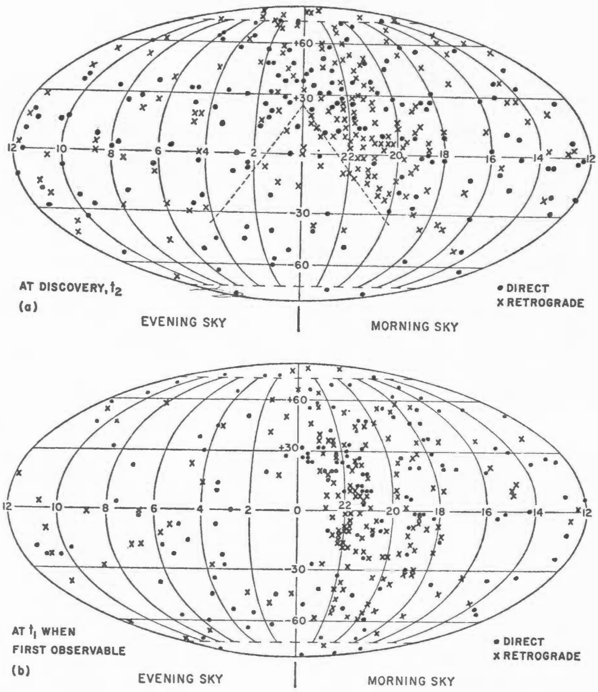

Figure 4. Two diagrams reproduced from The Astronomical Journal to illustrate Mr. Bortle's article on Dr. Everhart's report. In the top diagram we have the discovery positions of 337 long-period comets. The two dashed lines are the evening and morning horizons with the sun at -18° declination for an observing station at 40° north latitude. The bottom plot shows the positions at which these same comets could have been first seen with a 10-inch telescope at 40X. In both plots strong clustering in the morning sky is evident.

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the motion of the earth is, on the average, carrying it towards the comet, particularly for retrograde comets. Then and r (distance from sun) are both decreasing, and the magnitude changes rapidly with time. On the other hand, before perihelion in the evening sky the earth is, on the average, moving away from the comet. Then increases while r decreases, and the magnitude changes less rapidly with time.

In conclusion, it may be said that the morning sky is deserving of particular attention by those who would find comets. Observers may also be interested in the following statistics obtained from data stored on tape: at any given time there was (in the last 127 years) a 50% probability that there was an observable comet somewhere in the sky which was later discovered. Sometimes, of course, the comet may be below a particular observer's horizon; but for an observer at 40° N. latitude there was a 33% probability at any given time. This result may be further subdivided as 11% for his evening sky and 22% for his morning sky. These percentages are for a 10-inch seeker used at 40X. They become about 0.6 as great for a 4-inch telescope at 16X.

RATIONALE AND PROCEDURES FOR A JOVIAN RANK AND COLOR REPORT

By: Paul K. Mackal, A.L.P.O. Assistant Jupiter Recorder

The wide variations in intensity observations made by different observers of Jupiter of an identical section of a belt, a zone, or a component at the same time with similar instruments and good seeing have been thought largely to result from two factors: (1) different contrast sensitivity between observers, and (2), personal equation affecting light sensitivity and variability between observers. Added to these is another factor which has not been considered, the memory factor. Here is how it arises--an observer compares one intensity to another by utilizing his memory to compare a recalled light sensitivity with a certain numerical value which has been applied to it. The result may be to overestimate the value of the segment (or feature) or to underestimate it, more so than would ordinarily be the case if objective contrast difference over time elapsed and personal equation were the sole factors involved. This tendency applies to all past observations as well. Both the recalled intensity and the new intensity can be overestimated or underestimated; or the recalled intensity may be overestimated whilst the new one is underestimated, or conversely. This spiral of error accumulates over time and is definitely random in character!

This memory factor accounts for a rather small deviation compared to the non-random personal equation. Personal equation is a larger deviation which may be corrected as a constant value to be applied to each observer. It more or less dampens out the random memory factor when each observer's intensity results are charted separately. When we combine the work of many observer's sets of values, we discover that the cumulative effect of the individual memory factors makes it virtually impossible to correct the chart for random variations. The reason is that the one unknown we are looking for on the chart (intensity variation) may be confused with the random variable competing with it.

With this background, we must face the fact that the observer is not so accurate a photometer as we may have hoped in the past--especially for very small intensity values or very small intensity changes. I have found that a ten by ten step scale for Jupiter (1 through 10, with decimals at one-tenth intervals) is much too difficult to apply consistently for a group of observers. (I compared intensity observations by five A.L.P.O. observers of good repute in the Jupiter Section in 1962.) A ten step scale for Jupiter using small aperture telescopes (6-inch to 12-inch reflectors) is just precise enough not to worry about the random memory factor. (As the number of observers increases, further adjustments are necessary, however.) More concerted studies are in order to verify this conclusion, of course.

A more ideal scale could be devised, but the one unfortunate fact about all such intensity scales for analysis is the arbitrary way in which each step is defined. A better analytical approach entails the use of a rank scale rather than an intensity scale. By a rank scale I mean a comparison of the belt, zone, or component with other belts, zones, or components with appropriate notations on an observing sheet, listing their respective order of darkness or brightness. This process is less precise than the ten step scale but is still accurate enough to indicate major changes in the segments of the belts, zones, and components of Jupiter over time and space. Intensities may be easily converted to these ranks also.

The need for a procedure of presenting the ranks thus collected for a given apparition is by no means simple. Figure 5 shows the plan I recommend. The first order of concern is the separation of the data into periods of time, and this will constitute the vertical axis of a rank report chart. The second order of concern is the separation of the data by longitudes across the disc of Jupiter, taking into account the drift of the belt (zone or component) at any particular point based on the rotation period(s) of spot(s) in that region at about the same time. This will constitute the horizontal axis of the chart. Each chart will be confined to a single belt, zone, or component of a belt. The longitude will be System I or System II, according to convention. A schematic line of the belt, the zone, or the component will be drawn horizontally across the chart for the appropriate date when observations of rank were made over certain longitudes. The individual rank observation made at a particular moment will be placed over certain longitudes which these values have been perceived to cover (plus or minus 30°, I or II, in longitude from the central meridian at the time of observation).

There is no adjustment for drift of the top line on Figure 5 since it constitutes the time base. For each successive line, the rate of drift will be signified by slant lines which connect the various parts of the chart. Thus a point at the same longitude after a month or so will not be related to another rank directly above it or below it but instead to that rank which is on the drift line intercept.

The goal of such a procedure for presentation of ranks is to be able to distinguish the variation of rank due to rotational displacement from the variation of rank due to short term reversible changes of intensity for a given segment (or feature). With regard to belts we may see warmth coming into the belt all of a sudden, trace its movement for as long as it exists at a particular value, note its changes of value and its expansions and contractions over longitude, and even see it cool off and possibly fade away. With regard to zones, we may trace the origin of some obscuring patch, its movement and expansion, contraction and dissipation, or reintensification. All of these variations may be separated into vital changes and drifting changes, the former not to be confused with the latter. Likewise, vital and drifting color changes may be noted using a similar set of charts for each belt, zone, or component.

Postscript by Editor. In the next article Mr. Clark Chapman develops a somewhat different point of view toward the general subject discussed above by Mr. Mackal. At the end of Mr. Chapman's paper the Editor will offer a few comments on the two papers considered together.

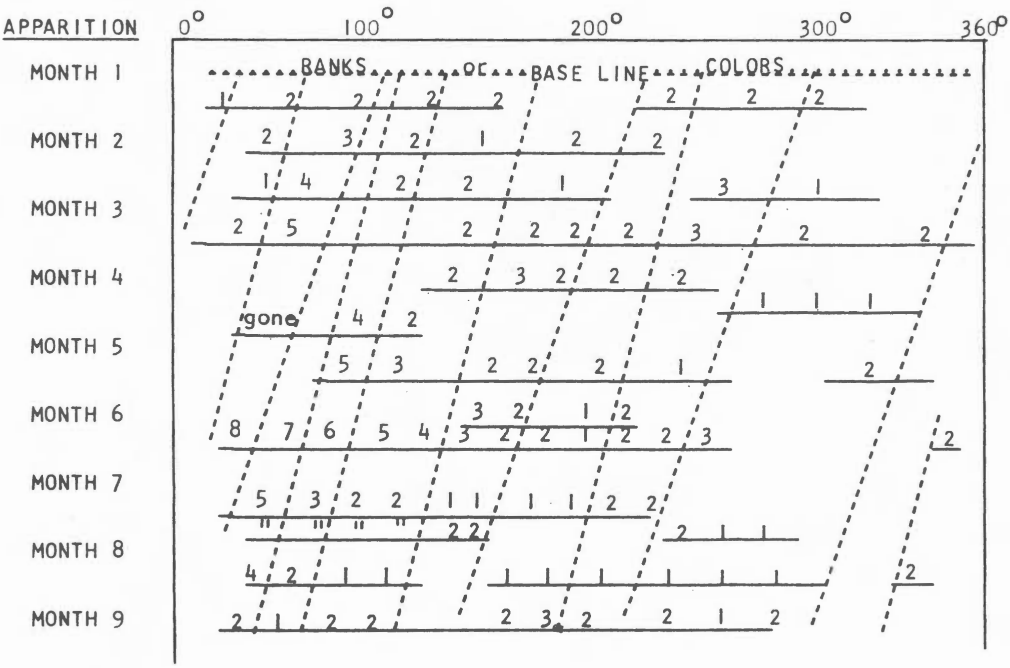

Figure 5. Sample chart prepared by Mr. Paul K. Mackal to illustrate recommended method of reporting observed ranks and colors of a Jovian belt, zone, or component. See also text of his paper, pg. 115. For each belt, zone, or component date of observation is plotted against longitude in System I or System II, whichever one applies.

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INTENSITY ESTIMATES AND A SEEING SCALE: COMMENTS ON A PAPER BY PAUL K. MACKAL

By: Clark R. Chapman

Paul K. Mackal has written an interesting paper entitled "Rationale and Procedures for a Jovian Rank and Color Report". In the past, visual intensity estimation has not been very carefully considered, and Mackal's contribution is welcome. He discusses the problems of the standard 0 to 10 intensity scale, and finds them numerous. He suggests that a fully adequate alternative is simply to rank the belts or zones in relative order, and he proposes a straightforward manner in which to plot such rankings and analyze them.

I wish to write in defense of the standard intensity scale (with appropriate qualifications), though I wish to make it clear that I have no quarrel with the use of rankings <u>in addition</u> to regular intensity estimates. Mackal is certainly correct that the problems of standardizing intensity estimates are severe, and that if estimates are not fully reduced (as they have not been in the past), then they yield information no better than the rankings Mackal proposes. But it <u>is</u> possible to obtain much more information from intensity estimates.

Of course, intensity estimates themselves are (and always have been) relative, not absolute. The human eye cannot gauge absolute intensities to within a factor of ten or worse (the eye is made this way so we can see in both daylight and in the light of the full moon, nearly a million times fainter). Use of the 0 to 10 intensity scale always requires a stated or implied standard. De Vaucouleurs (in Appendix II of <u>Physics of the Planet Mars</u>, which is <u>must</u> reading for anyone interested in visual photometry of the planets) uses three standards: the sky background, the mean brightness of the deserts, and the brightness of the typical polar cap. There is an implicit standard operating in the case of Jupiter as well. There is no hope through visual methods alone -- whether by ranking or by numerical intensity estimation -- to gauge long-term or short-term changes in the intensities of Jupiter's belts, <u>except in relation to each other</u>.

Estimating ranks is very simple compared with giving numbers to the relative intensities. And in many cases (e.g., for belts which are roughly similar in intensity) it is fully as adequate as making intensity estimates; in fact, in such cases the observer had best rank the belts before writing down intensities. But in other cases, it is not adequate. For instance, Mackal's figure is (unfortunately) unrealistic. In recent years, the N.E.B. has always been the darkest (or at least most prominent -- the distinction will be discussed later) Jovian belt in all longitudes. Hence the same belt would not likely have rankings 1, 2, 3, 4, 5, 6, 7, 8, and "gone" all in the same year -- in fact, it could well have rank 1 at all longitudes throughout the year, even though there were noticeable differences or changes in its darkness (e.g., varying from just darker than the 2nd ranking belt to <u>much</u> darker).

The appropriate method for reducing intensity estimates on the 0 to 10 scale is discussed at length in the A.L.P.O. Observing Manual (unfortunately still unpublished). Briefly, observers suffer from a personal equation (which is not static, but can vary with time as influenced by such factors as memory, as Mackal discusses), which can be reasonably accurately approximated by two parts: (1) a centering error, and (2), a scale error. A centering error is a tendency for an observer to record all intensities systematically too high or too low relative to other observers. A scale error is a tendency for an observer to record low intensities too low but high intensities too high (or low too high, and high too low). Provided that many observers make many intensity estimates, it is possible to correct individual estimates for these systematic personal equations, and the corrected estimates show surprisingly little scatter (Chapman, 1962). I urge that observers continue making such estimates and that the Recorders attempt complete reduction. The eye <u>is</u> a good relative photometer, as those in the AAVSO have long appreciated.

It is pertinent to remark here on the difference between the "prominence" of a belt or zone and its "intensity", and also to distinguish the <u>apparent</u> relative intensity from the <u>true</u> relative intensity. The ease with which a belt or zone may be seen (its prominence) is a function of its <u>size</u> as well as its <u>contrast</u> with neighboring regions. A ranking of belts or zones by prominence may well be interesting (they are the simplest rankings of all and may provide the best check upon relative changes in the appearance of Jupiter from year to year) but is <u>not</u> the same as a ranking by intensity (darkness or albedo). An intensity ranking or intensity estimate must, of necessity, refer to the <u>apparent</u> intensity, which is different from the true intensity -- especially for narrow belts or small spots -- because of smearing due to seeing and the inherent resolving limit of the telescope. Since different observers make rankings or intensity estimates under differing seeing conditions and with differing apertures, it is <u>imperative</u> that corrections be applied to such observations to obtain the <u>true relative</u> intensities (the physically meaningful quantity). This is quite straightforward (and is also discussed in the A.L.P.O. Observing Manual) but <u>requires</u> an objective estimate of the seeing which gives the true resolution or <u>effective aperture</u> of the telescope during the observation.

For this reason I urge the adoption by all A.L.P.O. Observing Sections of the following method of estimating the seeing (first discussed by Giffen, 1963, and in greater detail in the Observing Manual): (1) First determine your personal constant called the <u>ideal resolution for a one-inch aperture</u>. (This value need be checked only every few months and should be measured on nights of very good seeing.) Stop the telescope down to a one-inch aperture (off-axis so that the secondary is not in the way), and note the separation of the closest double star you can resolve. This is your personal constant, <u>r</u>. (Alternatively you can find the diameter of the smallest lunar crater you can see; then your personal constant is its diameter, <u>d</u>, perhaps expressed in kms. Any other high-contrast feature of well-known angular size or separation, such as Cassini's Division, can be used in a similar fashion.) (2) During <u>each</u> observation measure a second quantity called your <u>actual resolution</u> <u>R</u> (or D), which is obtained by the same technique described above, using the same standard and <u>using full aperture</u>. Then the <u>effective aperture</u> D* is given by D* = r/R (or d/D, etc.). This quantity D* should be entered as the <u>seeing</u> for every observation. (3) After considerable practice in measuring the effective aperture by step 2, you should develop the ability to estimate it from previous experience merely by examining the steadiness and sharpness of the image you are observing (as in estimating the old 0 to 10 seeing). So while measuring the effective aperture by step 2 may be time-consuming during the first few months, the measuring technique can be dispensed with later on (except for occasional checks). An estimate of the <u>effective aperture</u> and an estimate of the <u>transparency</u> (T_r = limiting magnitude for person with normal eyesight, except when there is extraneous moonlight or twilight) should accompany every observation. Otherwise visual photometry of all except the very largest planetary features is meaningless.

In closing, I might remark that Paul Mackal's chart method of presenting rankings (applicable also to intensity estimates and color estimates) is excellent, and I hope to see it employed in future A.L.P.O. Jupiter Reports. However, let us not give up estimating intensities on the 0 to 10 scale. Let's just estimate ranks in addition.

References

Chapman, C. R., 1962, "The 1961 A.L.P.O. Simultaneous Observation Program--First Report", Str. A., 16 (3-4), pp. 56-69.

Giffen, C. H., 1963, "Foundations of Visual Planetary Astronomy", Str. A., 17 (3-4, 5-6), pp. 59-72, 113-120.

Postscript by Editor. We would cordially invite interested readers, but particularly experienced observers of Jupiter, to comment on the two preceding papers by Messrs. Mackal and Chapman. We are at all times anxious to improve (or replace) our estimates of numerical intensities on the surface of Jupiter and also to make our estimates of the seeing more meaningful. These goals will be attained better if we may have the benefit of constructive group discussion, and policies adopted will mean nothing if they are not supported by an informed membership.

If I may offer a few thoughts to initiate such discussion, I would recommend the continuation of numerical intensity estimates on a 0 to 10 scale and the regular making of rank estimates to supplement them. It is, of course, the estimated intensities, and not ranks, which contain potential physical meaning about Jupiter. More information about random and systematic errors in visual estimates of intensities on Jupiter might be obtained by planned group-studies of Jupiter at pre-selected dates and times, or perhaps also by studies of artificial discs. I would certainly encourage experimentation in using the method of estimating the seeing described by Mr. Chapman but would have reservations at the moment about how much seeing estimates can be improved thereby. In a view of Jupiter I shall ordinarily have no knowledge of the exact angular dimensions of any of the surface features near the limit of resolution. If I do not wish to use double stars or lunar craters to estimate R, and if I falsely assume a Jovian spot actually 1".0 in diameter to be 0".6 in diameter, the numerical effect on the computed "effective aperture" will be considerable.

The two authors and the Editor would like to have your ideas!

ADDITIONS TO THE A.L.P.O. LUNAR PHOTOGRAPH LIBRARY:

ORBITERS II, III, AND IV AND SURVEYOR III.

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

(manuscript received in July, 1967)

Introduction

This latest contribution by N.A.S.A. to the A.L.P.O. is rather sizeable--150 photographs in all, distributed as follows: 4 from Lunar Orbiter-II (in addition to 46 Orbiter-II photographs already in the Library), 51 from Orbiter-III, 9 from Orbiter-IV, and 86 from Surveyor-III.

All photographs listed are 8 x 10 inch glossy prints, excepting LO-II-3146-MF, which is 9½ x 18 inches. Four of these new photographs are reproduced here as Figures 6-8 and on the front cover. All directions in their captions, and in the listing, follow the I.A.U. convention, where Mare Crisium is near the moon's east limb.

This influx of new photographs makes the original Lunar Photograph Library Catalog quite obsolete; and a new edition, complete through July, 1967, is now available. To obtain a copy, please send a request to:

John E. Westfall
Dept. of Geography
San Francisco State College
1600 Holloway Ave.
San Francisco, California 94132

Orbiter Photographs

The following abbreviations are used in this listing: (T) = telephoto (24-in. focus) lens; (W) = wide-angle (80-mm. focus) lens; and Av. Hem. = averted hemisphere ("back side"). Scales are expressed as follows: "100T" = 1/100,000 (i.e., about 1.6 mis. = 1 in.); 2M = 1/2,000,000 (i.e., about 32 mis. = 1 in.). Scales are not given for oblique photographs.

Orbiter - II

Code No.: 67-H-	Description	Lat./Long.	Solar Alt.	Scale
111	(T) Ranger-8 impact crater.	2°06'N/24°37'E	--	1/880
112	(W) Area of Ranger-8 impact (Sabine EA).	2°06'N/24°37'E	--	167T
510	(T) 30 ft. boulder & furrow in Sabine D.	1°.1N/23°.7E	--	1/1500
(LO-II-3146-MF)	(W) M. Tran. W of Maskelyne FC. (This print is reversed and is a 9½ x 18 inch format.)	3°.4N/36°.2E	14°	90T

Orbiter - III

Code No.: 67-H-	Description	Lat./Long.	Solar Alt.	Scale
184	(W) SE M. Tran. ca. 40 kms. WSW of Maskelyne F.	2°48'N/35°02'E	14½°	240T
185	(T) SE M. Tran. S of Maskelyne F.	2°42'N/35°09'E	14½°	29T
186	(T) SE M. Tran. ca. 50 kms. S of Maskelyne F.	2°30'N/35°25'E	14½°	33T
187	(T) Craterlet with ejecta ca. 30 kms. S of Maskelyne F.	2°35'N/35°11'E	14½°	1/3300
195	(T) Ridge w/boulders NE of D'Arrest.	2°32'N/15°25'E	15°	1/5900
196	(T) M. Tran. ca. 50 kms. ESE of Maskelyne F.	2°43'N/36°00'E	15°	1/5900
197	(W) (OBL) Hyginus Rille.	8°N/6°E	6°	-----
201	(W) (OBL) Kepler and Kepler A.	8°N/38°W	--	-----
204	(T) Craterlet w/ejecta in O. Proc. S of Maestlin G.	1°45'N/42°00'W	--	1/4500
214	(W) Rimae Hevelius I, II, and III.	2°N/67°W.	--	240T
215	(W) Cavalerius hills & Galilaei; area of Lunik IX landing. (OBL)	7°00'N/64°34'W	--	-----
264	3 photographs (left to right):			
	(i) (W) (OBL) Flamsteed ring.	2°27'S/43°12'W	--	-----
	(ii) (T) Surveyor-I impact area.	" " " "	--	26T
	(iii) (T) Surveyor-I casting shadow.	" " " "	--	1/650
265	(W) (OBL) Flamsteed P ring.	3°S/44°W	18°	-----
266	(T) Area of Surveyor-I site.	2°27'S/43°12'W	19°	22T
267	(T) Surveyor-I casting shadow.	2°27'S/43°12'W	19°	1/630
291	(W)(OBL) Damoiseau.	5°S/61°W	--	-----
304	(T) SE M. Tran. SW of Maskelyne F.	3°.1N/34°.4E	19°	26T
305	(T) W M. Fecund. SE of Lubbock.	0°.6S/42°.1E	23°	24T
306	(T) W M. Tran. NE of Ritter B.	3°.5N/19°.2E	9°	25T
307	(T) S M. Tran. S of Maskelyne G.	0°.5N/27°.2E	19°	23T
308	(W) (OBL) Theophilus.	8°.1S/26°E	--	-----
309	(T) N of Theon Junior B.	1°.34S/13°.7E	22°	23T
310	(T) (OBL) Sinus Medii SW of Bruce.	1°N/1°W	--	-----
311	(W) (OBL) Murchison and Pallas.	5°N/0°	--	-----
312	(T) W Sinus Medii.	1°.1N/1°.7W	14°	23T
313	(W) (OBL) Gambart J-Fra Mauro B area.	1°S/20°W	--	-----
314	(T) Av. Hem.-W portion of Tsiolkovsky.	23°S/125°E	--	760T*
315	(W) (OBL) Wichmann c - Wichmann b area.	3°S/35°W	--	-----
316	(T) NE portion of Flamsteed ring.	2°S/43°.3W	17°	24T
317	(T) N portion of Flamsteed ring.	2°S/44°.5W	8°	24T
318	(T) E portion of Flamsteed ring.	2°.7S/42°.7W	19°	24T
320	(T) SW portion of Arago B.	3°N/20°.6E	10°	25T

* Refers to unforeshortened (maximum) component of scale.

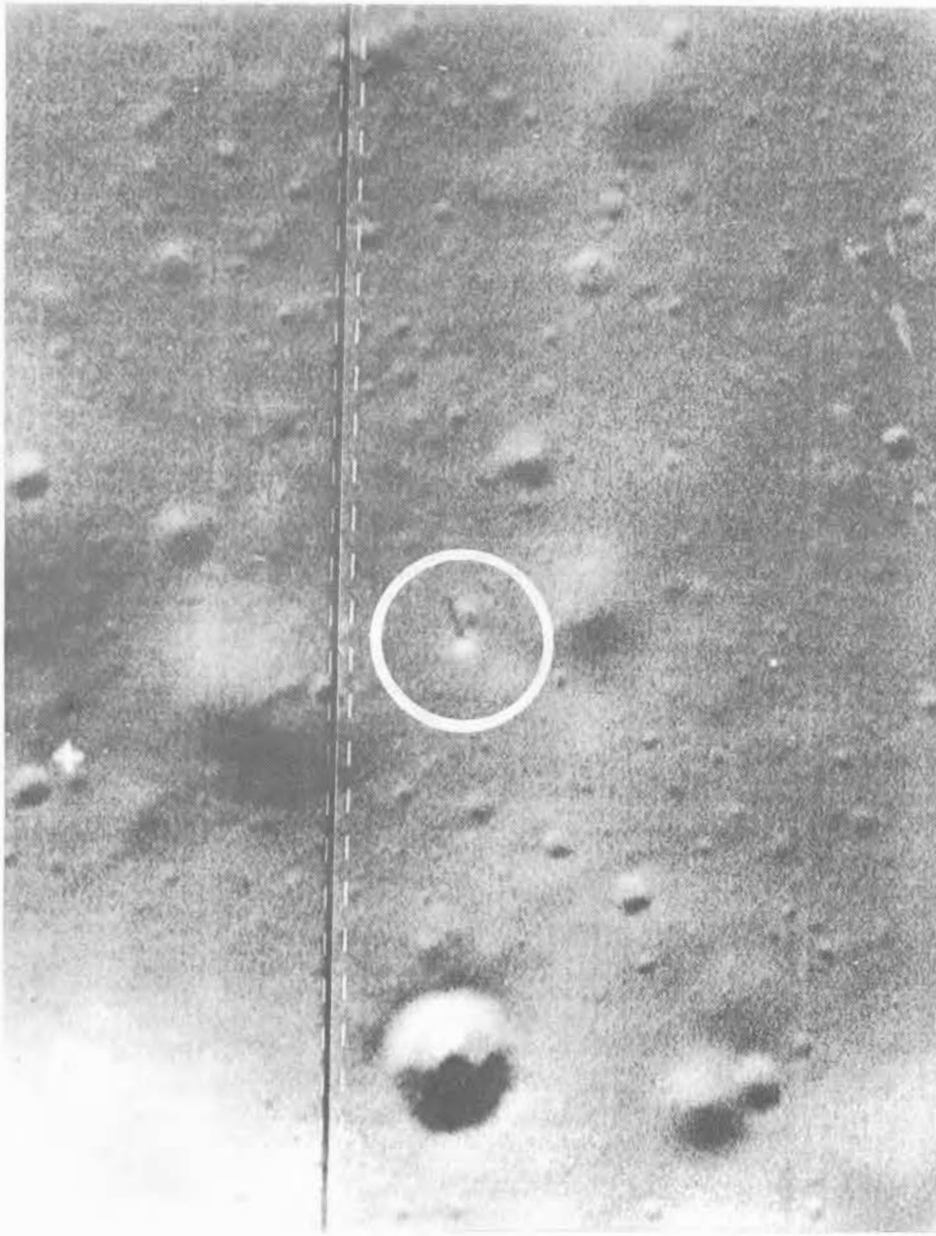

Figure 6. The Surveyor-I landing site as photographed by Orbiter-III's telephoto (24-inch focus) lens. The Surveyor spacecraft itself is at the center of the circle, casting a shadow to the top and left. The area of coverage is about 100 x 150 meters (350 x 500 feet). (Photo. No. 67-H-267).

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Orbiter - III (Cont.)

Code No.: 67-H-	Description	Lat./Long.	Solar Alt.	Scale
321	(T) S M. Tran. N of Moltke.	0°.3N/24°.3E	19°	23T
322	(T) Part of Agrippa D.	4°N/6°.6E	8°	25T
323	(W) (OBL) Landsberg P-Euclides K-Euclides P area.	3°.1S/22°.9W	--	-----

Code No.: 67-H-	Description	Lat./Long.	Solar Alt.	Scale
324	(T) WNW of Fra Mauro B.	2°.8S/22°.6W	22°	23T
325	(W) (OBL) O. Proc.--Encke E-Suess-Suess F area.	2°N/43°W	--	-----
326	(T) NE rim of Flamsteed ring.	2°.4S/42°.8W	19°	24T
327	(T) N portion of Flamsteed ring.	2°.16S/44°.3W	21°	25T

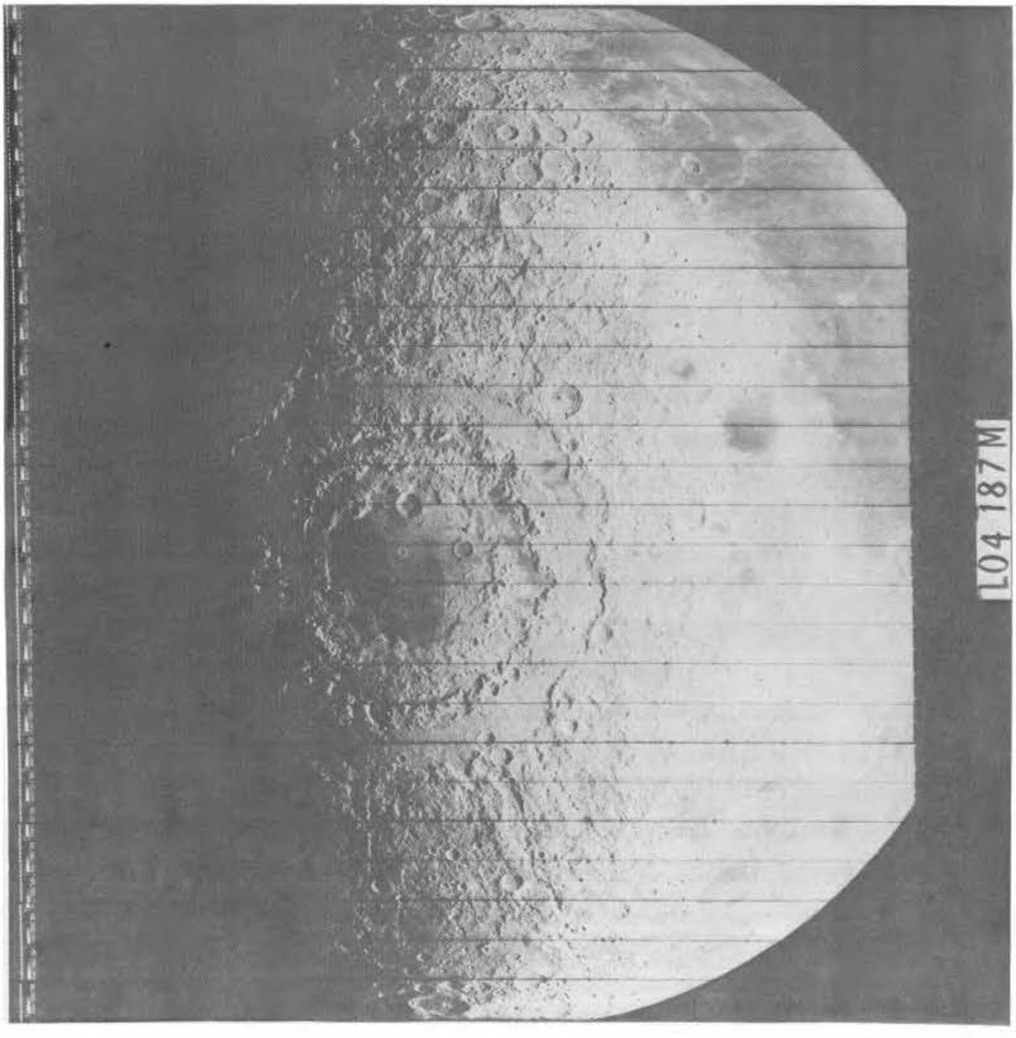


Figure 7. The Mare Orientale Basin, a vertical wide-angle Orbiter-IV photograph of what is, from the Earth, the extreme west limb of the moon. The outermost ring of the Basin is the Cordillera Mountains, some 1000 kms. (600 mis.) in diameter and rising to 6000 meters (20,000 feet). The Rook Mountains form the next smaller ring, some 650 kms. (400 mis.) across. Traces of two smaller concentric rings are also visible. North is at top; Oceanus Procellarum is on the upper right limb; Schickard is near the lower right limb (about "5 o'clock" on the disk); and part of Bailly is on the bottom edge. (Photo. No. 67-H-934).

Orbiter - III (Cont.)

Code No.: 67-H-	Description	Lat./Long.	Solar Alt.	Scale
328	(W) Part of Av. Hem. w/Tsiolkovsky N of center.	15°S/125°E	--	5.6M/ 8.8M**
329	(T) W M. Tran. N of Hypatia CB.	0°.4N/21°.8E	19°	23T
330	(T) E edge of Moltke.	1°.5S/24°.2E	23°	20T
331	(W) Mösting and area to N.	0°.6S/5°.5W	18°	180T
333	(T) O. Proc. SW of Maestlin R.	1°.2N/42°.1W	11°	24T
334	Duplicate of 67-H-317.	----------	--	-----
336	(T) (OBL) NE of Hortensius.	8°N/27°W	--	-----
389	Duplicate of 67-H-323.	----------	--	-----
734	(T) Surveyor-III landing point.	2°.94S/23°.34W	--	1/2600
799	(W) Surveyor-III landing area.	2°.9S/23°.3W	--	140T
804	(T) Surveyor-III landing site.	2°.94S/23°.34W	--	1/3150
880	(T) Surveyor-III landing point.	2°.94S/23°.34W	--	1/740

Orbiter-IV

Code No.: 67-H-	Description	Lat./Long.	Solar Alt.	Scale
743	(T) S Polar Region--Demonax-Scott-Amundsen -Hale area. (Overlaps 67-H-747.)	90°S-----	0-9°	1.8M
745	(W) Whole-disk view of E limb portion of Av. Hem. Colong. = 299°.3.	---------	--	10.3M/ 15.5M**
747	(W) Valley on Av. Hem. (Overlaps 67-H-743.)	65°S/105°E	--	2.1M*
833	(W) Whole-disk view of N Hemisphere; Colong. = 6°.9.	72°N/27½°E	--	9.4M/ 13.1M**
897	(T) Alpine Valley.	50°N/0°	20°	1.14M
934	(W) Whole-disk view centered on M. Orientale Basin.	15°S/89°W	--	ca.13M
935	(T) M. Veris - NE M. Orientale.	15°S/89°W	--	ca.1.5M
936	(T) Inghirami-Vallis Inghirami.	43°S/68°W	--	ca.1.4M
937	(T) Riccioli-Hartwig.	3°S/77°W	--	ca.1.7M

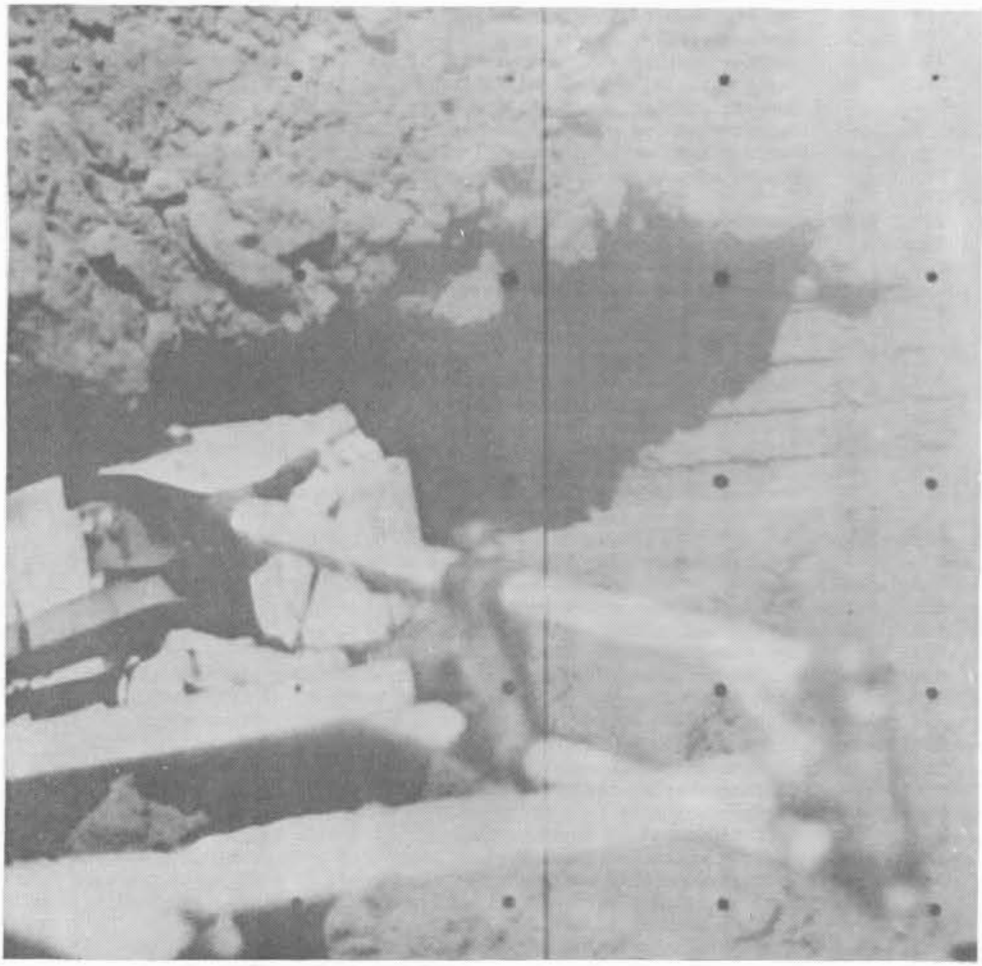
Surveyor - III

Surveyor-III successfully (though somewhat roughly) landed on the moon at 00:04 on 19 April, 1967, U.T., in eastern Oceanus Procellarum at 2°.88 south latitude, 23°.21 west longitude--about 130 kms. (80 mis.) southeast of the crater Landsberg. Under "Format" in the listing: W = wide-angle (25° field); N = Narrow-angle (6° field); M = mosiac (a joining of two or more photographs).

Code No.: 67-H-	Format	Description
384	--	Earthbased view of landing area in O. Proc. 3°20'S/23°10'W. Unforeshortened scale ca. 1.05M.
446	W	Landing leg and omni antenna.
447	W	Omni antenna and helium tank.
456	W	Footpad #2 and imprint.
457	W	Opposite inner wall of crater.
458	W	Footpad #2 and imprint.
462	N	2-ft. diameter crater N. of spacecraft.
463	-	Crater rim with rock blocks.
464	N	Surface 2½ meters distant (solar altitude = 15°).
465	-	North interior of crater.
467	W	Surface sampler above surface.

*Refers to unforeshortened (maximum) component of scale.
**First figure is scale at center of apparent disk; second figure is tangential (unforeshortened) scale at apparent limb.

Figure 8. Surveyor-III's surface sampler on its fourth pass through a trench, which it has deepened to about 17 cms. (6½-7 ins.). Taken May 1, 1967. (Photo. No. 67-H-839). Top is to right.



Surveyor-III (Cont.)

Code No.: 67-H-	Format	Description
469	-	Surface sampler touching surface.
470	-	2 photos.: (1) surface sampler pushed into surface. (2) resulting depression.
471	-	Surface sampler and first trench dug.
472	-	Surface as disturbed by surface sampler.
473	-	Upper end of first trench dug.
474	-	Upper end of second trench dug.
475	-	Surface sampler at upper end of trench.
481	N-M	15-inch trench and surface sampler.
482	-	6-inch deep trench and surface sampler.
483	-	Earth near mid-eclipse of April 24, 1967.
484	-	Earth 42 minutes into total eclipse of April 24, 1967.
490	-	Surface sampler near footpad #2.
491	N	Lunar material on footpad #2 (taken with red filter).

Code No: 67-H-	Format	Surveyor-III (Cont.) Description
525	-	Surface sampler and spacecraft shadow.
526	-	Surface sampler and spacecraft shadow.
539	W-M	Inner wall of crater.
540	-	North side of crater.
758	N	Two boulders north of spacecraft.
789	W	Surface sampler and trench.
790	W	Surface sampler and footpad #2.
791	W	Lunar material on footpad #2 (taken with red filter).
792	-	Surface sampler and pebble.
793	-	Imprint left by surface sampler.
794	-	Surface sampler holding small rock.
795	-	Closer view of surface sampler and small rock.
796	W	Surface sampler and trenches 1 and 2.
797	N	Surface sampler and light rock.
798	-	Close-up of surface sampler scoop.
800	-	Earthbased view of landing area in O. Proc. (University of Arizona Lunar & Planetary Lab. 61-inch photo.). Unforeshortened scale ca. 900T.
801	-	Crescent Earth: 1967, April 30, 11:37, U.T.
802	-	Earthbased view of landing area in O. Proc. (Yerkes Observatory 40-inch photo.). Unforeshortened scale ca. 800T.
803	-	Earthbased view of landing area in O. Proc. (McDonald Observatory 82-inch photo.). Unforeshortened scale ca. 800T.
805	N-M	20-inch rock block near spacecraft w/circles to measure roundness factor.
809	N-M	(same as 67-H-805, without circles).
810	W	Footpad #2 and its imprint.
811	N	Footpad #2 and its imprint.
812	N	2nd imprint of footpad #2.
813	W	Rounded rock fragment.
814	-	Angular rock block.
815	N	Rock wedge and 4½- and 6-ft. craters.
816	N	Surface with rock fragments.
820	N-M	Trench dug by surface sampler.
821	-	Two views of surface sampler.
834	-	Surface sampler crushing clod.
835	-	Clod crushed by surface sampler.
836	-	Rock imbedded in surface.
837	-	Third trench dug by surface sampler.
838	-	Surface cracks caused by surface sampler.
839	-	Surface sampler making fourth pass through trench.
840	-	Surface wrinkled by bearing test.
841	-	Surface dented by surface sampler.
842	-	Surface sampler crumpling soil.
843	-	Surface sampler preparing to pick up rock.
844	-	Surface sampler making 2nd pass through 2nd trench.
845	-	Surface sampler poised for impact test.
846	N-M	Area N of spacecraft, including 42-ft. crater.
847	N-M	(Spherical mosaic). Horizon and parts of spacecraft.
848	N	Rock fragments on north wall of crater.
849	N-M	Tracks left by rolling or skidding rocks.
850	N-M	Glass mirror on top of spacecraft compartment A.
851	W	Imprint of footpad #3.
852	N-M	Trench to east produced by exhaust gases.
853	N-M	View to east, with imprints of footpads #1 and #2.
854	N-M	View to east: footpad and exhaust gas imprints.
858	N-M	Double imprint of footpad #2.
859	W-M	Double imprint of footpad #2.
860	W	Waffle pattern made by footpad #2.
862	N-M	Southwest wall of main crater.
863	N-M	Rock field on northeast wall of main crater.
864	N-M	Rock field on northeast wall of main crater.
868	(MAP)	Map of area near spacecraft; scale = 1/440.
870	(MAP)	Contour map of area near spacecraft; scale = 1/1440.
872	-	Two superimposed views of Earth during eclipse.
878	N-M	Area north of spacecraft, showing craters and boulders.
879	N	Twin boulders north of spacecraft.

A.L.P.O. Lunar Photograph Library Rules

Many A.L.P.O. members have not received copies of the Lunar Photograph Library Catalog, and have joined the A.L.P.O. since the Library rules were originally published. For their sake, the rules for loans follow here:

1. Requests are to be mailed to: John E. Westfall, Dept. of Geography, San Francisco State College, 1600 Holloway Ave., San Francisco, California 94132.

2. The letter of request should include:

   a. Either a list of the photographs wished or a description of the area(s) for which coverage is wished. Also list colongitudes preferred, if any.
   b. A brief description of the use to which the photographs are to be put.
   c. Twenty-five cents in stamps to cover postage.

3. The date the photographs are to be mailed back to the Librarian will be the last date on the back of the photograph--normally six weeks from the date they are mailed to the borrower. ALL PHOTOGRAPHS ARE TO BE RETURNED ON OR BEFORE THIS DATE. A six-week renewal is allowed, if requested in advance of the return date and if no other requests are outstanding.

4. All photographs are to be returned to the Librarian unfolded and unmarked, in manila envelopes reinforced with cardboard.

REPORT ON THE 1964-65 APPARITION OF MARS - PART II

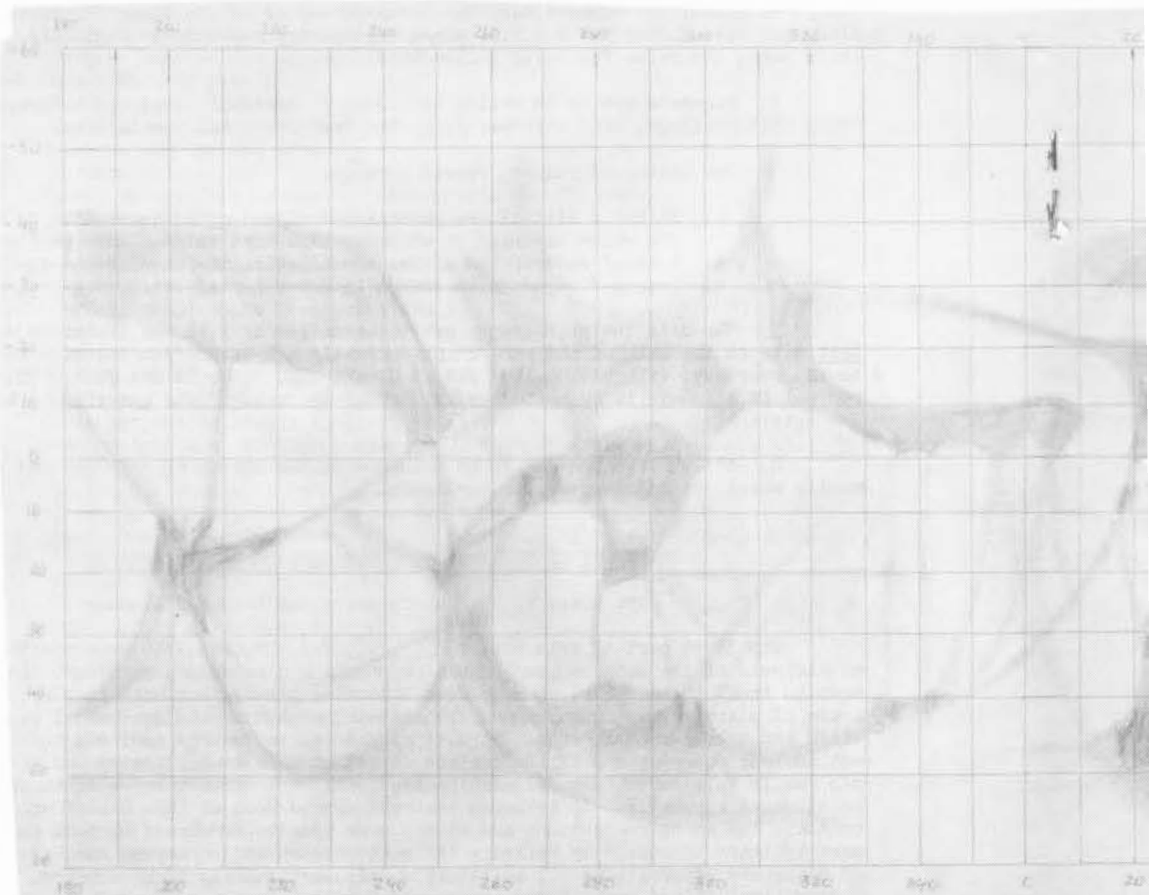
By: Klaus R. Brasch, former A.L.P.O. Mars Recorder

The first part of this Report (Str. A., Vol. 20, Nos. 1-2) was confined largely to an analysis of the data on atmospheric phenomena and polar cap behavior. An attempt was made to treat these topics in some detail because it was felt that they are among the main areas of planetary astronomy where the amateur, with moderate equipment, can still make a valid and useful contribution. It must also be quite frankly admitted that even the finest amateur observations of the surface detail of Mars are of limited scientific value and can really only serve to supplement professional work carried out with larger and more sophisticated apparatus. It is hoped that the second part of this Report will serve to accentuate the above contentions and at the same time to encourage serious amateurs to resort to their ingenuity by refining their techniques and employing more advanced methods of planetary observations. I am thinking here particularly of micrometry, photography, and critical filter work, three astronomical tools readily accessible to the amateur but only infrequently employed as yet. It is becoming increasingly important that the serious student of Mars make every effort to obtain the use of as large a telescope as possible, within the 12- to 24-inch aperture range, and so in effect to become a professional amateur. This may well prove to be a difficult and expensive proposition but is literally a price paid for progress.

The results of the more useful and accurate observations of the Martian surface features, as observed by A.L.P.O. members during the 1964-5 apparition, are summarized in the accompanying map of Mars. It must be stressed that both the nature and quality of this map are quite heterogeneous. Some areas were observed more frequently and under better seeing conditions than others. Thus the region lying between 200° and 300° longitude received what is considered to be adequate and accurate coverage throughout the apparition. Very sparsely studied was the region extending from about 70° to about 180° longitude, and hence this section of the map is considered to be sketchy and rather unreliable. This remark applies particularly to the less prominent features encompassed within these limits. The positions of the main features on the chart were secured by combining I.A.U. chart positions, A.L.P.O. drawings, and micrometric observations obtained by Kenneth Schneller. A map of this nature represents an "average" picture, so to speak, as compiled throughout several months of observations. As a consequence, seasonal intensity variations and the personal drawing styles of the various observers had to be normalized in the final product. It must also be pointed out that many of the finer details shown in the map are not normally resolvable with smaller telescopes (4-8 inches aperture) since these details were obtained from sketches made with 16- to 30-inch instruments.

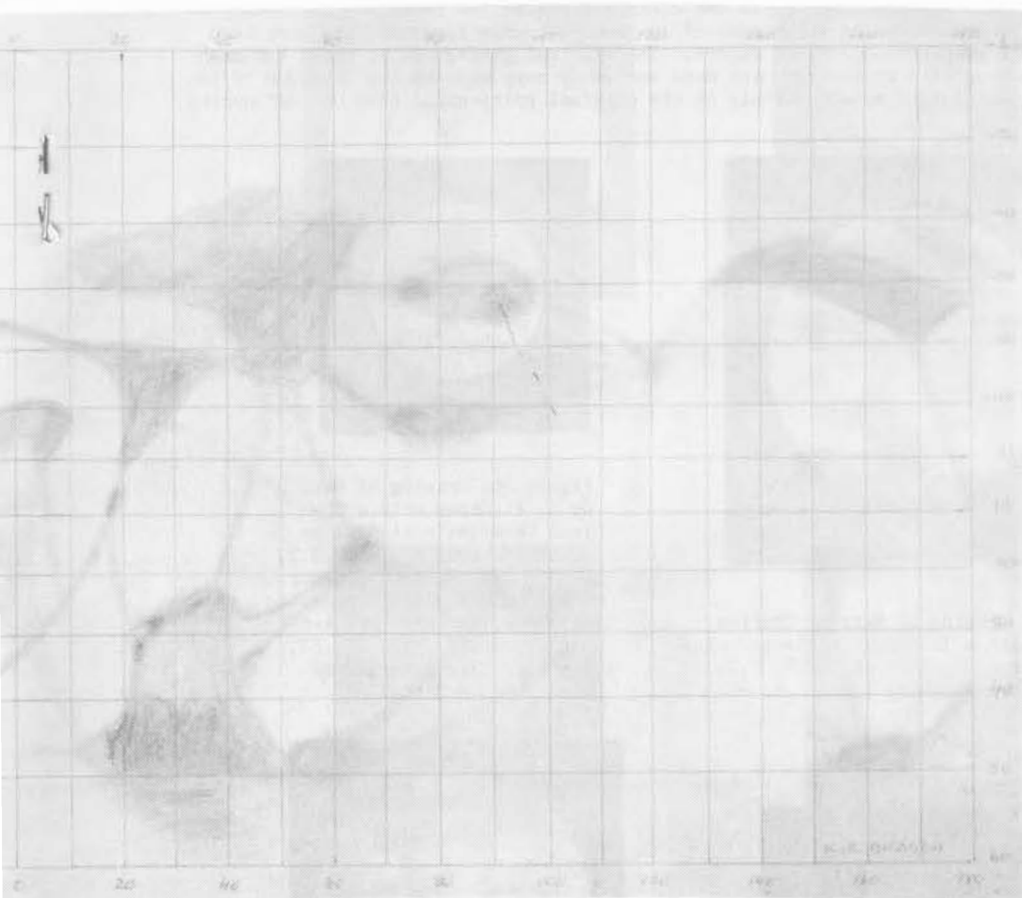
Turning now to a more detailed discussion of some of the areas which received close scrutiny, the following presentation has been adopted: For several parts of the planet

Mars 1964-65



MAP OF MARS FOR THE 1964-65 APPARITION. Based on observations by the Mars Section of the Association of Lunar and Planetary Observers. Map drawn by Klaus R. Brasch, then the A.L.P.O. Mars Recorder. Positions based on the I.A.U. chart of Mars, A.L.P.O. drawings, and micrometric measures by Kenneth Schneller. See also text on page 125.

1964-65



Mars was at opposition on March 9, 1965. The most, and the best, of the observations used in making the map were secured within about six weeks of this date on either side. Mars was closest on March 12, 1965, when the angular diameter was 14".0. On the date of opposition the tilt of the axis of Mars toward the earth was 21°.2 N., and the areocentric longitude of the sun was 80°. (The summer solstice of the northern hemisphere of Mars is at areocentric longitude 90°.)

some of the better sketches of the region in question, made with both small and medium-to-large sized telescopes, are compared to one of the superb photographs by C. F. Capen. The Mars Section is particularly indebted to the contributions of the Table Mountain Observatory. These were obtained with telescopes of 16- and 30-inches aperture, and have been invaluable in the preparation of this Report. The original photograph is shown for each region chosen, along with an enlarged and more contrasty copy made by the Recorder in the hope that none of the fine detail visible on the original print would then be lost during reproduction.

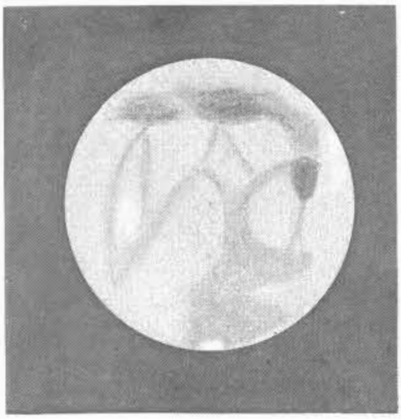


Figure 9a. Drawing of Mars by Charles M. Cyrus with a 12.5-inch reflector at 326X on March 21, 1965 at 3^h26^m, U.T. Seeing 5, transparency 5.5. C.M. = 257°.

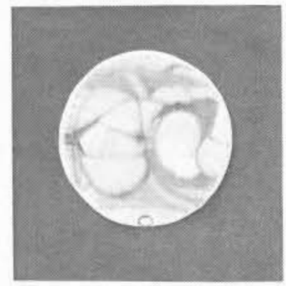


Figure 9b. Drawing of Mars by C. F. Capen with a 30-inch Cassegrain at 562X on March 28, 1965 at 7^h30^m, U.T. Seeing 2 to 5, transparency 5 with cumulus and cirrus. C.M. = 255°. Used Wratten Filters 12, 25, 38, 47, 57, and 64. Blue clearing on Mars on this date.

Figure 9c. Photograph of Mars by C. F. Capen on March 30, 1965 at 8^h23^m, U.T. C.M. = 250°.

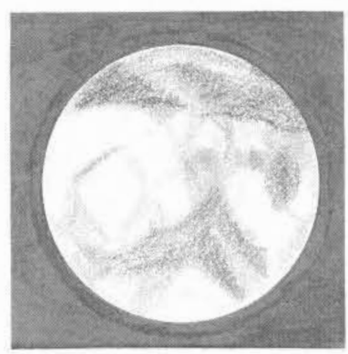


Figure 9d. Copy of photograph of Figure 9c made by Klaus R. Brasch. Enhanced contrasts.

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Figure 9 on this page shows several aspects of the region near 255° longitude, which encompasses Mare Tyrrhenum, the Nodus Laocoöntis-Thoth complex, and Utopia. It will be noted at once that the caliber of the best modern photographs (9c and 9d) is such as readily to match the visual capabilities of a 12-inch reflector (Figure 9a). All the subtle canal detail observable with this telescope are recorded on the photograph. It is not until a much larger aperture (30 inches) is used that visual work again has a distinct advantage (Figure 9b). The reader will appreciate, in making comparisons of this kind, that the drawings and photographs compared were made under differing conditions of observation and that the finer and fainter detail may be lost in published reproduction to a varying extent with different drawings and photographs.

Figure 10 on page 129 demonstrates this point even more dramatically. The illustra-

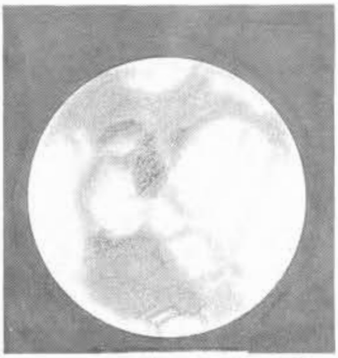

Figure 10a. Drawing of Mars by Klaus R. Brasch with a 20-cm. reflector at 250-375X on March 16, 1965 at 3^h20^m, U.T. Seeing 2-5, transparency 2-3. C.M. = 299°.

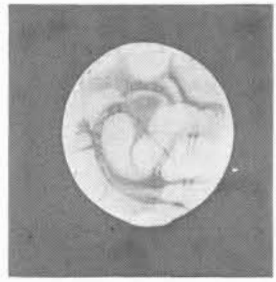

Figure 10b. Drawing of Mars by C. F. Capen on February 14, 1965 at 9^h40^m, U.T. with an 84-inch Cassegrain reflector at 500X. Seeing 1-5, transparency 4-5. C.M. = 294°. No filters.

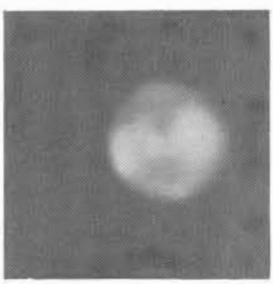

Figure 10c. Photograph of Mars by C. F. Capen on March 23, 1965 at 6^h45^m, U.T. C. M. = 288°.

Figure 10d. Copy of photograph of Figure 10c made by Klaus R. Brasch in order to enhance contrasts.

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tions portray the area arond 300° longitude, dominated by Syrtis Major. Here the photograph (Figures 10c and 10d) readily exceeds the visual capabilities of an 8-inch reflector (Figure 10a). Once again only when a much larger telescope (84 inches) is used visually (Figure 10b) can much more detail be seen.

Figure 11 centers around 20° longitude and includes Mare Acidalium and Mare Erythraeum. The photograph (11c and 11d) once again surpasses in detail visual work done with 7- and 12-inch telescopes (11b and 11a). Moreover, it very distinctly shows the extremely fine canal structure Oxus, clearly demonstrating the reality of such features on Mars.

From the foregoing brief analysis, it is evident that amateur work on Mars is in need of a serious and realistic reappraisal. If the Red Planet is to be studied telescopically for reasons other than the purely aesthetic enjoyment of observing another world in space, then a thorough program must be drawn up and followed. Such a program must be subject only to the limitations imposed by the equipment employed and the seeing conditions under which the observer is working.

Too frequently the Recorder receives sporadic drawings submitted by enthusiastic but inexperienced novices. Usually these take the form of sloppy pencil sketches, executed hastily at the eyepiece of a small telescope during a convenient moment. It must be clear by now that such efforts are almost totally useless, even from a training standpoint. The beginner must realize that skill and accuracy in planetary observing are not acquired without much patience and perseverance. The Strolling Astronomer is filled with articles and

Figure 11a. Drawing of Mars by Walter H. Haas with a 12.5-inch reflector at 303X on March 14, 1965 at 7^h2^m, U.T. Seeing 3-5, transparency 0-4. C.M. = 10°.

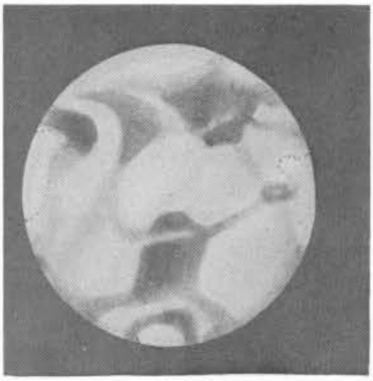

Figure 11b. Drawing of Mars by J. Dragesco with a 175-mm. reflector at 200X to 300X on April 4, 1965 at 21^h, U.T. Seeing 3-4, transparency 1-5. C.M. = 30°.

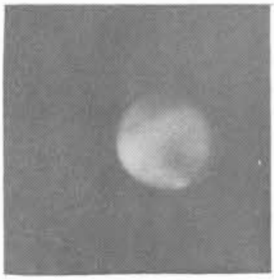

Figure 11c. Photograph of Mars by C. F. Capen on April 16, 1965 at 4^h36^m, U.T. C.M. = 43°. On the original print fine-line canal structure and an irregular north cap are apparent.

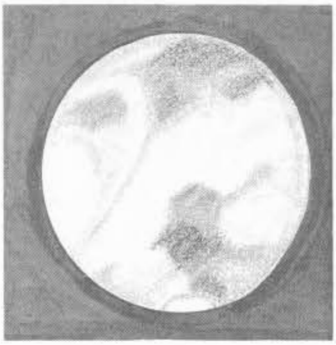

Figure 11d. Copy of photograph of Figure 11c made by Klaus R. Brasch. Enhanced contrasts.

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reports on both general and specific information regarding planetary observing techniques. Such literature should, and indeed must, be consulted before any actual observing attempts are made.

Another class of essentially useless observations reaching the Recorder includes work often submitted by competent observers who have, however, failed to apply themselves to any systematic study program. Thus perhaps half a dozen observations, scattered throughout the apparition, are included. These may be fairly good in themselves but contribute little towards a unified A.L.P.O. effort. It would be far more fruitful if such observations were confined to, for example, a systematic survey of cloud detail close to the period of opposition. In this manner even a limited sequence of observations could prove invaluable.

In summary, the retiring Recorder suggests the following guide lines for future A.L.P.O. work on Mars. Where possible, a reference to similar work is provided. This list is not intended to be exhaustive, but merely to furnish interested individuals with some readily available background material.

A - <u>Telescopes less than 6" (150 mms.) in aperture</u>

Generally useful only for training purposes.
Of little or no use in study of surface feature details.
Limited study of large scale cloud and haze phenomena possible with suitable filters (see below).

For a reference to some of the best work possible with instruments in this range see: Binder, A., "Mars Observations 1962-63", Str. A., Vol. 17, pg. 217, published 1964.

B - Telescopes in the 6" to 10" (150 to 250 mms.) category

Useful work on more conspicuous surface detail possible, particularly near opposition and under excellent atmospheric conditions.
Seasonal intensity variations can be studied usefully, especially if done in a continuous patrol fashion.
Positional micrometric work can be done simply and effectively; see:
Glaser, P., "A New Type of Micrometer for Use at the Telescope", Str. A., Vol. 18, pg. 131, published 1965.

For a general reference on work done with telescopes in this aperture range see: Brasch, K., "Some Montreal Centre Observations of Mars in 1962-63", Str. A., Vol. 18, pg. 148, published 1965.

For an example of top caliber work refer to:
Both, E., "Recent Visual Observations of Mars", Sky & Telescope, Vol. 26, pg. 17, 1963.

C - Telescopes of 12" (300 mms.) aperture and larger

Much serious and useful work at all levels remains to be done.
Critical visual work of surface detail variations is needed, especially from highly experienced observers.
Intensity and color variation observations should be carried out with larger apertures so that subtle changes will become evident.
Accurate positional work is needed, both micrometric and photographic.
Continuous critical photography, especially in light of different wavelengths, should be emphasized.
Enormous amounts of detail can be photographed with modern fine grain emulsions, even with relatively modest apertures.

The above list could be expanded to the point where it would merge with professional efforts. Suffice it here to present a final list of references for those interested in specialized programs:

Photography

Eastman, J., "A Planetary Camera for a 12½" Telescope", Str. A., Vol. 15, pg. 149, 1961.

Eastman, J., "Measuring Planetary Photographs", Str. A., Vol. 19, pg. 187, published 1966.

Critical Visual Work

Ebisawa, S., "A Map of Mars 1907 - 1956", Str. A., Vol. 14, pg. 132, 1960.

Saheki, T., "Surface Features of Mars in 1956", Str. A., Vol. 15, pg. 191, 1961.

De Vaucouleurs, G., "Observations of Mars in 1958", Sky & Telescope, Vol. 18, pg. 484, 1959.

Filter Work

Capen, C., "Filter Techniques for Planetary Observers", Sky & Telescope, Vol. 17, pg. 515, 1958.

THE OBSERVER AND MARS IN 1969

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

Planetary Aspects

The 1969 Mars apparition is considered perihelic because the orbital longitude at opposition is only 86° from the perihelion longitude. Opposition occurs on May 31, 1969, with an apparent planetary disk diameter of 19".2; and a maximum diameter of 19".5 occurs ten days later on June 10. Mars has an observable disk diameter greater than 6 arc seconds during most of the year. A useful disk diameter of 8 arc seconds for photography exists for a period of 8 months, from March through October. The geometry of the heliocentric aspects of Mars relative to the Earth is shown in Figure 12.

Although Mars has a favorable apparent disk diameter for observing, it will be relatively low on the horizon during the entire apparition for observers in middle northern latitudes, which will make the quality of astronomical seeing below average. The apparent declination of Mars is -10° in January, 1969; Mars then continues southward until it reaches -26° in September; and then it slowly rises to -8° by January, 1970. The maximum altitude of Mars when on the terrestrial meridian will be approximately 25° to 35° for an observer in the United States. Consequently, observers located in the Southern Hemisphere will have the planetary disk high in the sky, where observing conditions can be ideal.

The aspects and range of the axial tilt of the globe of Mars make possible observation of both poles and the equatorial region during the 1969 apparition. The global tilt is synonymous to the apparent declination of the Earth (D_e) as viewed areocentrically, which is also the sub-earth point or latitude of the center of the Martian disk. This D_e is tabulated in the AENA under the heading, "Mars, 1969, Ephemeris for Physical Observations." The sub-earth and sub-solar points are graphically represented in Figure 13.

Observational Possibilities

Pre-opposition allows observation of the North Cap during its summer regression phase, a high resolution study of arctic and north temperate region dark surface features, and observation of summer recurrent cloud ontogeny in the Great Martian Desert region because of the global tilt and larger disk diameter. The dark features of the equatorial region during the heightened seasonal activity of northern hemisphere summer are available from March until June, terrestrial dates, and again during the southern hemisphere spring in September and October, terrestrial dates. This will allow observation of the seasonal behavior of surface features during the controversial two darkening-wave periods. Post-opposition allows observation of the North Cap and arctic region features during the Martian fall season until the sub-earth point crosses the Martian equator on September 19, TD, after which Mars' South Pole is tilted toward the Earth. Throughout the remainder of the apparition the South Cap and the southern hemisphere are well placed for observation during their spring and summer seasons. The Martian seasons for the northern hemisphere relative to the terrestrial date encountered during the apparition are as follows: Martian summer (22 June, Martian Date) begins on December 26, 1968, TD; autumn (22 Sept., MD) occurs on June 25, 1969, TD; and winter (22 Dec., MD) begins on Nov. 20, 1969, TD. Descriptions of modern diurnal, seasonal, and secular changes and their map coördinates are given in "Mars - A Dynamic World;" Review of Popular Astronomy; Vol. 68; No. 555; Feb., 1969, by the author.

Observing at the Telescope

Useful observational data can be obtained with telescope apertures of from 4 inches to 16 inches over an extended period of from 8 to 12 months and centered on the date of opposition. Observations may be acquired through color filters at the eyepiece or by employing a suitable panchromatic film, e.g., Ansco Hypan-X or Kodax Plus-X with the appropriate color filter. Agfachrome or Kodachrome-X may also be used in order to obtain color transparencies for tricolor filter study. The image of Mars usually appears too bright in reflecting telescopes, which promotes irradiation within the observer's eye that degrades the quality of image definition. Irradiation can easily be controlled by selecting the highest practical ocular power that the telescope aperture, seeing conditions, and transmission of the filter in use will allow, or by employing a neutral density filter. The image quality may change during the period of observation, making it necessary to focus the telescope often because of the low altitude of Mars during this apparition.

The classical method of optical investigation covers nearly one octave of the visible spectrum from the violet to the deep red. In 1909, E. C. Slipher at Lowell Observatory discovered the fact that the photographic disk of Mars appears completely devoid of the dark surface features on violet light images relative to yellow light images. The normally uniform opaque violet disk is occasionally broken only by bright, impermanent, mobile patches of white-type clouds or temporary blue-hazes on the limbs. The atmospheric opacity was found to be greater with decreasing wavelength toward the ultraviolet. The surface detail can be perceived in any light of a wavelength greater than 4550Å and is absent from the planetary disk in light with a shorter wavelength. Reference is here

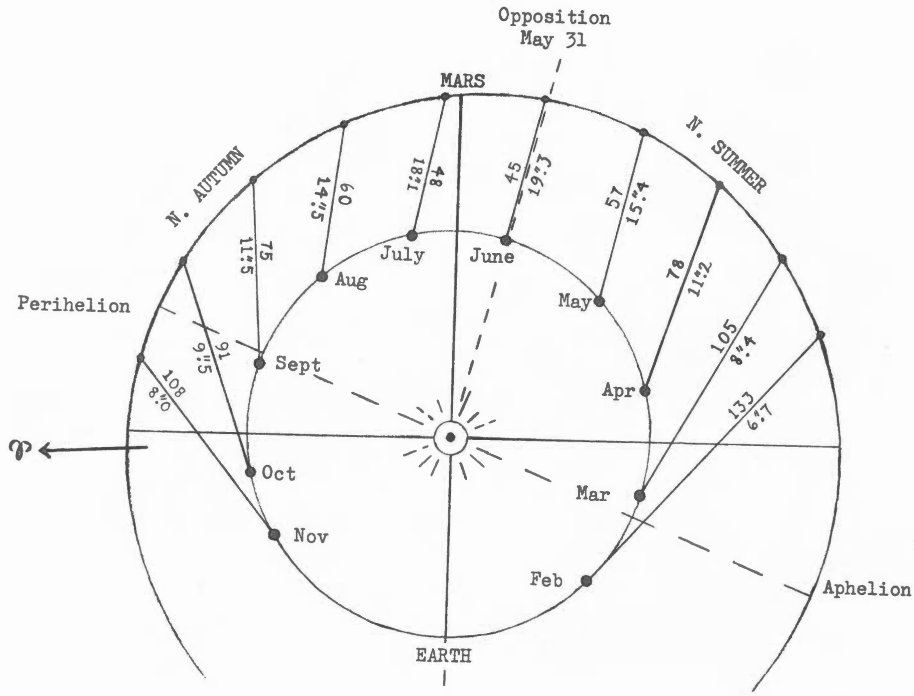

Fig. 12. Heliocentric chart of Earth and Mars showing the orbital geometry of their positions, distances in millions of miles, disk diameters in seconds of arc, and the Martian seasons to be encountered during the 1969 apparition.

made to Mars - The Photographic Story, by E. C. Slipher, Sky Publishing Corp., 1962.

During the past decade A. Firsoff and C. Capen have made independent, empirical filter observations which indicated that the Martian atmospheric scattering allows observation of different relative atmospheric depths; violet light records the upper atmospheric planetary current system phenomena, blue light reveals mid-level cloud activity, and green light records ground-fog type haze and surface frost deposits relative to surface features. However, the observed clouds may actually have little relative height in view of recent knowledge that the Martian atmosphere is extremely tenuous and that surface topography appears to affect cloud formation and movement. Normally the dark surface features can be vaguely seen with ill-defined boundaries in blue light and in blue-green light. Clouds observed best in blue-green light may indeed lie next to the surface and be indistinguishable from ground frosts, except for the appearance of their haze boundaries. Limb blue haze is observed equally over both light and dark surface areas. Individual recurrent clouds appear to form most often over discrete light areas, and sometimes move with the atmospheric currents to cover dark areas. The presence of cloud or haze decreases the definition of the dark surface boundaries. Yellow light records yellow dust cloud activity and enhances the definition of the dark surface markings, while orange and red light effectively penetrate the Martian atmosphere and further enhance definition of the surface features. Cloud and haze are usually lost in orange and red light unless the visible cloud is extremely dense or is associated with surface frost. Color contrast enhancement

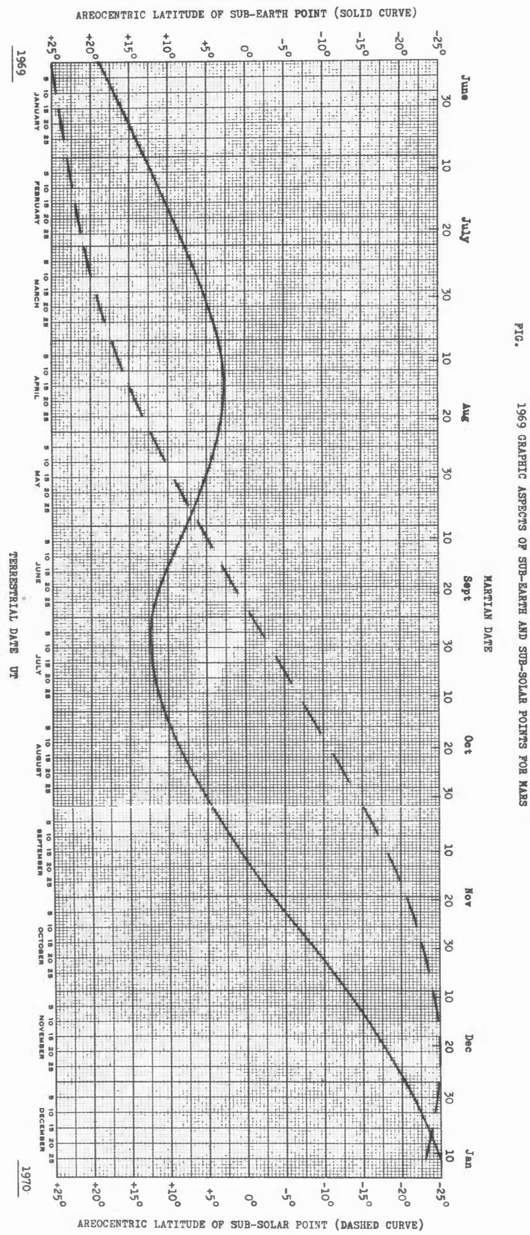

Figure 13. Graph of tilt of axis of Mars toward the earth and the sun during 1969, plus when the latitude on Mars of the sub-earth, or sub-solar, point is north and minus when south. Graph contributed by C. Capen and re-photographed for publication here by R. B. Minton. See also text of Mr. Capen's article.

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between most dark features and the surrounding deserts can be obtained in yellow, orange, or red light. Such colored filters brighten the ocher-colored deserts while darkening the maria, oases, and linear detail, which indicates that the deserts are reddish and that the dark features tend toward green or bluish hues.

Slipher also made the interesting discovery that at unpredictable times the Martian atmospheric opacity varies to a point of transparency, allowing surface detail then to be recorded in violet light. This temporary atmospheric transparency to violet light is called blue clearing. The blue clearing is not always planet-wide but is localized at times in different hemispheres. The blue clearing phenomenon is found to begin somewhere between the wavelengths of 4550Å and 4250Å, with appreciable surface contrast sometimes noted as far down as 4000Å, which is normally quite opaque. Atmospheric blue clearing is not predictable. It has been observed to occur over 100 days from opposition, as well as around the time of opposition. It is uncertain how far down the spectrum toward the ultraviolet that the phenomenon can be detected. Visual and photographic violet light records should be obtained during each Martian apparition in an effort to increase our knowledge of the phenomenon and to study the tenuous aerosol content of the atmosphere.

Data records of each visual and photographic observation are very important. A complete written record should be made in some chosen order each night, and never left to memory for the following day. The UT date, Universal Time, telescope, ocular power or Barlow lens, seeing, sky transparency, filters employed, and a description of each observed disk object's appearance in different color filters are recommended data whether or not they accompany a visual drawing. The 1969 Mariner spacecraft will be in the proximity of Mars during the latter part of July and the first part of August. Consequently, cloud, frost, and surface feature contrast observational data will be most useful from the first of July to mid-August, 1969. Copies of written records and drawings may be sent to the ALPO Mars Recorders on a regular basis, such as bi-monthly, throughout the apparition for inclusion in the next ALPO Mars Report and for individual acknowledgement.

WRATTEN FILTER SPECTRAL TRANSMITTANCE CURVES EMPLOYED IN PLANETARY OBSERVATION

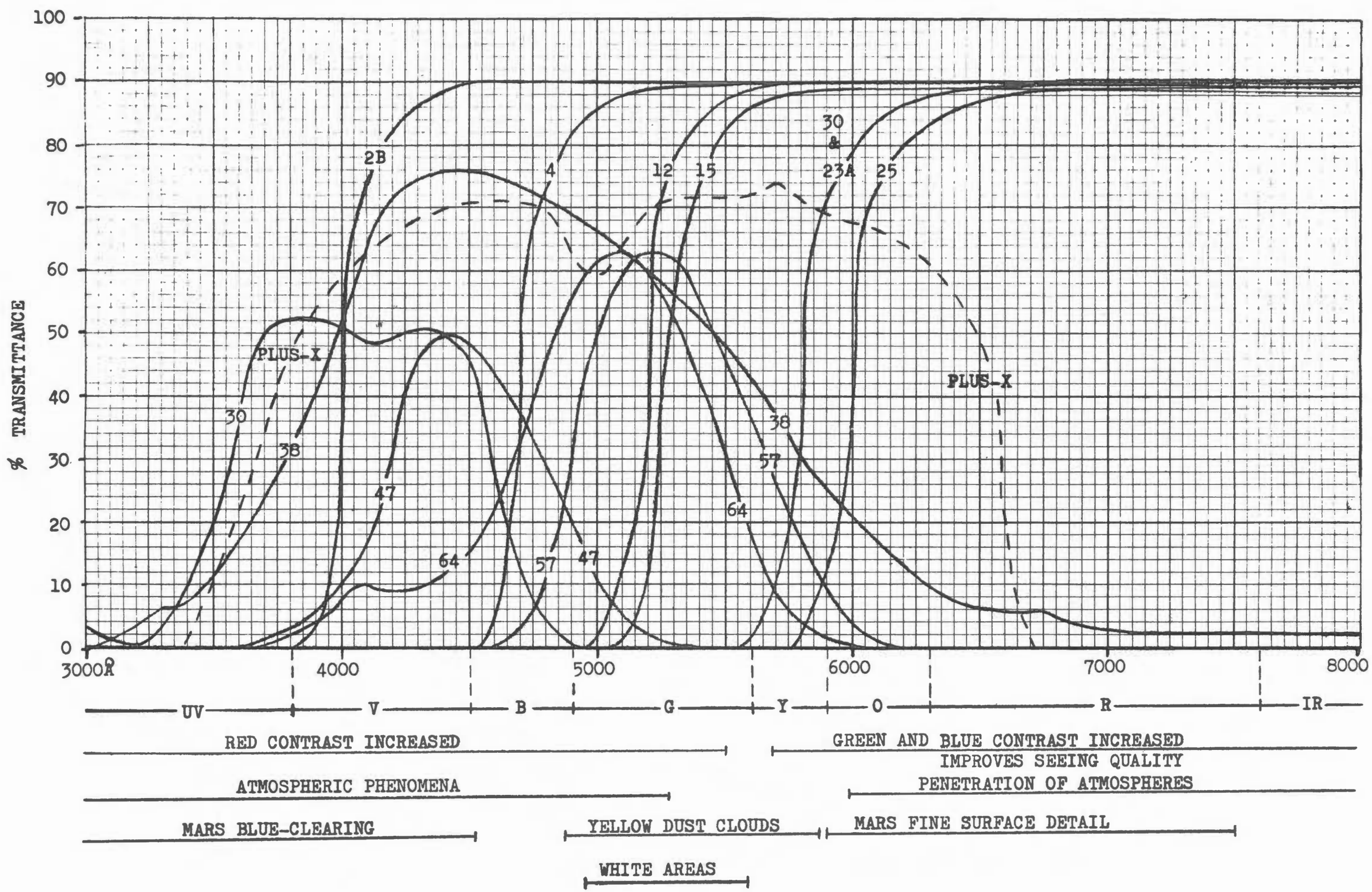

Figure 14. Wratten Filter spectral transmission curves for a number of color filters useful in the photographic and visual observation of Mars. Martian phenomena at different wavelengths are indicated along the left margin. Diagram contributed by Charles F. Capen.

AN ANALYSIS OF LUNAR STEEP PLACES AND ITS SELENOLOGICAL IMPLICATIONS

By: Carl F. Dillon, Jr., Lowell, Massachusetts

Abstract

The lunar steep places on the moon's visible hemisphere have been mapped. Relationships between steep places and the lunar tectonic grid system, maria coasts, and crater diameters have been established. Present data tend to show similarities between the earth's surface and that of the moon, and also tend to support a plutonic explanation of the formation of lunar steep places.

Foreword by Charles L. Ricker, A.L.P.O. Lunar Recorder.

The following article, by Carl F. Dillon, Jr., one of the Lunar Section's most active members, is a direct result of his participation in the formal steep places program. Since Mr. Dillon contributed over 90% of the observations, and in addition undertook the tedious task of reduction of the observations, it is only proper that the formal report be written by him.

In consulting several lunar experts, I have found that their viewpoints differ greatly as to the possible significance of the following data. The major objection is that the possibility of observational bias exists. It has been suggested that a survey be made in accordance with a prearranged plan of areas and times. While this idea certainly has merit, it is doubtful that sufficient observer interest exists to carry such a plan to a successful conclusion. It is this writer's opinion that the data contained herein is complete and accurate to the limit of the 6" aperture employed. Unquestionably, larger apertures would reveal additional steep places; but it is my opinion that the statistical relationships would still hold up. In the final analysis, the reader must consider the data, and the observations upon which they are based, and draw his own conclusions.

One thing is certain, though; this study dramtically demonstrates the fact that serious lunar research is still possible for an amateur, working alone and with very modest equipment.

Introduction

The apparent ruggedness of the lunar surface is merely an illusion caused by sharp shadow contrasts and the lack of lunar atmosphere. Few observations are made in areas under high solar lighting. Hence, there is comparatively little that has been written about such lighting in selenological studies. Under high lighting, however, are found a few craters and faults that still contain traces of dark shadow, thus denoting that the steepness of the terrain here is greater than the sun's angular elevation above the lunar horizon at the time of observation. In this analysis, areas that are over 30° in inclination will be considered "steep places".

What relationships exist between steep places and their distribution? How does their distribution relate to existing theories concerning the origin of the lunar surface features? Where are these steep places found? Such are a few of the questions that I have tried to answer - some of which are still unanswered.

Observational Procedure

The project was divided into two parts: (1) finding the general distribution of steep places, and (2), studying these areas in detail. The second part has not yet been fully completed. Although there may be a few undiscovered steep places in the moon's western (IAU) hemisphere and in the west inner walls of a few craters, the first part is complete.[1]

Present visual observations number over 1500 and are supplemented by about 1000 photographic observations, giving a fairly complete coverage up to colongitude 174°. Observational data were obtained by recording places that exhibited shadow with the terminator 30° or more away. Since the actual solar altitude is dependent upon lunar latitude

[1]Personal correspondence with Mr. Charles L. Ricker (Oct. 17, 1968) shows that other observers list 15 other possible steep places, too few to affect this present analysis of over 275 places to any great extent.

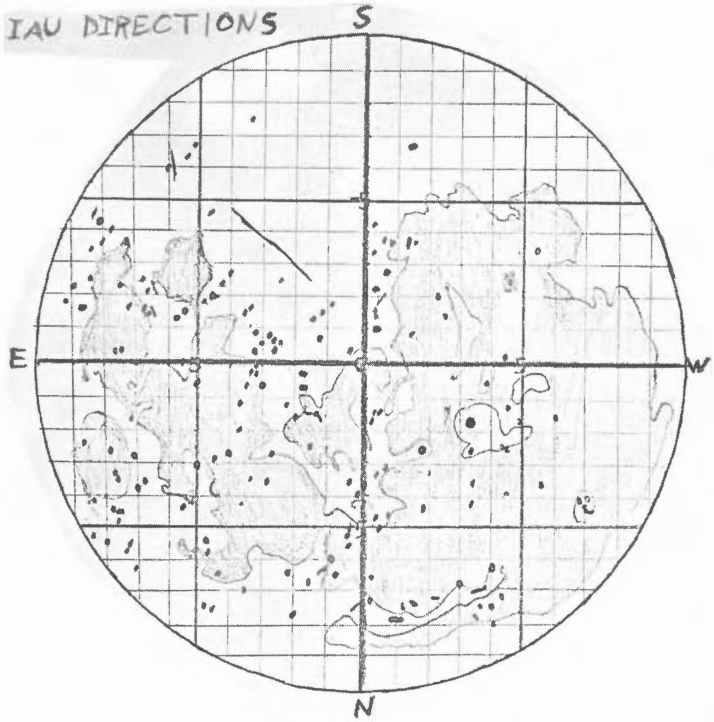

Figure 15. Diagram of earth-turned hemisphere of moon to show general distribution of lunar steep places discovered and/or studied by Carl F. Dillon, Jr. See text of his article in this issue.

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as well, areas were not accepted as steep places until values of over 30° were obtained when using a simplified formula for solar elevation.[2] Observations were made using a 6-inch homemade Newtonian reflecting telescope. Along with the steep place positions and the size, type, and magnification of the telescope, the date and time (UT), seeing conditions, and transparency were also recorded. Later, using the information cited and a simplified formula, I determined the sun's altitude.

Conclusions

Through the data tables, the following conclusions can be drawn:

1) Most steep places occur in: a) craters (49%).[3]
b) ringed plains (22.8%)
c) interior mountains (13.4%).
d) mountains (4.9%).
e) walled plains (3.56%).

2) By quadrant, most steep places occur as follows:
a) Quadrant I (37%).
b) Quadrant IV (32.2%).
c) Quadrant II (19.6%).
d) Quadrant III (11.2%).

3) The sum of steep places in diagonal quadrants is approximately 50%. That is:
Quad. I + Quad. III = 48.2%.
Quad. II + Quad. IV = 51.8%.

From the graphs, it may be concluded that:

4) The number of steep places, in general, is inversely proportional to the crater diameter (Figure 16). This inverse proportion closely corresponds to a straight line (linear function) having the formula $f(x) = -0.9x + 31$, where x is the crater diameter in miles and f(x) is the number of steep craters known. In the right hand portion of the graph (Figure 16) are two groups not lying on the straight line. Since their frequencies are only 1, they may be considered as random. When craters are classified into smaller categories (i.e., craters proper, walled plains, ringed plains), this inverse relation is much more irregular, though still present.

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[2]Charles L. Ricker, "Lunar Section: The Steep Places Program", Strolling Astronomer, Vol. 20, Nos. 1-2, pp. 4-5.

[3]Classification of craters, ringed plains, and walled plains was obtained using The Moon, by H. P. Wilkins and Patrick Moore, Faber and Faber, Ltd., London, 1961.

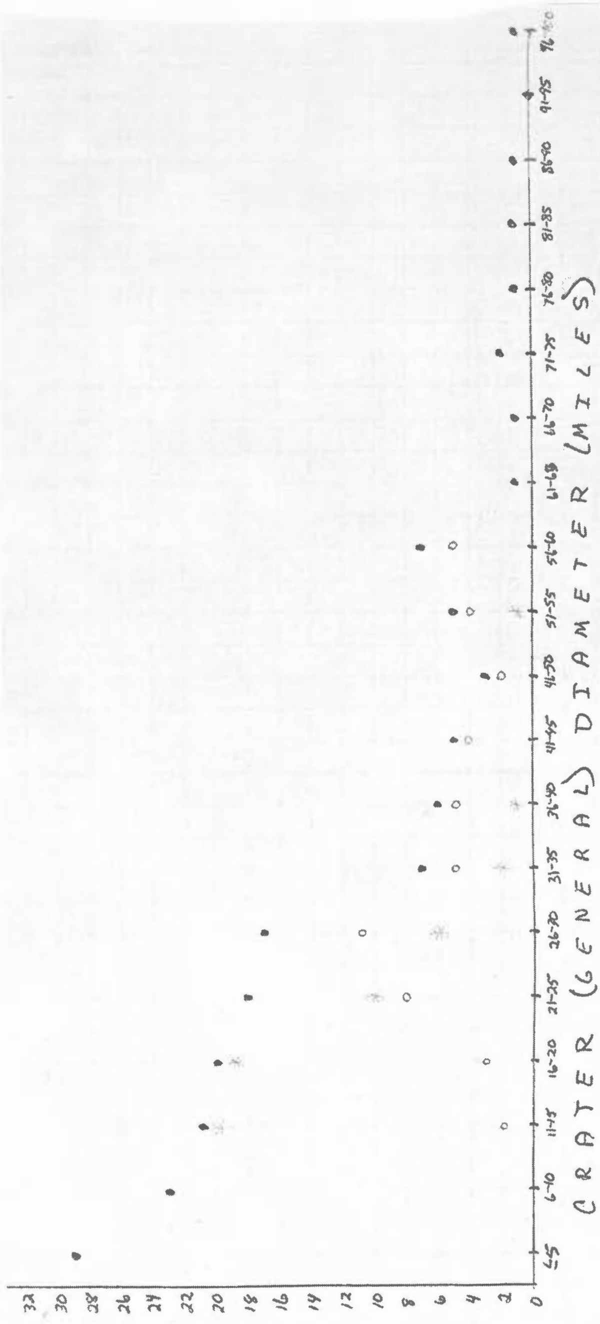

Figure 16. Graph of the known number of lunar steep places in craters in different diameter-intervals against the crater diameter in miles. Graph drawn by Carl F. Dillon, Jr. See also text.

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From the map of the general distribution of steep places (Figure 15):

5) Most steep places occur fairly close to the "shores" of the <u>maria</u>, seldom in the older southern highlands or <u>maria</u> centers, and lie in groups that run parallel to these shores. Although the distribution of steep places is 31.2% in <u>maria</u>, 17.4% bordering <u>maria</u>, and 24.2% in highlands, with 61 places unclassified, approximately 85% lie within 90 miles of <u>maria</u> shores.

6) Steep craters appear to occur in a system that lies in N-S, NW-SE, and NE-SW directions.

Possible Implications

Today's selenologists are divided between the plutonic (volcanic) and meteoritic hypotheses of lunar crater origin. The implications of my project, like theirs, are highly subject to controversy and are included as hypotheses to supplement the formal report. Of all the conclusions of the project, the ones that have, perhaps, the greatest selenological implications are (5) and (6) above, which state that these steep places occur in certain patterns on the lunar surface and that they lie parallel to the <u>maria</u> "shores".

The N-S, NW-SE, and NE-SW patterns of steep places are especially significant; for these are the patterns that are common to the lunar tectonic system. Thus, steep place craters may be a part of this system and may possibly lie on fault or fracture lines on the lunar surface. Further evidence is supplied by an inspection of steep places superimposed on charts of the lunar tectonic system,[4] which shows that many steep places are

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[4]Robert G. Strom, "Analysis of Lunar Lineaments, I: Tectonic Maps of the Moon", <u>Communications of the Lunar and Planetary Laboratory</u>, July 1, 1964.

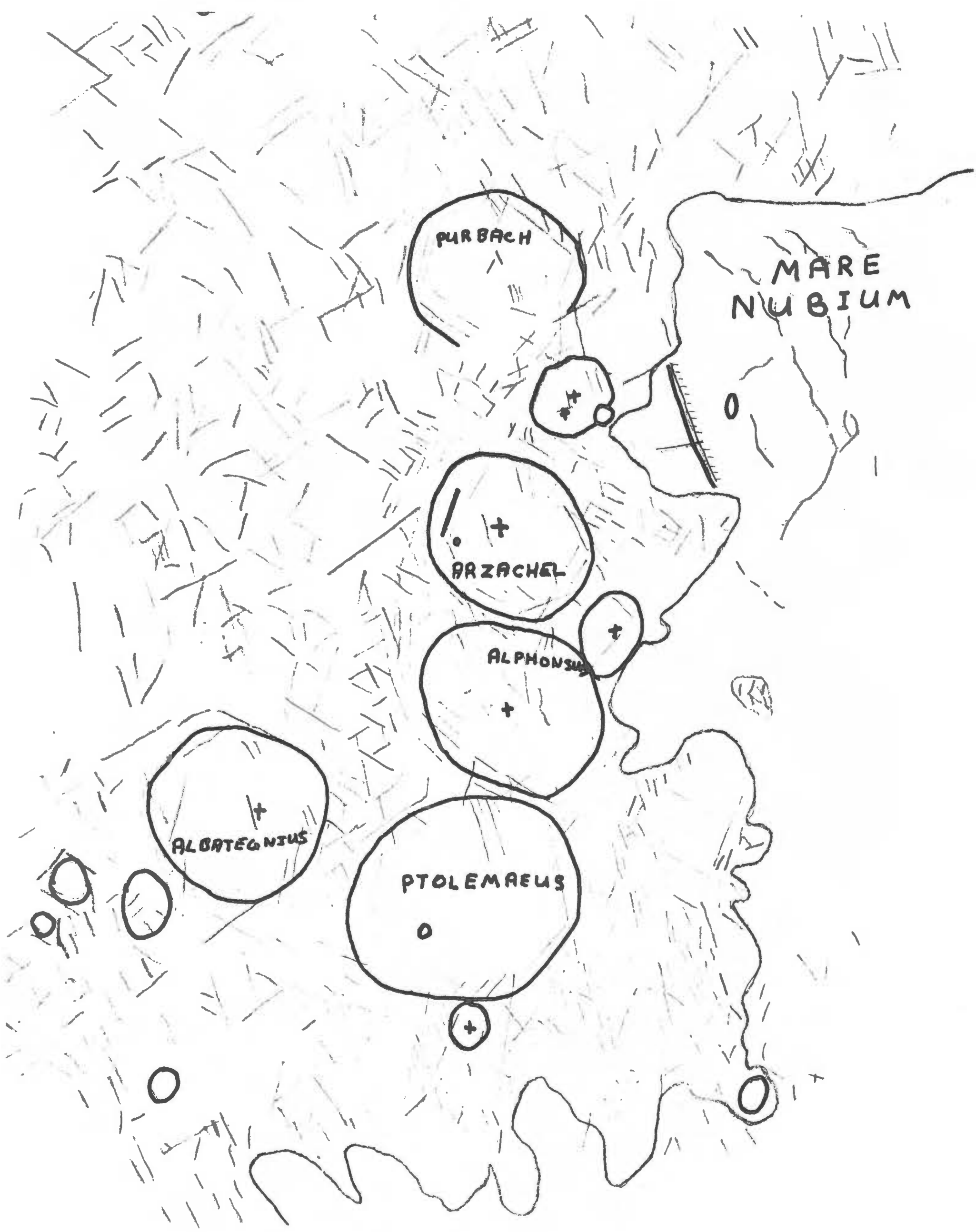

Figure 17. Ptolemaeus region of the moon, showing lunar lineaments as traced by Carl F. Dillon, Jr. from Tectonic Map of the Moon (maps 1A and 1B), interpretation by Robert G. Strom. Lunar steep places are superimposed with heavy outlines. Many steep craters are composed of these lineaments, and many groups of steep places lie in chains parallel to the directions of the tectonic grid. See also text.

Trivial Filler by Editor. First of all, I think that we should all congratulate Mr. Dillon on carrying out so well a lunar project of such great scope--many, many hours were needed for its completion. It is most heartening that one of our younger lunar observers should show such diligence and devotion. This praise must come before any adverse criticisms of his interpretations of his results.

surrounded by, or lie parallel to, the tectonic lines. Figure 17 is an example.

The marked resemblance of lunar steep places that run parallel to the maria "coasts" to the earth's distribution of its volcanic system that frequently parallels the continental coastlines gives rise to much speculation over whether they share a common origin. However, although present data may at first favor a plutonic type of origin, more data are needed before these relationships can be clearly apparent. Subsequent investigation may prove the preceding hypothetical reasoning to be totally wrong.

Most important, however, new knowledge concerning the nature of the moon has been found using modest equipment; and new questions have been uncovered. It remains for future investigations to attempt to answer them.

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4) Joseph Ashbrook, "Steep Places on the Moon", The Strolling Astronomer, Vol. 17, Nos. 7-8, pp. 136-137.

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BOOK REVIEWS

Technical Report 32-990 "The Mars 1964-1965 Apparition", by C. F. Capen, published by Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, December 15, 1966. 187 pages.

Reviewed by Gene Lonak

During this aphelic apparition of Mars, the planet approached earth to within 62,-100,000 miles and subtended a maximum diameter of 14."0. Observations conducted at the JPL Table Mountain Observatory with a 16" Cassegrain f/20 reflector and at the U. S. Geological Survey Astrogeology Gilbert Observatory with a 30" Cassegrain f/15 telescope produced excellent results.

The abstract preceding the report describes the photographic and visual observations conducted and summarizes the Martian seasonal events observed from September, 1964 to September, 1965. The Martian polar regions, atmospheric phenomena, and a description of the surface features are contained in 358 drawings and photographs, various tables, and a daily observation report. The Mariner IV contact of July 15, 1965 is also included, and the data from it are presented for further study and analysis.

An introduction contains a heliocentric chart showing the orbits of Earth and Mars and indicating their various positions at opposition for the years from 1963 to 1978. Disk diameter, phase, and axial positions are included to indicate the appearances of the planet in aphelic and perihelic positions. This introduction along with a short description of the observing program and observational techniques begins the coverage for six Martian months - from March (late northern winter) to September (end of northern summer). The observations include 292 multi-color spectroscopic film records, containing about 2,450 images made with the 30" instrument, 65 color films containing 650 images, 321 filter-aided visual observations, and several photographs taken with the McDonald 82" reflector to fill in record gaps. Continuing with nomenclature and abbreviations, the report contains a description of the Martian date used to illustrate the seasonal phenomena. The reader should have no difficulty in visualizing the apparition since concise explanations, tables, and illustrations of all the data are used throughout.

With the termination of the introductory chapters, the report continues with the Martian seasonal events, in general, observed during the apparition. Initially, the Martian disk subtended a diameter of 4".7 revealing gross dark surface features, much sunrise limb haze, a south polar hood, a large clear north cap, and a terminator cloud projection. A general atmospheric clearing was also noted and was attributed to a moderate blue clearing which lasted for about two weeks. Continuing to March, 1965, at opposition, many high quality observations of the darkening surface features were secured; and increased atmospheric activity was noted. The north cap continued its maximum rate of melting, and many recurrent clouds were evident over defined surface features. Many frost patches were observed on both limbs, and a green haze initially observed in February was also evident.

April produced high quality seeing, revealing cloud activity which reached its maximum during the first part of this Martian summer. Surface contrast of all major dark features and details also reached its maximum. The Arctic regions of the north cleared of haze, and the northern cap showed an irregular periphery with two cap projections and a dark rift. The south polar region freed itself of haze except for an evening limb haze. Blue clearing was also observed during this time, and frosted areas and cloud activity declined slightly toward the end of the month. Maria and oases expanded in size, and the Martian disk showed unusual fine canal structure. Many excellent photographs were secured during this observational period. In May the good conditions continued, although no atmospheric blue clearing or green haze was detected. During June and July, 1965 the diameter of the disk decreased from 8" to 6", and a general decrease in haziness was noted. At the time of Mariner IV encounter in July, the Martian atmosphere was extremely clear.

The report continues with details of the Martian polar regions, including two tables of retrogression measurements in red and green light. An additional figure shows retrogression curves from the north polar cap from April through August in Martian dates. Drawings and photographs of the region include the geometry of the cap measurements and show clearly the activity observed. Although the south polar cap was not visible during most of the apparition, a short table of its hood measurements is given.

A lengthy discussion concerning atmospheric and meteorological phenomena follows. A table depicting these is included as two pull-out pages showing the different cloud types, latitudes, longitudes, and occurrences, along with suitable remarks. Green and violet opacity are discussed, and blue clearings observed are tabulated. The white areas seen are also included in a final table, along with two histograms showing blue and white clearing activity. The Martian surface features are covered in the next chapter and indicate that a great deal of attention was paid to several distinct portions of the planet.

A daily observation report of surface and atmospheric phenomena begins the next section, giving a critical evaluation of data for a given night. For easy reference, the telescopic observations are listed in one order, beginning with the polar regions, atmosphere, surface whitenings, gross dark surface features, and oases and ending with canals. Instrumentation and magnification and a short statement indicating axial tilt, disk diameter, and width of terminator are also given.

The next section contains a Martian pictorial atlas consisting of multi-color spectroscopic pictures and black and white reproductions of color transparencies with low-quality images or drawings used where necessity dictated. Termination of this chapter begins the next - photographic data produced by Mariner IV.

In his first appendix, Mr. Capen includes the observation log for the entire apparition - all relevant and tabular data used for the physical observations. A reader who has made observations during this period will find such data extremely interesting in orienting his own observations and in comparing aspects of the physical relationships between the two planets. The second appendix, in supplement to the first, clarifies the orientation of the Martian disk to further illustrate the observations presented. The final appendix illustrates the change in Martian longitude versus Universal Time interval, a table which should be in the possession of all observers of Mars. Finally, an index of aerographic names is included. These names can easily be located in the various portions of the report or on the ALPO key map attached, modified for this 1964-65 apparition.

The entire report is extremely well-written in an orderly and illustrative manner. It should be read to furnish a potential observer information upon the type of observations that can be made. The wealth of material presented cannot be given justice in a review of this type. After reading this report and comparing it to my own observations, I have augmented my own knowledge and anticipate that future observational periods will produce more critical observations and analyses of data secured from other sources.

******

The Other Star, by Arthur Eedle. Published by Miles Henslow, printed by Portia Press Ltd., 249 pages. $5\frac{1}{2}$ X $8\frac{1}{2}$ inches, paper bound. Price 25 shillings.

Reviewed by A. Wade Mount

Oddly enough, the title page shows no publication or copyright date, but from the text one would judge that the book was written rather recently. However, on page 62 the period of axial rotation of Mercury is given as 88 days rather than the recent radar determination of some 59 days.

Chapters one and two are largely devoted to a brief general description of the Solar System and to certain theories of its origin, together with some of the shortcomings of these theories. The author builds on this background and then in chapter three draws nearer to his "new theory" of the origin of the sun's family.

Although a theory involving the intrusion of another star into the gravitational field of the sun as a possible mechanism for the Solar System's formation has been with us since the work of Sir James Jeans, the author's version of that possible occurrence is essentially new in its development and presentation. The close approach of "the other star", the motion of the star and sun about their common centers of mass, the resulting tidal effects on both the near and far sides of the sun with respect to the star and the resulting planetary system all form an interesting back-drop to much of the subsequent discussion.

A wide range of Solar System elements and relationships, ranging from asteroids and comets to a "twin tidal law", are discussed in the ten chapters of the book. The publication is non-mathematical; but the author has a pleasing way with words and presents his case in a clear, convincing, and easily read narrative form. The book is well illustrated with drawings, tables, graphs, and photographs; the book is unusually well printed on good quality paper and is provided with an entirely adequate index.

This publication is, perhaps, not a book that will find wide use as a source for general reference by the average reader, but it is certainly a book that will prove very informative to anyone interested in keeping abreast of current thinking on the origin of our Solar System. The Other Star is recommended reading.

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The Earth's Moon, The National Geographic Society. $1.00 on paper, $2.00 on plastic, plus 15¢ and 30¢ respectively for postage and handling. The National Geographic Society, Washington, D.C. 20036.

Reviewed by Charles L. Ricker

This map of the moon, which was sent to all subscribers to The National Geographic Magazine, along with the Feb., 1969, issue of that magazine, is by far the best small lunar map to be published to date. This reviewer spent an entire evening examining its many interesting features. The map is on a scale of 1:11,620,000 and portrays both the near and far sides of the moon. It is constructed using Orbiter photographs as a basis, and great care and some novel and ingenious methods were employed in drawing the various formations upon the map in precisely the correct locations with respect to the grids. An amazing amount of detail is depicted, and the view is similar to what one might see in a 2" or 3" telescope. The realistic depictions and attention to detail should make identification of minor formations very easy at the telescope. This improvement will be welcome to those who have tried to match telescopic views to previous maps! Formations are shown unforeshortened, which certainly is the true picture, though many formations near the limbs will necessarily appear very different in a telescope.

A vast amount of useful and interesting information and diagrams are contained on the margins, including a comprehensive list of all major formations and their coördinates. Views of the moon at different phases and many useful notes about the moon and the space program are also included. The beauty of this map will make it ideal for adorning the den or observatory wall, and its usefulness will necessitate owning two copies so that one copy may be used at the telescope. This map is a must for a beginner who is just starting to find his way around on the moon, and the experienced lunar enthusiast will find many useful applications for this very timely addition to the lunar literature.

******

Is Anyone There?, by Dr. Issac Asimov. Ace Pocket edition, New York, N. Y., by arrangement with Doubleday & Co., Inc., 1967. 319 pages, price $0.95.

Reviewed by Gene Lonak

The controversial subject of extraterrestrial intelligence has been treated in several ways in past literature, extending from the classical titles Life on Other Worlds, by H. Spencer Jones and Intelligent Life in the Universe, by Shklovskii and Sagan, among others, to the present writers such as the author in the above work. The different point of view in Is Anyone There? is brought about by the fact that Dr. Asimov is primarily notable in the field of biochemistry, as his faculty status at the Boston University School of Medicine will attest. In addition, his imagination and speculative thinking have made him one of the most popular science-fiction authors in the country.

Dr. Asimov has clearly divided this book into three sections, the first being subjects "more or less known" - life, and non-life; the second, subjects "more or less unknown" - other life, and future life. His third section concerns science-fiction; and although it does not add to his speculation regarding extraterrestrial life, it does render interesting reading by calling attention to his gift of imagination and by presenting ideas in a popular form through humor and his erudition. In reality, Is Anyone There? is a collection of essays presented previously in various publications and brought together in a manner which collects various subjects and condenses them into a book of this type. Each essay could be read alone and with profit for the reader; but by placing them together, the author makes fact and speculation work hand in hand to present a clear picture of the possibilities of life elsewhere and the problems of detecting it.

Beginning with the basic properties of life itself, the author carries the reader through the world of biology by discussing the basic building-blocks of life - nucleic acids, DNA, RNA, the mechanics of heredity, and much more. In detail he describes the characteristics of the blood, brain, and nervous system, how they are inter-related to one another, and irregularities in the functions of the various organs. When finished with the section, the reader can fully appreciate the necessity of establishing a firm foundation of knowledge in understanding known life before any attempt can be made to speculate on other life in the universe. The science of exobiology has been initiated, but as Dr. Asimov points out "it is a science with no subject!"

In section two, we are transported into the universe, beginning with the basic unit of matter - hydrogen. Our course of travel from the oceans is discussed, past the atmospheres of the various planets of the Solar System and out to the extreme edges of the visible and known universe, stopping only to describe the mysteries of quasars and Einstein's theory of time dilation and changes in physical properties as matter approaches the critical velocity of light. Big-bang and steady-state hypotheses are brought to light, along with the assumptions which can be realized from considering either theory; and it is explained why our present knowledge now condones the view of George Gamow and the big-bang.

Dr. Asimov considers in his remaining chapters the problems of population, future generations, and how interstellar flight could readily be achieved (within an astronomically short period of time). He coins the term "spome" (contraction for "space-home") and through logic and deduction carries our progeny out to the extreme limits of space. I believe he means also that other cultures which may exist may already have travelled in this manner. Even though Man's information regarding the extraterrestrial is practically nonexistent, a book such as Is Anyone There? should be read in interpreting our own culture and in setting goals for our future course to the stars.

W.A.A.-A.L.P.O. Convention in August, 1969. A joint Convention of the Western Amateur Astronomers and the Association of Lunar and Planetary Observers will be held at San Diego, California on August 21, 22, and 23, 1969. The site will be the Stardust Motor Hotel, 950 Hotel Circle, San Diego, California 92110. All program sessions and the banquet will be in this motel, which is one of San Diego's newest and finest. There will be a choice of tours to Palomar Observatory and alternate points of astronomical interest. Besides the amateur papers, there will be one professional speaker on each day of the Convention. Reservations should be made directly with the Stardust Motor Hotel, and no later than August 13, 1969. Registration is being handled by Wilbur L. Will, 3905 Violet St., La Mesa, Calif. 92041. Those having astronomical exhibits--drawings, charts, photographs, and the like--should contact Colin MacDonald, 3933 St. James Place, San Diego, Calif. 92103. The General Convention Chairman is Howard L. McCalla, 1845 Primera St., Lemon Grove, Calif. 92045. Since the City of San Diego is celebrating its 200th Anniversary this year, there will be many attractions for the vacationer and the non-astronomer conveniently at hand.

Special Request for A.L.P.O. Papers. Qualified A.L.P.O. members are most heartily invited to read a paper at the San Diego Convention. Indeed, so few papers have yet been even promised that this request is an urgent one. A helpful brochure called "How to Prepare a Paper" from the San Diego Astronomy Association describes in detail what is necessary for a paper to appear in the Convention *Proceedings*. A copy of this brochure will be supplied by the Editor upon request. All ALPO papers should be mailed to Walter H. Haas, Box 3AZ, University Park, New Mexico 88001. Papers must be received here by July 16, 1969 at the latest if we are to be sure of inclusion in the *Proceedings*.

New A.L.P.O. Assistant Mars Recorder. We gladly announce that this position is now being filled by Thomas R. Cave, 265 Roswell Ave., Long Beach, California 90803. Mr. Cave has been an enthusiastic observer of Mars for many years. He and Mr. Charles Capen, the Mars Recorder, both live in southern California, see each other at frequent intervals, and plan to work together closely in supervising A.L.P.O. studies of Mars. Mr. Cave was at one time our Venus Recorder - we heartily welcome him back to our staff.

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