THE 1983-85 APHELIC APPARITION OF MARS—REPORT II

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ABSTRACT

The meteorology of Mars from 1983 through 1985 is presented along with an update of a long-term statistical analysis of Martian atmospheric phenomena. Five transient or localized dust storms, as well as a major dust storm, were observed during this apparition. Possible relationships between these storms and the variations of Mars' polar caps are discussed. Several light and dark surface features underwent changes during the apparition, possibly as a result of the dust-storm activity.

INTRODUCTION

During the last several apparitions of Mars there has been an increase in both the quantity and the quality of the observations submitted to the Mars Section. A greater interest in the Red Planet , and improved observing skills, are evident in the visual observations and photographs recorded each day during an apparition. More A.L.P.O. Mars Section contributors are making systematic color-filter observations and are performing quantitative studies such as micrometry and photography. The writers feel that this is, in large part, the result of the systematic observing program initiated by our late Mars Recorder, C.F. ("Chick") Capen. We also wish to thank the many contributors during the 1983-85 Apparition for their patience throughout the long delay in publishing the results of their work.

Report I covered observations of the Martian Arctic. [Beish and Parker, 1988] This report describes meteorology and surface-feature changes, illustrated by the drawings and photographs in *Figures 21-25* (pp.70-79).

METEOROLOGY

The Martian atmosphere is very dynamic, exhibiting several types of clouds and hazes that are easily detected with the aid of color filters and modest-sized telescopes. White water clouds, local yellow dust clouds, global dust storms, bluish limb hazes, and bright surface ice-fogs and frosts have been studied with increased interest during the past two decades. During the 1960's and 1970's, C.F. Capen classified Martian atmospheric and near-surface clouds and hazes as: *Polar Hood*, *Polar Haze*, *Planetary System Cloud Banding*, *Limb Brightening* (non-rotating haze), *Recurrent Cloud* (diurnal orographic), *Seasonal Cloud* (stable topographic), and *White Area* (frost or fog). These classifications are still in use by the Mars Section. [Michaux and Newburn, 1972] Observations of these meteorological features suggest that their behavior and times of occurrence are most often coupled with the seasonal sublimation and condensation of polar-cap material. [Beish and Parker, 1988]

Meteorological activity during the Northern-Hemisphere Spring, Summer, and Autumn was well recorded during this aphelic apparition. The results are summarized below.

Visibility of Martian Atmospheric Phenomena, 1983-85.

Limb Phenomena.—Martian *Limb Clouds* are best seen with violet (Wratten 47 or "W47") or blue (W38A, W47B) filters. *Limb Hazes*, or "Limb Arcs," are also seen through these same filters; and often also through green (W57) and yellow (W8, W12, and W15) filters. The visibility of atmospheric features through different color filters defines the relative heights of atmospheric aerosols and condensates. Violet and blue filters are best for showing high-altitude clouds; while light-blue (W38A), green (W57, W58), yellow-green (W56), and yellow (W12) filters show low-lying hazes and surface ice-fogs.

Bright limb clouds and limb hazes were observed throughout the 1983-85 Apparition. Several astronomers noted that the white-cloud frequency was below "normal" for the early portion of the apparition. This view was later confirmed by statistical analysis.

Orographic Clouds.—These discrete white clouds begin to condense above mountainous regions and volcanoes as local noon approaches, due to the uplifting of water vapor in the Martian atmosphere after the rapid thawing of the North Polar Cap (NPC) begins. By early local afternoon, they appear as bright round or oval-shaped individual clouds, producing a "domino effect" on the Martian disk [i.e., appearing similar to the white dots on a domino]. They can be seen without filters, but tend to be brighter in blue light. These clouds continue to expand and brighten as the planet rotates them toward the sunset limb, when they can best be seen in violet light, which indicates that they also expand upwards by convection. Some of these clouds coalesce with other clouds to form large, bright limb clouds such as the well-known "W-Clouds" observed in the Tharsis-Amazonis region. [For a map of Martian features, see *Figure 19* on p. 68.]

Discrete white and blue-white orographic clouds were observed in the Elysium and Tharsis regions during Northern-Hemisphere Spring, Summer, and Autumn in 1983 and 1984. However, a "below-average" frequency of occurrence was noted for these features in Northern Spring and Autumn. Statistical analysis reveals that their frequency of occurrence fell far below the averages for those same seasons during the 1977-79, 1979-81, and 1981-

83 Apparitions. Orographic clouds became more abundant during the Northern Summer, after the rapid retreat of the NPC had begun.

Topographic Clouds.—Dense bluish-white clouds of limited extent populate many areas of Mars during local Spring and Summer and persist for days in the same general areas. They are classified as *topographic* because they appear in or near large, deep craters and over great plains and valleys. Three areas, Aram, Edom, and Ophir, are particularly productive sites for white-cloud formation. Another region that has been observed to be cloudy during each apparition is the Isidis-Libya-Crocea region near Syrtis Major. Yellow clouds, blue-white clouds, and low hazes appear to gravitate into this large depression which lies north of the Tyrrhenum-Hesperia block and just east of the up-slopes of the Syrtis Major Planum. Shortly after the Northern Summer Solstice, an increase in discrete-cloud activity was reported by J. Beish, J. Dragesco, M. Nakajima, R. Fabré, D. Parker, M. Legrand, and others. These topographic clouds had become quite numerous by late Summer (areocentric solar longitude, Ls, 160°), and were prominent in Libya, Aeria, Moab, Edom, and Candor.

Topographic clouds grow and move within a region, especially when near the sunset limb. These clouds, often called "localized" or "regional" discrete clouds, appear to be white, but will brighten when observed through a blue or blue-green filter, indicating that they are possibly blue or blue-white clouds. Their color can vary; they can become prominent in green or can brighten in yellow light. This fact has led the late C.F. Capen and the present writers to think that they are a combination of water vapor and dust.

These discrete clouds followed the same frequency distribution and relative frequency of occurrence as did the orographic clouds. This pattern was characterized by low activity during local Spring, then increasing during Summer, and finally decreasing during Autumn. White clouds were seen more often from March, 1984 (Ls = 111°) onward, as reported by A.Wilson, M. Will, D. Moore, M. Legrand, G. Rosenbaum, F. Van Loo, G. Nowak, C. Capen, and R Fabré.

White Areas.—Ice-fogs and frosts, often called *bright patches*, can be distinguished from elevated clouds by means of comparing their relative brightness and definition of boundary as seen with the aid of blue (W38A), blue-green (W64), green (W58), yellow (W8, W12, or W15), and orange (W21 or W22) filters. The behavior and location of a bright patch also helps to distinguish it from a cloud or limb haze. If the suspect bright feature appears brighter in blue light than it does in green or yellow light, it is an atmospheric cloud. If it is brighter and more clearly defined in blue-green light than in blue or yellow light, it is probably ice-fog on or near the surface. If the patch appears brighter and with a sharp boundary in green and yellow light, and is not well seen in blue light, it can be identified as surface frost. Fogs and frosts form in the chill of the Martian night, rotate with the planet, sublimate in the morning sunlight, and usually disappear by local noon. Fogs normally form in valleys, basins, and on upper slopes.

Certain light areas exhibit temporary bright light patches which usually form when a polar cap is thawing rapidly; prior to the Summer Solstice in the appropriate hemisphere. These bright areas were mysteries to Mars observers until Viking Orbiter space missions identified them as surface frosts and dense fogs lying near the surface. They are analogous to terrestrial polar ice-fogs, known as "white-outs." The bright patches are thought by some to be topographically controlled. If this belief proves to be correct, careful observations of their occurrences and locations will be useful for improving local elevation maps of Mars. One example of such a region is the "Tractus Albus," a Y-shaped bright streak which runs southward from Tempe into Tharsis, bifurcating just north of Solis Lacus. This feature is seen well in green and yellow light and is most likely caused by the formation of patches of low fog in the system of valleys between the Acidalium Plate and the Tharsis Bulge. The Tractus Albus was not prominent during the 1983-85 Apparition, although D. Moore observed its partial formation during Northern Summer.

Blue Syrtis Cloud.—This feature was named the "Syrtis Major Blue Cloud" by C.F. Capen in 1978, who traced its seasonal occurrence as far back as 1858, when it was described by the astute Vatican Observatory astronomer Angelo Secchi, S.J. Employing an excellent 9.6-inch refractor, Father Secchi described a large blue triangular feature which he named the "Blue Scorpion." This cloud was next seen by J.N. Lockyer in 1862. Members of the British Astronomical Association reported it in 1911, and Lowell Observatory astronomers in 1920 saw this cloud appear to divide Syrtis Major into three sections. During the early Martian Summer of the 1950 Apparition, C.W. Tombaugh, C.H. Nicholson, and C.F. Capen made a number of observations of this feature. Capen later named it the "Blue Syrtis Cloud" because, when viewed through a yellow filter, Syrtis Major turned a vivid green; blue plus yellow makes green. [At times Syrtis Major itself has been reported as blue. Ed.] Although prominent in the 1960's and in 1982, this feature was not observed during the 1983-85 Apparition. Observers are encouraged to look for it during the aphelic apparitions of the 1990's because it is one of the most beautiful and mysterious features on Mars.

Equatorial Cloud Bands (ECB's).—These are rare, faint cloud streaks that tend to girdle the planet's equatorial zone. ECB's are only seen in violet light, suggesting high altitudes. The writers observed and photographed ECB's twice in 1984 during mid- and late northern Summer (Ls = 123° and 166°).

Zeta Clouds.—On 1984 APR 21, D.C. Parker photographed a very interesting and unusual white cloud formation that extended northward from Ophir (065°W/10°S) to Tempe (075°W/40°N), passing just east of the Nilus (082°W/25°S). Subsequently, for the period APR 16-20, visual and photographic reports of these same clouds were received from J. Dragesco, F.R. Van Loo, A. van de Jeugt, and Leo Aerts. The writers call these formations the "Zeta Clouds," because on violet photographs they resemble the Greek letter zeta (ζ). [Parker *et al.*, 1986] Individual white clouds are often observed in Ophir, Nilus, and Tempe during Northern Summers, as they were in 1984, but no extended formations of bright white clouds like these have been reported there.

Dust Storms

Although immense global dust storms are firmly entrenched in Martian lore, they may be rare. Lowell Observatory's Leonard Martin states that there have been only five well-documented *global* or *planet-encircling* Martian storms. These were reported in 1956, 1971, 1973, and 1977; in the last year, there were two storms discovered by the Viking space mission. [Martin, 1984] Records of observations of Mars indicate that most dust storms occur near the time of Southern Summer Solstice (Northern Winter Solstice; Ls = 270°), soon after perihelion passage (Ls = 250°).

While numerous yellow clouds have been seen on Mars in the Northern Spring and Summer, extensive and long-lasting dust storms are extremely rare in those seasons. Small transient aphelic dust storms were reported in 1914, 1915, 1929, 1959, 1961, 1967, 1969, and 1981-83, but they were observed to last only a few days and did not show expansion or significant motion.

From late October, 1983 (Ls = 053°), through mid-February, 1984 (Ls = 105°), an unusual number of dust storms was reported by Leo Aerts, J. Beish, C. Capen, F. Van Loo, J. Dragesco, D. Troiani, J. Olivarez, D. Parker, and others. Although these sightings have been discussed previously [Beish *et al.*, 1984], careful analysis of the A.L.P.O. observations by the present writers and by Lowell Observatory's Leonard J. Martin has resulted in a reassessment of the data. There was so much dust-cloud activity during this period that it was often difficult to determine when one storm began and another ended. Furthermore, the planet's small apparent diameter (approximately 6 arc-seconds) and inclement winter weather in much of Earth's Northern Hemisphere resulted in some gaps in the observational coverage. Nevertheless, there was enough international coverage of Mars during this period to permit an accurate picture of this early storm activity. To minimize ambiguity, only those clouds that were bright in red light, moved or expanded, and obscured surface features, are included in the following list, which is arranged chronologically in increasing order of areocentric solar longitude (Ls).

1. Ls = 053°-057°. Yellow clouds were suspected very early during the 1983-85 Martian Apparition when D. Parker noted on 1983 AUG 13 (Ls = 022°) that Chryse appeared very bright in orange light. On the following day, he saw a possible dust cloud in Chryse. Parker also reported a general "washed-out" appearance of Mars between 1983 OCT 20 and OCT 30 (Ls = 053-057°), when a bright yellow streak appeared over the Chryse-Oxia region. J. Beish, C. Hernandez, and D. Parker detected dust clouds in the area after OCT 30. On NOV 04 (Ls = 060°), D. Troiani reported that Mars appeared "dusty," with Sabaeus Sinus barely visible. According to observations by L. Aerts, J. Beish, D. Parker, D. Troiani, and A. Wilson, surface features remained dusty in appearance and difficult to observe through the last week in November.

2. Ls = 069°-077°. On 1983 NOV 27 (Ls = 069°), a dust cloud was sighted over Phaethontis, southwest of Solis Lacus. This cloud rapidly expanded to the northeast into Thaumasia, Daedalia, and Candor; covering Solis Lacus by NOV 28! On DEC 01, F.R. Van Loo, observing from Belgium, reported bright dust clouds in Aeria and Chryse, with obscuration of the previously conspicuous Meridiani Sinus. Within a few days, American observers confirmed these clouds which, by DEC 04 (Ls = 073°), had spread westward across Chryse, covering Lunae Lacus (Palus) and Ganges and appearing to merge with the dust clouds in Candor. Several observers noted that Meridiani Sinus and part of Sabaeus Sinus could not be seen until DEC 07. No further observations were obtained until DEC 11 when Parker noted bright clouds extending from Hellas-Noachis northward across Deltoton Sinus, merging with the cloud in Aeria. By DEC 13 (Ls = 077°), Beish reported that this complex of dust clouds was intensely bright, and even perceived anomalous dark features in violet light in the Moab-Aeria region. Unfortunately, no data were received from abroad until the end of December, so that observations during this critical period were limited to the region of Mars spanning approximately 130° to 320° west longitude.

From December 18, 1983, to mid-January, 1984, other types of Martian meteorology began to predominate, such as limb hazes and localized or orographic clouds. Sporadic dust activity was observed, however, with Beish reporting two long yellow streaks extending from Hellas northeastward into Libya on 1983 DEC 23 (Ls = 081°). Parker observed possible bright dust clouds in the regions of Electris, Atlantis, and Mesogaea on DEC 26 (Ls = 083°). This latter observation is of interest because Parker also perceived a conspicuous anomalous dark streak in Electris in violet light, adding to the suspicion of the presence of a dust cloud.

The period of time that spans Ls = 069°-077° is interesting in that at least two dust-storm systems appeared to be present simultaneously. Despite Mars' apparent diameter of only about 5 arc-seconds, these events are documented well worldwide by a number of independent observers.

3. Ls = 089°-092°. On 1984 JAN 11 (Ls = 089°), the writers independently observed dust clouds extending from Moab across Chryse, partially obscuring Meridiani Sinus and Margaritifer Sinus. In orange light, they also detected a brilliant morning-limb projection over Thaumasia. At the same time, J. Dragesco, observing the portion of the planet farther to the east, reported a brilliant cloud over Deltoton Sinus, obscuring most of Sabaeus Sinus. Over the next several days, the dust clouds extended from the Hellas-Yaonis region into Aeria, covering the eastern half of Sabaeus Sinus, and also westward across Moab and Chryse. Again, anomalous dark streaks were noted in these regions in violet light. This storm may well have extended into Candor, as Ganges became obscured; but there were no observations of longitudes west of Candor at the time of this storm. By JAN 18 (Ls = 092°), the dust began to subside, and Mars returned to a more normal appearance.

4. Ls = 097°-105°; A Major Dust Storm. A major dust storm began on 1984 JAN 29 (Ls = 097°) and lasted until at least FEB 15 (Ls = 105°). It covered much of the Martian Southern Hemisphere from Argyre to Ausonia and even extended into the Northern Hemisphere from Elysium to Nilokeras. Drawings made on JAN 29 by Dragesco and Robotham reveal some obscurations of the southern Maria Sirenum and Cimmerium. Beish noted bright dust clouds farther to the west over the Libya-Isidis region. On the following day, Parker reported dust clouds obscuring the Tyrrhenum Mare. They also reduced the intensity of Trivium Charontis, which has remained relatively inconspicuous throughout the next two apparitions. During the next several days, the storm expanded eastward, obscuring the northern borders of Cimmerium and Sirenum Maria, and also northward to cover Elysium and most of Tharsis.

By FEB 05 (Ls = 101°), Beish observed most of the planet's disk, centered at longitude 138°, as covered with dust *except* for a dark spot at the position of Olympus Mons! As the storm was followed eastward, it merged with dust clouds in Chryse-Xanthe, which clouds had been sighted from Europe by Dragesco and Van Loo, and completely obscured Solis Lacus, eastern Sirenum Mare, Ganges, and Lunae Lacus. Interestingly, as the storm moved east, dust clouds were seen to mingle with white orographic clouds over eastern Tharsis. Several observers reported anomalous dark features in violet light over areas where the dust clouds were brightest. Between Martian longitudes 070°-200°, Troiani, Beish, and Parker found that the entire southern half of the disk appeared dark in violet light.

By 15 FEB (Ls = 105°), the dust began to subside rapidly; and Mars appeared to be fairly normal for the season except for a fading of eastern Sabaeus Sinus, Trivium Charontis, and the northern border of Sirenum Mare. Reports from European astronomers revealed that the storm spared the regions from 290° westward to 010° longitude. Thus, this was not a *planet-encircling* storm, but nevertheless was a major event which long will be remembered by those who observed it. For further information on this storm, see Beish *et al.*, 1984, and *Figure 22* (pp. 72-73).

5. Ls = 113°-121°. Between 1984 MAR 03 and MAR 22, several observers reported dust clouds in Memnonia and Zephyria. The character of these clouds was confirmed by color-filter study of slides submitted to the Mars Section. By MAR 10 (Ls = 116°), most of Sirenum Sinus again appeared obscured and Solis Lacus became subdued. Sirenum Mare was invisible by MAR 18 (Ls = 120°), as reported by Aerts, Van Loo, Beish, and Parker; but Solis Lacus had returned to prominence. However, several elongated dust clouds were reported extending from Chryse into Candor and eastern Tharsis, covering Ganges. These clouds extended little farther and dust-cloud activity had subsided by MAR 22 (Ls = 121°).

6. Ls = 169°; A Solitary Dust Cloud. On JUN 24 (Ls = 169°), J. Dragesco observed and photographed a bright yellow cloud in eastern Thaumasia, obscuring eastern Solis Lacus, Nectar, and Agathodaemon. On JUL 02 (Ls = 173°), Parker photographed approximately the same longitudes, revealing that the region had returned to normal. From JUN 26 through 29, yellow clouds in Chryse were reported by L. Aerts, J. Beish, R. Fabré, R. McKim, and K. Rhea; and in Aeolis by D. Parker. The last of these yellow clouds appeared in Chryse and along the Ganges between JUL 03 and 06 (Ls = 174-176°), and was photographed in color by Beish and Parker.

Dragesco's drawing and photograph of JUN 24 and Parker's photograph of JUL 02 are shown in *Figure 25* (pp. 78-79). They illustrate nicely the value of timely photography and international communication in following the course of a Martian dust cloud. More importantly, the value of familiarizing oneself with the "normal" appearance of Mars cannot be overrated. Martian dust storms are at once among that planet's most scientifically important phenomena and the most difficult to observe, at least in their early stages. Data are sadly lacking on these early, formative stages of Martian dust storms, so that it is important that the observer be able to recognize the phenomenon. While the terms "washed-out" and "yellow-appearing clouds" are helpful, they are usually quite subjective, even when interpreting photographs. The *sine qua non* of Martian dust storms is movement with the *obscuration* of previously well-defined albedo features, producing an abnormal appearance for the Martian surface. The observer, then,

must be able to appreciate what "normal" is. Probably the best way to accomplish this goal is by systematically drawing the planet, starting several months before opposition. Thus, when an obscuration occurs, the astronomer will be immediately alerted to it, almost by reflex, and will be able to take appropriate action. For example, if Dragesco had not *seen* the JUN 24 dust cloud, he might well not have bothered to photograph it and certainly would not have alerted other observers to follow up when this region of Mars was no longer visible from his terrestrial longitude. This rapid international communication and cooperation has been the goal of the A.L.P.O. Mars Section International Mars Patrol (IMP).

Meteorological Interactions

Report I for this apparition disclosed that the rapid-regression phase of the North Polar Cap (NPC) in 1984 was delayed by approximately one Martian "month," or by 30° Ls. In reviewing the records of that apparition, it was found that the periods of anomalous behavior of the NPC coincided with the occurrences of four significant dust storms which appeared during late Northern Spring and early Summer (Ls = 069°-105°). Such yellow-cloud activity could have created enough atmospheric dust to upset the delicate energy balance of Mars' Arctic. Viking spacecraft data confirmed that such atmospheric aerosols absorb heat and retard NPC retreat. [James, 1979]

SURFACE FEATURES

In addition to its atmospheric phenomena, Mars exhibits varied and often-mysterious surface changes. The dark blue-green "maria," an example of "albedo features," appear to darken during local early Spring in such a manner that a "wave of darkening" appears to sweep from the thawing polar cap towards the equator. [Note: Photometry indicates that the blue-green color is a contrast effect and that the maria are neutral in hue. Ed.] This event, which occurs during each hemisphere's Spring, lent credence to the theory that the maria contain vegetation, which is replenished when water flows from the melting polar cap towards the equator. Now, we know that this concept is false. In fact, the late C.F. Capen showed that the wave of darkening is in actuality a "wave of brightening." These albedo features only appear to darken because the adjacent ochre desert areas have brightened during local early Spring. This explanation has been confirmed by Viking Lander images, which revealed a fresh, bright layer of dust that appeared on the ground during local early Spring.

Light and dark surface features tend to change in albedo and color diurnally and more slowly with the seasons. *Seasonal* variations are usually predictable, but *secular* (long-term) changes are unpredictable. Several regions that display seasonal changes are: Syrtis Major (293°W/10°N), Pandorae Fretum (345° W/25°S), Nilokeras-Lunae Lacus (or Palus) (060°W/25°N), Candor-Tharsis (090°W /10°N), Elysium-Trivium Charontis (215°W/ 23°N), Mare Australe (340°W/65°S), and Aonius Sinus (115°W/47°S). Another region of Mars that is subject to radical change is the Thaumasia-Solis Lacus ("Eye of Mars") area (085°W/28°S). For example, during the 1983-85 Apparition, J. Olivarez reported that Solis Lacus was not visible at Ls = 139°.

The Hellas Basin (292°W/50°S) is one of the most active areas on Mars, not only for its dynamic meteorology but also for its never-ceasing albedo changes. Its surface structure becomes apparent when its darker center (Zea Lacus) extends its arms or "canals" (Alpheus) to the north. This extension connects Hadriacum Mare (270°W/40°S) and Yaonis Fretum (312°W/ 35°S) eastward to the western edge of Peneus. As the Martian Southern Summer Solstice approaches, the Hellas Basin often becomes flooded with dust if and when a violent storm begins. Indeed, Hellas was involved in the 1983 DEC 11 and 1984 JAN 05 dust storms. Otherwise, it displayed no unusual changes. As the 1983-85 Apparition progressed and Southern-Hemisphere Winter got underway, Hellas and the high basin of Argyre (030° W/50°S) appeared as brilliant white on the southern limb. These great basins are the water-ice reservoirs for the Southern Hemisphere and are often covered with frost or with low clouds. Owing to the foreshortening caused by the planet's axial tilt, these features were often confused with the South Polar Cap (SPC) or its winter Hood.

Other seasonal changes of the Martian surface appear to be the result of the distribution of fine layers of surface dust by seasonal winds. The seasonal change in shape of Syrtis Major is an example of this. This dark, wedge-shaped feature, always a favorite subject for observers, classically broadens during Northern-Hemisphere Summer, reaching its maximum breadth near 145° Ls. [Dollfus, 1961] The eastern edge of Syrtis Major expands eastward to about 275° W longitude. Near the time of the Northern Autumnal Equinox (Ls = 180°), this boundary begins to retreat westward, reaching 283°W longitude during Northern Winter (Ls = 290°). P.A. Silveira of Caracas, Venezuela, along with C.L. Evans and J. Corder, showed Syrtis Major as very dark and possibly blunted at its north end during this apparition. However, the dramatic widening of Syrtis Major was not seen in the 1983-85 Apparition.

In addition, Syrtis Major has undergone some rather dramatic long-term or "secular" changes over the years. During recent apparitions, this feature appears to have become narrower and blunted compared with its appearance in the 1950's; and the once-conspicuous region to the east, called Nepenthes-Thoth, has all but disappeared. Osiridis Promontorium [not shown in *Figure 19*; position *ca.* 285°W/15°N] became very dark in 1984, appearing as a dark bar jutting out into Libya from the northeastern border of Syrtis Major.

This feature had been conspicuous in 1879, 1909, and during the 1940's and 1950's. The broad "canal," Nilosyrtis, which curves northeast from the northern tip of Syrtis Major, was inconspicuous in 1984.

Areas that have been observed to undergo secular changes during the past two decades are: Laocoontis Nodus-Amenthes (246°W/23°N), Nepenthes-Thoth (265°W/15°N), Thoana Palus (256°W/35°N), Moeris Lacus (270°W/08°N), the Antigones Fons-Astaboras complex (298°W/22°N), Margaritifer Sinus-Hydaspes Sinus (030°W/02°S; the Hydaspes Sinus is not shown in *Figure 19*), Solis Lacus (085°W/28°S), Nilokeras-Lunae Lacus (Lunae Palus) (060°W/25°N), and Acidalius Fons (not shown in *Figure 19*; 063°W/ 56°N).

Recent investigations revealed a possible secular change that occurred in the Trivium Charontis region (198°W/20°N) during the 1981-83 Mars Apparition. This area appears to have been covered over with dust during February and March, 1982. A somewhat "washed-out" appearance of this feature was observed during the remainder of that apparition, and it has been reported as low in contrast ever since. Dust storms during 1983 and 1984 appeared further to lower the contrast of the Elysium and Trivium Charontis region. On 1984 MAY 14, J. Olivarez reported that the Trivium Charontis-Cerberus was very difficult to see, or even missing from the face of Mars. This appearance was later confirmed by T. Dobbins.

The Nepenthes-Thoth (265°W/15°N) features, lying to the west of the Elysium Shield, which was so prominent in the 1940's and 1950's, decreased in size in 1960 and began fading in 1971. It was virtually undetectable in 1984. Laocoöntis Nodus (246°W/23°N), first described by S. Kibe in 1935, had faded during the 1970's and was not seen during the 1983-85 Apparition. Lying to the east of this region, toward Elysium, is Hyblaeus-Aetheria, an area that has undergone dramatic changes in recent years. In 1978, A.L.P.O. astronomers reported that the normally insignificant "canal," Hyblaeus (230°W/30°N), had darkened and expanded westward into Aetheria. Termed the "Hyblaeus Extension" by Capen, this change has persisted into the 1980's. On 1984 JUN 10 (Ls = 162°), J. Dragesco observed and photographed a further darkening in this region, located in Morpheos Lacus (not shown in *Figure 19*; 228°W/37°N). Later in June, J. Beish, R. Robotham, and D. Parker observed a bright streak running east-west from 160° to 260°W between 50° and 60°N. At 220°W longitude, another streak extended at right angles from the first streak southward into Elysium. These streaks were bright with all filters used, and their nature is not known. This entire region needs careful scrutiny and will be well-placed for observation during the aphelic apparitions of the 1990's.

Another area which has undergone change is the Daedalia-Claritas region (111°W/28°S) and Sirenum Mare (140°W/40°S). In 1973, the normally light region located between Sirenum Mare and Solis Lacus, consisting of Daedalia and Claritas, underwent a dramatic darkening which persisted through 1980. In 1984, this region had returned to normal. However, during March and April, 1984, D. Parker, J. Beish, R. Fabré, K. Schneller, T. Dobbins, and L. Aerts reported that northeastern Sirenum Mare had faded considerably. This appearance may have been the result of dust deposition from the storms sighted earlier in that region.

CONCLUSION

The 1983-85 Mars Apparition provided some interesting surprises for A.L.P.O. Mars Section astronomers. An unusual NPC regression, active Arctic meteorology, and moderate white-cloud activity were observed. The hallmark of this apparition, however, was the record number of significant dust storms that occurred when Mars was just past *aphelion*. The present writers feel that observational evidence already points to this unseasonable yellow-cloud activity as the cause of the retardation in the regression of the NPC, which in turn produced a diminution in white (water-ice) cloud activity. If this presumption is correct, the data furnished by the A.L.P.O. International Mars Patrol observers provides us with the first direct evidence of the relationships between Martian meteorology and the North Polar Cap.

REFERENCES

Beish, J.D.; Parker, D.C.; and Capen, C.F. (1984). "A Major Martian Dust Storm in 1984." *J.A.L.P.O.*, *30*, Nos. 9-10 (Aug.), 211-217.

_____ (1986). "The Meteorology of Mars–Part I." *J.A.L.P.O.*, *31*, Nos. 11-12 (Nov.), 229-235.

Beish, J.D.; Capen, C.F.; and Parker, D.C. (1987). "The Meteorology of Mars–Part II." *J.A.L.P.O.*, *32*, Nos. 1-2 (Mar.), 12-21.

Beish, J.D.; and Parker, D.C. (1987). "The Meteorology of Mars–Part III." *J.A.L.P.O.*, *32*, Nos. 5-6 (Oct.), 101-114.

_____ (1988). "The 1983-85 Aphelic Apparition of Mars–Report I." *J.A.L.P.O.*, *32*, Nos. 9-10 (Aug.), 185-197.

Capen, C.F.; Parker, D.C.; and Beish, J.D. (1984). "Observing Mars XI–The 1984 Aphelic Apparition." *J.A.L.P.O.*, *30*, Nos. 5-6 (Jan.), 125-130.

Dollfus, A. (1961). "Visual and Photographic Studies of Planets at the Pic du Midi." In: Kuiper, G.P., and Middlehurst, B.M., eds., *The Solar System. Vol. III: Planets and Satellites*. Chicago: University of Chicago Press. pp. 534-571.

James, P.B. (1979). "Recession of Martian North Polar Cap: 1977-1978 Viking Observations." *J. Geophys. Res.*, *84*, No. B14 (Dec. 30), 8332-8334.

—Continued on p. 69—

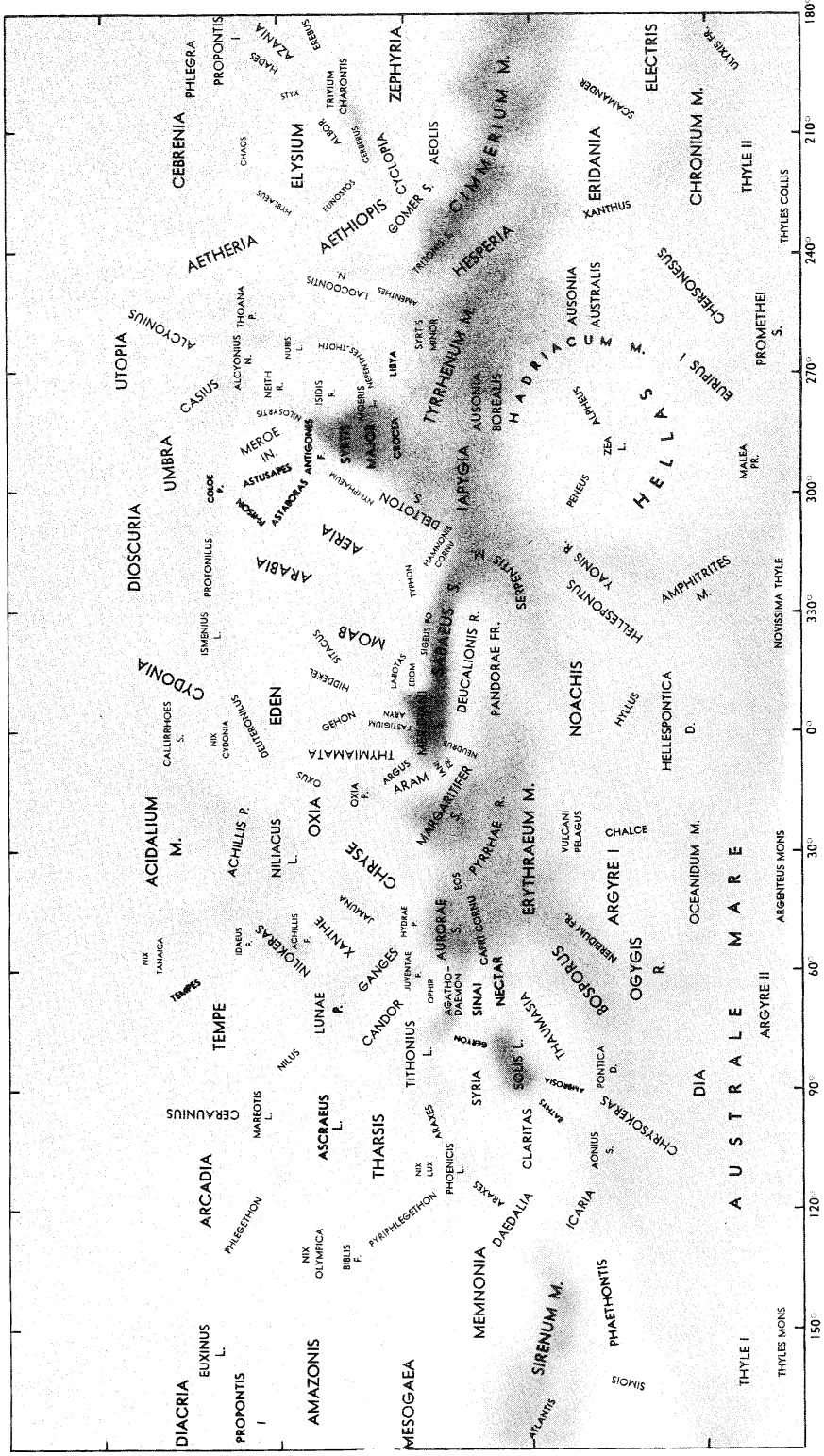

Figure 19 (on facing page). Chart of Mars for surface-feature identification. Prepared at Lowell Observatory in 1971. Note that, in order to fit the page, this chart has been rotated 90° so that Martian north is to the left, south to the right, east at top, and west at bottom. The tick marks along the minor dimension are for every 30° of latitude from 60°N to 60°S. The abbreviations used on this chart are as follows: **D.**, *Depressio*; **F.**, *Fons*; **Fr.**, *Fretum*; **In.**, *Insula*; **L.**, *Lacus*; **M.**, *Mare*; **N.**, *Nodus*; **P.**, *Palus* or *Pons*; **Po.**, *Portus*; **Pr.**, *Promontorium*; **R.**, *Regio*; and **S.**, *Sinus*.

Continued from p. 67—

Martin, L.J. (1984). "Clearing the Martian Air: The Troubled History of Dust Storms." *Icarus*, *57*, 313-321.

Michaux, C.M.; and Newburn, R.L. (1972). *Mars Scientific Model*. JPL Document No. 606-1, Section 4.1, p. 7.

Parker, D.C.; Beish, J.D.; and Capen, C.F. (1986). "A Simple Technique for Obtaining Violet Light Photographs of Mars." *J.A.L.P.O.*, *31*, Nos. 9-10 (July), 181-183.

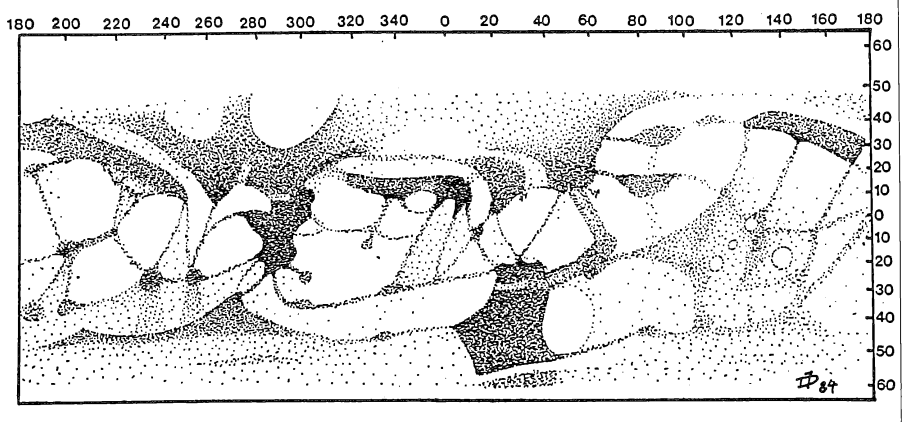

Figure 20. Map of Martian albedo features as they appeared in 1983-85. Drawn by J. Dragesco and based on his observations with a 36-cm catadioptric telescope during that apparition. This figure is oriented so that Martian south is at the top and west to the right.

Explanation for Figures 21-25.

The captions for the individual drawings and photographs in *Figures 21-25* are on the page facing each figure. The captions are arranged in rows and columns so as to match the illustrations. All Martian disks are oriented with south at the top and celestial east to the right.

In each caption, information is arranged as follows: Universal Date and Time; Ls, the areocentric longitude of the Sun; CM, the longitude of the central meridian; De, the areocentric declination of the Earth; k, the phase coefficient (proportion of disk illuminated); Dia., the apparent diameter of the disk in arc-seconds. These data are followed by the aperture of the telescope in centimeters followed by the focal ratio, if known; then by the type of telescope, where C indicates Cassegrain; N, Newtonian; R, refractor; and SC, Schmidt-Cassegrain. If "photograph" is not stated, the illustration is a drawing. Under "Filter," the Wratten numbers indicate the following colors: 8, yellow; 11, yellowish-green; 12, deep yellow; 15, deep yellow; 21, orange; 22, deep orange; 23A, light red; 25, red tricolor; 30, light magenta; 35, purple; 38, light blue; 38A, blue; 47, blue tricolor ("violet"); 47B, deep blue tricolor; 58, green tricolor; 64, light blue-green; and IL, integrated light (no filter). This information is followed by the observer's name, which in turn is followed by comments.

Figure 21 (facing).

1983 OCT 30, 11:15.
Ls 058°. CM 016°.
De +25°. k 0.95.
Dia. 4".3. 32-cm.
f/6.5 N. Filters: 30, 15.
D.C. Parker.
Brilliant streak on SW limb over Oxia-Chryse. Brightest in orange and yellow.

1983 OCT 30, 10:30.
Ls 058°. CM 005°.
De +25°. k 0.95.
Dia. 4".3.
32-cm. f/16.5 C.
Filters: 15.
J.D. Beish.
Bright cloud in Chryse. Dark streak (Arnon) extending S. from North Polar Collar.

1983 OCT 31, 10:30.
Ls 058°. CM 356°.
De +25°. k 0.95.
Dia. 4".4.
32-cm. f/16.5 C.
Filters: 23A.
J.D. Beish.
Bright yellow cloud in Chryse extending to Ophir.

1983 NOV 03, 11:25.
Ls 059°. CM 340°.
De +25°. k 0.95.
Dia. 4".4.
32-cm. f/6.5 N.
Filters: 23A, 15.
D.C. Parker.
Yellow clouds in Chryse and Aeria.

1983 NOV 24, 10:40.
Ls 068°. CM 124°.
De +24°. k 0.93.
Dia. 4".8. 32-cm.
f/6.5 N. Filters: 47.
D.C. Parker.
Conspicuous E. limb cloud over Candor. Note dark band N. of equator, seen only in violet light. Possible yellow cloud.

1983 NOV 27, 10:30.
Ls 070°. CM 092°.
De +24°. k 0.93.
Dia. 4".8. 32-cm.
f/30 C. Filters: 25, 23A, 58. J.D. Beish.
Yellow-cloud activity over Daedalia-Phaethontis Note dark streak along S. limb; Poss. shadow. Yellow cloud also in Candor.

1983 NOV 28, 11:00.
Ls 070°. CM 090°.
De +24°. k 0.93.
Dia. 4".9.
32-cm. f/30 C.
Filters: 22, 23A, 64.
J.D. Beish.
Dust storm obscuring Solis Lacus.

1983 NOV 28, 11:20.
Ls 070°. CM 095°.
De +24°. k 0.93.
Dia. 4".9.
32-cm. f/6.5 N.
Filters: 15, 22.
D.C. Parker.
Dust over Chryse and Candor, obscuring Ganges. N. Polar Collar broad and bluish.

1983 NOV 29, 10:35.
Ls 071°. CM 074°.
De +24°. k 0.93.
Dia. 4".9. 32-cm.
f/30 C. Filters: 22, 8.
J.D. Beish.
Mixture of yellow and white clouds over Solis Lacus; white area in Boreum Mare. Strong violet clearing despite dust.

1983 NOV 30, 10:40.
Ls 071°. CM 066°.
De +24°. k 0.93.
Dia. 4".9.
32-cm.f/30 C.
Filters: 8.
J.D. Beish.
Yellow clouds persist over Solis Lacus region. Bright yellow clouds in Chryse-Xanthe.

1983 DEC 01, 05:20.
Ls 071°. CM 338°.
De +24°. k 0.93.
Dia. 4".9.
25-cm. N.
Filters: orange.
F.R. Van Loo.
Bright yellow clouds in Aeria and Chryse. Sabaeus Sinus and Meridiani Sinus not seen.

1983 DEC 04, 10:40.
Ls 073°. CM 027°. De +24°. k 0.93. Dia. 5".0. 32-cm. f/30 C. Filters: 25, 23A, 30, 12, 58.
J.D. Beish. Yellow haze on Eve. limb, with bright yellow streak extending from limb (Eden) into Chryse. NOTE: Meridiani Sinus completely obscured; very dark albedo feature along S. limb may be cloud shadow.

1983 DEC 06, 10:00.
Ls 074°. CM 358°.
De +23°. k 0.92.
Dia. 5".0.
32-cm. f/30 C.
Filters: 25, 12, 58, 30.
J.D. Beish.
Yellow clouds and hazes obscuring Meridiani Sinus and Margaritifer Sinus. No albedo features seen in Eden or Arabia.

1983 DEC 11, 10:40.
Ls 076°. CM 319°.
De +23°. k 0.92.
Dia. 5".2.
32-cm. f/6.5 N.
Filters: 12, 25, IL.
D.C. Parker.
Bright yellow cloud extending from Hellas-Noachis across Deltoton Sinus into Aeria. A second yellow streak on morning limb in Eden. Meridiani Sinus now visible.

1983 DEC 13, 10:15.
Ls 077°. CM 294°.
De +23°. k 0.92.
Dia. 5".2.
32-cm. f/30 C.
Filters: 12.
J.D. Beish. Large yellow cloud extending from Hellas across Deltoton Sinus and E. Sabaeus Sinus into Aeria along W. border of Syrtis Major, thence westward across Moab and Eden. See next observation.

1983 DEC 13, 10:15.
Ls 077°. CM 294°. De +23°. k 0.92. Dia. 5".2. 32-cm. f/30 C. Filters: 47, 47B, 38A. J.D. Beish.
NOTE: Anomalous dark streak in Moab; probably the yellow cloud appearing dark in violet light! Also numerous white discrete evening and morning clouds.

1983 DEC 26, 10:00.
Ls 082°. CM 164°.
De +21°. k 0.91.
Dia. 5".6. 32-cm.
f/6.5 N.
Filters: 15, 23A, 30.
D.C. Parker.
Bright yellow streak across Atlantis extending NE. into Zephyria-Amazonis. Bright E. limb clouds in green and blue-green light—possible orographic clouds.

1984 JAN 12, 11:30.
Ls 090°. CM 022°.
De +19°. k 0.91.
Dia. 6".2.
32-cm. f/6.5 N.
Filters: 12, 15.
D.C. Parker.
Brilliant morning limb cloud over Xanthe-Candor; also bright in violet. Yellow haze across Eden and Chryse. Margaritifer and Meridiani Sinus poorly defined.

1984 JAN 17, 10:05.
Ls 092°. CM 314°.
De +19°. k 0.90.
Dia. 6".4. 32-cm.
f/30 C. Filters: 25, 15, 58, 30.
J.D. Beish.
Yellow clouds/haze obscuring eastern Sabaeus Sinus and covering Aeria, Moab, and Eden. In violet light (see next observation) dark streaks in Moab still persist.

1984 JAN 17, 10:05.
Ls 092°. CM 314°.
De +19°. k 0.90.
Dia. 6".4.
32-cm. f/30 C.
Filters: 47, 47B.
J.D. Beish.
Six discrete clouds in Aeria-Moab-Eden. Anomalous dark streaks; probably yellow clouds.

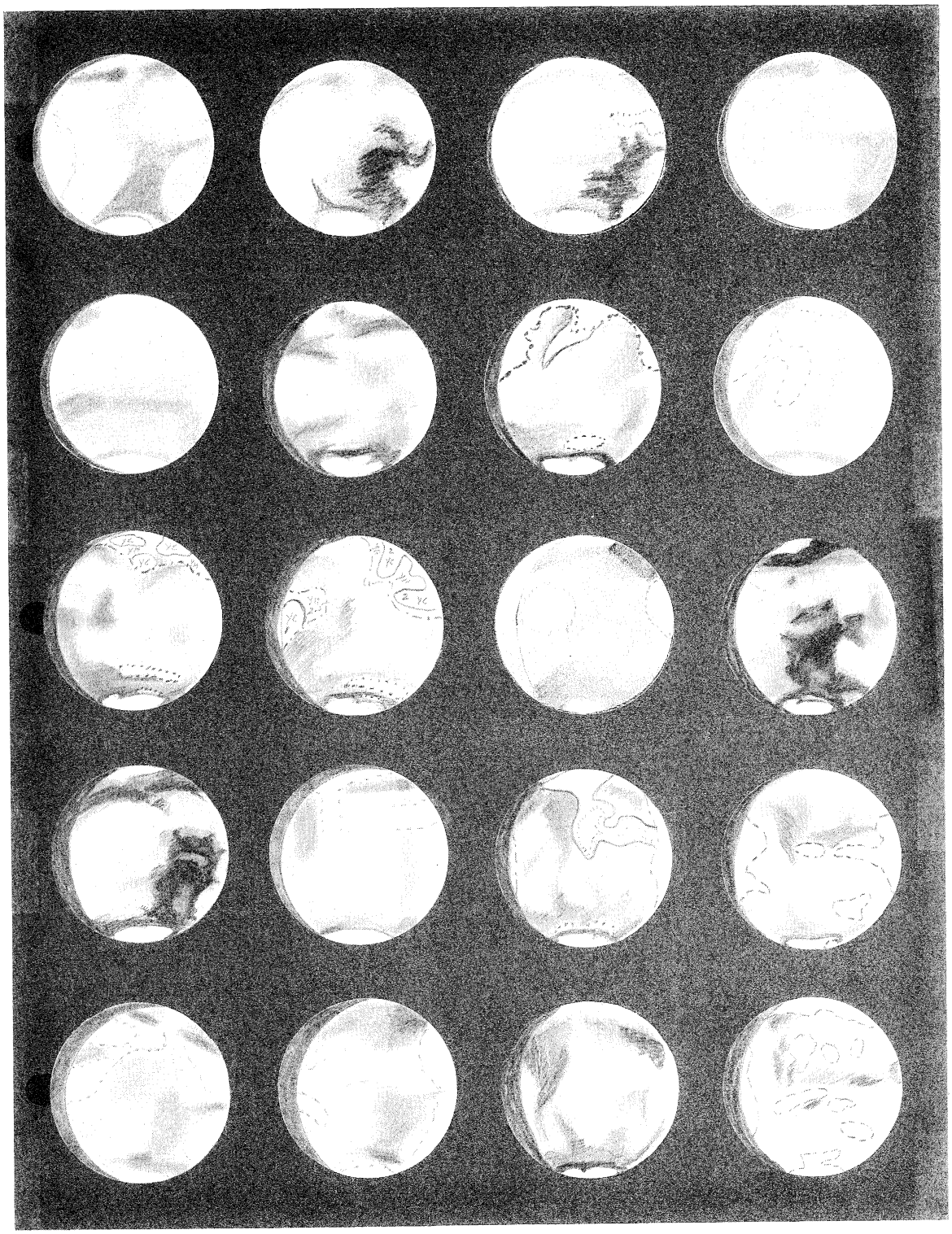

Figure 22 (facing).

1984 JAN 26, 04:55.
Ls 096°. CM 152°.
De +17°. k 0.90.
Dia. 6".9.
35.5-cm. SC.
J. Dragesco.
Bright orographic clouds on evening limb.

1984 JAN 29, 05:00.
Ls 097°. CM 124°.
De +16°. k 0.90.
Dia. 7".0.
35.5-cm. SC.
J. Dragesco.
Bright morning cloud obscuring Sirenum Mare—dust?

1984 JAN 31, 10:00.
Ls 098°. CM 178°. De +16°. k 0.90. Dia. 7".1.
32-cm. f/30 C. Filters: 15, 58, 30. J.D. Beish.
Bright yellow clouds in Zephyria and yellow haze covering southern half of disk. Cimmerium and Sirenum Maria washed out. Numerous discrete, orographic, and limb clouds seen in violet light.

1984 FEB 04, 05:05.
Ls 100°. CM 068°.
De +16°. k 0.90.
Dia. 7".4.
35.5-cm. SC.
J. Dragesco.
Bright clouds over Chryse-Xanthe and on morning limb, obscuring Solis Lacus.

1984 FEB 05, 10:30.
Ls 101°. CM 138°.
De +16°. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
Dust storm obscuring major albedo features except Olympus Mons. See next observation.

1984 FEB 05, 10:50.
Ls 101°. CM 143°.
De +15. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Anomalous dark feature positioned where yellow cloud was brightest!

1984 FEB 06, 09:25.
Ls 101°. CM 113°.
De +15°. k 0.90.
Dia. 7".5.
32-cm. f/6.5 N.
Filters: 12.
D.C. Parker.
Major obscuration of surface details by yellow cloud. Aonius Sinus seen on S. limb. Sirenum Mare obscured.

1984 FEB 06, 10:15.
Ls 101°. CM 125°.
De +15°. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
Major surface features completely obscured by dust.

1984 FEB 06, 10:15.
Ls 101°. CM 125°.
De +15°. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
White cloud on evening limb near Lunae Lacus, apparently projecting onto terminator. See next observation.

1984 FEB 08, 11:10.
Ls 102°. CM 119°.
De +15°. k 0.90.
Dia. 7".6.
25-cm. N.
Filters: 47.
D. Troiani.
Evening limb cloud apparently projecting onto terminator. Surface features largely obscured in red light.

1984 FEB 13, 06:30.
Ls 104°. CM 004°.
De +14°. k 0.90.
Dia. 8".0.
25-cm. N.
Filters: Orange.
F.R. Van Loo.
Bright yellow clouds on SW. limb. N. Hemisphere features faint, such as Acidalium Mare.

1984 FEB 24, 05:15.
Ls 109°. CM 241°.
De +13°. k 0.91.
Dia. 8".8.
35.5-cm. SC.
J. Dragesco.
No yellow-cloud activity. Morning clouds in Libya, Isidis, and Aeria. Elysium not brilliant.

1984 FEB 24, 11:20.
Ls 109°. CM 330°.
De +13°. k 0.91.
Dia. 8".8.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
No Evidence of dust.

1984 FEB 24, 11:40.
Ls 109°. CM 335°.
De +13°. k 0.91.
Dia. 8".8. 32-cm. f/30 C. Filters: 47, 47B, 38A.
J.D. Beish. Violet clearing relatively prominent. Evening cloud apparently projecting on terminator. Morning clouds and hazes. Edom cloudy.

1984 MAR 03, 05:10.
Ls 113°. CM 165°.
De +12°. k 0.91.
Dia. 9".5.
35.5-cm. SC.
J. Dragesco.
Bright orographic clouds on evening limb. Morning haze.

1984 MAR 07, 04:40.
Ls 115°. CM 120°.
De +11°. k 0.91.
Dia. 9".9.
35.5-cm. SC.
J. Dragesco.
"Domino" (white-dot appearing) orographic clouds.

1984 MAR 07, 07:30.
Ls 115°. CM 161°.
De +11°. k 0.91.
Dia. 9".9.
25-cm. N.
Filters: 47.
D. Troiani.
Elysium cloud on morning limb; orographic clouds near Olympus Mons.

1984 MAR 25, 08:36.
Ls 123°. CM 010°.
De +10°. k 0.93.
Dia. 11".9. 32-cm. f/6.5 N. Filters: 47.
D.C. Parker.
Violet-light photograph. Faint Equatorial Cloud Band; brilliant morning cloud over Xanthe, Candor, and Tempe.

1984 APR 01, 04:15.
Ls 126°. CM 242°.
De +10°. k 0.95.
Dia. 12".8.
35.5-cm. SC.
J. Dragesco.
Hellas brilliant. Discrete clouds over Elysium, Libya, and Aeria.

1984 APR 03, 18:20.
Ls 128°. CM 070°.
De +10°. k 0.95.
Dia. 13".1
20-cm. N.
M. Nakajima.
Solis Lacus small and weak. Claritas dusky. Bright cloud in Oxia-Chryse.

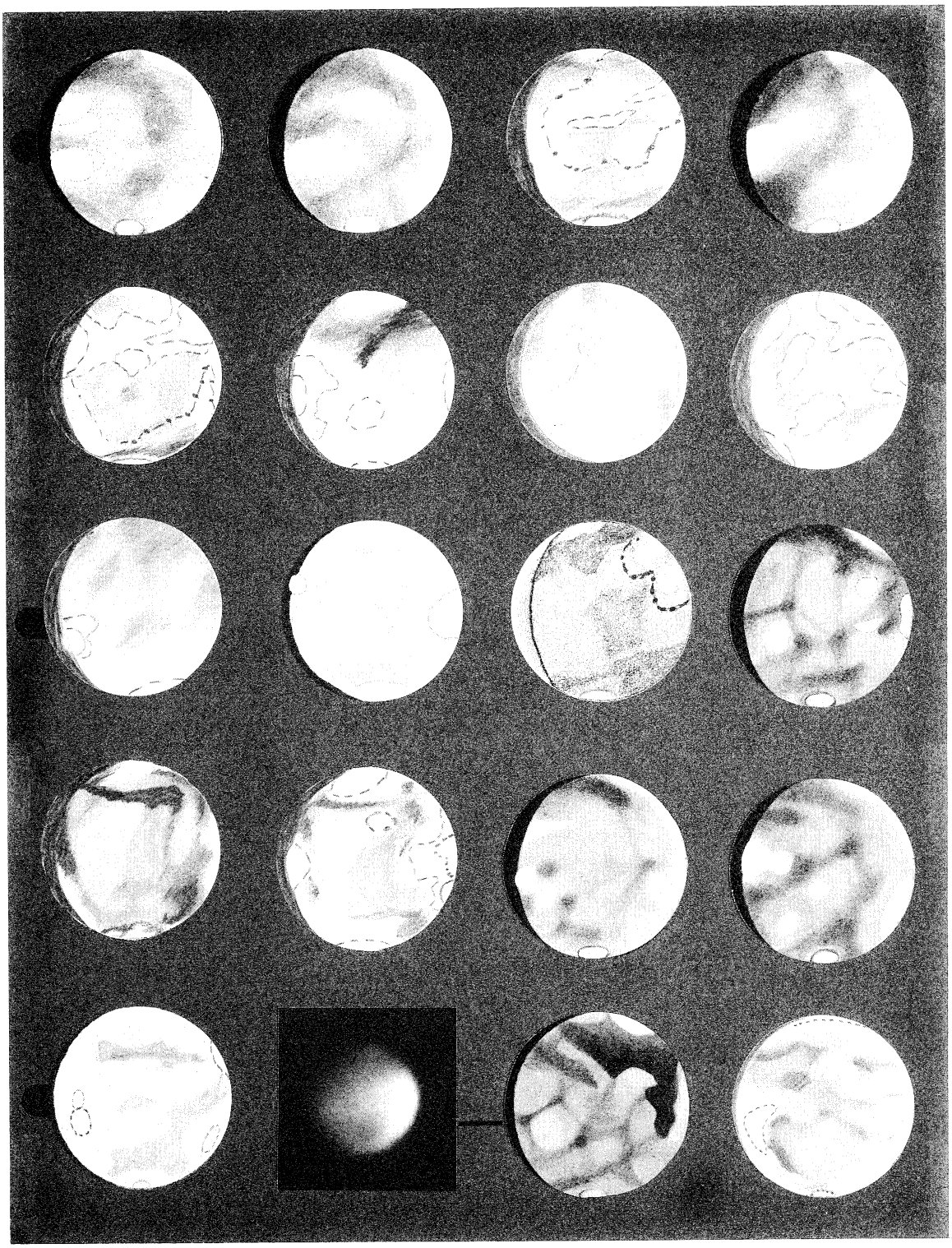

Figure 23 (facing).

1984 APR 06, 03:45.
Ls 129°. CM 189°.
De +10°. k 0.95.
Dia. 13".4.
35.5-cm. SC.
J. Dragesco.
Brilliant orographic cloud near Olympus Mons. Elysium dull.

1984 APR 06, 07:50.
Ls 129°. CM 249°.
De +10°. k 0.95.
Dia. 13".5.
25-cm. N.
Filters: IL, 58, 38.
J. Olivarez.
Elysium has now brightened during Martian afternoon, especially in green light. Hellas brilliant. North Polar Region dull.

1984 APR 09, 11:00.
Ls 130°. CM 268°.
De +10°. k 0.96.
Dia. 13".9.
28-cm. SC.
Filters: 47.
G. Rosenbaum.
Bright cloud over Elysium on evening limb. Morning cloud over Aeria. Hellas brilliant.

1984 APR 11, 05:30.
Ls 131°. CM 170°.
De +10°. k 0.96.
Dia. 14".1.
32-cm. f/6.5 N.
Filters: 15, 25.
D.C. Parker.
Atlantis appears widened due to S. limb haze. Trivium Charontis, Ceberus, and Propontis complex very faint.

1984 APR 12, 07:00.
Ls 132°. CM 182°.
De +10°. k 0.97.
Dia. 14".2.
25-cm. N.
Filters: Light blue.
R. Tatum.
Olympus Mons orographic cloud bright on evening limb. Elysium light; Cerberus-Trivium Charontis washed out.

1984 APR 15, 04:20.
Ls 133°. CM 116°.
De +10°. k 0.97.
Dia. 14".7.
35.5-cm. SC.
J. Dragesco.
"Domino" clouds.
Discrete clouds over Olympus Mons, Arsia Mons, Alba Patera, and on evening limb over Tempe and Ophir.

1984 APR 19, 07:17.
Ls 135°. CM 124°.
De +11°. k 0.98.
Dia. 15".2.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing "Domino Clouds." Compare with previous observation.

1984 APR 18, 04:00.
Ls 134°. CM 085°.
De +10°. k 0.98.
Dia. 15".1.
35.5-cm. SC.
J. Dragesco.
Possible yellow clouds obscuring Tithonius, Candor, Xanthe, and Ophir. Brilliant white cloud in Tempe.

1984 APR 19, 06:30.
Ls 135°. CM 112°.
De +11°. k 0.98.
Dia. 15".2.
32-cm. f/6.5 N.
Filters: 25, 23A, 35.
D.C. Parker.
Tempe brilliant in red through violet. Ophir-Candor very bright. Cloud over Daedalia. N. border of Sirenum Mare very faint.

1984 APR 21, 06:03.
Ls 136°. CM 088°.
De +11°. k 0.98.
Dia. 15".5.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing "Zeta Cloud." (See text on p. 64.)

1984 APR 21, 06:40.
Ls 136°. CM 097°.
De +11°. k 0.98.
Dia. 15".5.
32-cm. f/6.5 N.
Filters: 23A.
D.C. Parker.
Tithonius now visible. Candor returned to normal. NE. border of Sirenum Mare very faint.

1984 APR 21, 07:15.
Ls 136°. CM 105°.
De +11°. k 0.98.
Dia. 15".5.
32-cm. f/6.5 N.
Filters: 47.
D.C. Parker.
Orographic clouds over Ascraeus and Olympus Montes and Alba Patera. "Tractus Albus" partially formed. (See text on p. 63.)

1984 APR 29, 06:30.
Ls 140°. CM 023°.
De +12°. k 0.99.
Dia. 16".4.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing brilliant cloud in Argyre, morning-limb arc, and bright cloud in Tempe.

1984 APR 29, 07:00.
Ls 140°. CM 031°.
De +12°. k 0.99.
Dia. 16".4.
16.5-cm. R.
Filters: 21.
T. Dobbins and K. Schneller.
Noachis and Argyre bright. Small bluish cloud noted in Tempe.

1984 APR 30, 00:29.
Ls 140°. CM 286°.
De +12°. k 0.99.
Dia. 16".5.
35.5-cm. SC.
J. Dragesco.
Integrated-light photograph. E. Sabaeus Sinus weak.

1984 MAY 09, 05:50.
Ls 145°. CM 285°.
De +14°. k 1.00.
Dia. 17".3.
32-cm. f/6.5 N.
Filters: IL.
D.C. Parker.
Crocea bright. Nepenthes-Thoth, Laocoöntis, and most of Casius not seen.

1984 MAY 09, 06:30.
Ls 145°. CM 295°.
De +14°. k 1.00.
Dia. 17".3.
32-cm. f/6.5 N.
Filters: 47
D.C. Parker.
Strong violet clearing. Elysium not especially bright on evening limb..

1984 MAY 05, 05:51.
Ls 143°. CM 321°.
De +13°. k 1.00.
Dia. 17".0.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing Arctic clouds, haze in Libya, and cloud in Hellas.

1984 MAY 11, 10:00.
Ls 146°. CM 329°.
De +14°. k 1.00.
Dia. 17".4.
44-cm. N.
Filters: 11.
R. Fabré.
Arctic cloud. E. Sabaeus Sinus and Iapygia Mare weak.

1984 MAY 13, 05:00.
Ls 147°. CM 238°.
De +14°. k 1.00.
Dia. 17".5.
32-cm. f/6.5 N.
D.C. Parker.
IL photograph. Trivium Charontis -Cerberus weak. "Hyblaeus Extension" broad & dusky. Morpheos L. darkened. (See text on p. 67.)

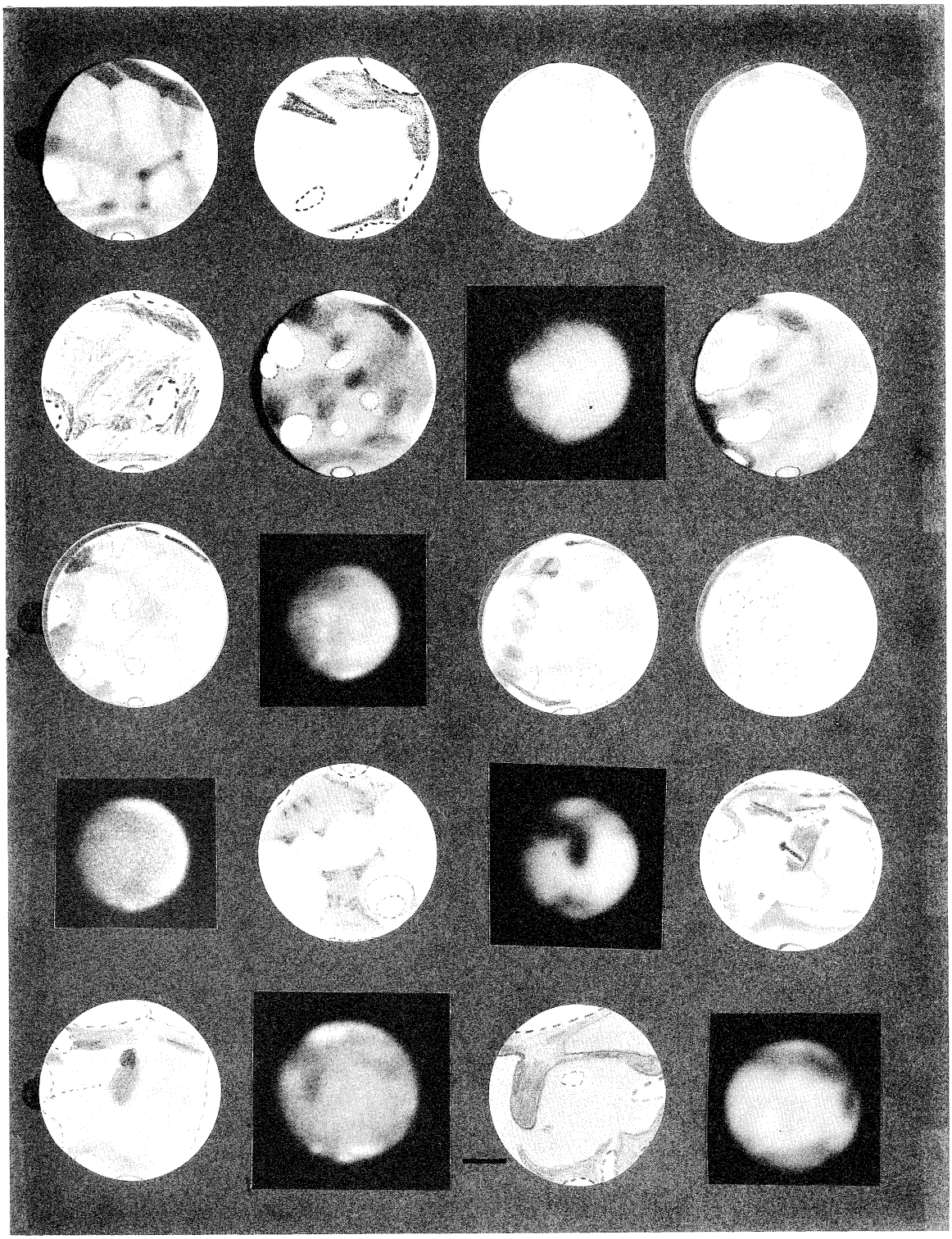

Figure 24 (facing).

1984 MAY 13, 06:50.
Ls 147°. CM 265°.
De +14°. k 1.00.
Dia. 17".5.
16.5-cm. R.
Filters: 21.
T. Dobbins and K. Schneller.
Morpheos Lacus unusually dark. Evening cloud over Elysium.

1984 MAY 19, 22:15.
Ls 150°. CM 077°.
De +16°. k 1.00.
Dia. 17".6.
35.5-cm. SC.
J. Dragesco.
White cloud in Argyre, crossing Bosporus (South Polar Hood?).

1984 MAY 19, 22:29.
Ls 150°. CM 081°.
De +16°. k 1.00.
Dia. 17".6.
35.5-cm. SC.
J. Dragesco.
Integrated-light photograph. Ganges prominent.

1984 MAY 20, 03:33.
Ls 150°. CM 155°.
De +16°. k 1.00.
Dia. 17".6.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing orographic clouds over Arsia Mons and cloud activity in Arcadia and on morning limb.

1984 MAY 20, 21:05.
Ls 151°. CM 052°.
De +16°. k 0.99.
Dia. 17".6.
20-cm. C.
R. de Terwangne.
Limb clouds. Note streak in Chryse (Jamuna).

1984 MAY 24, 01:40.
Ls 152°. CM 093°.
De +16°. k 0.99.
Dia. 17".5. 32-cm. f/6.5 N. Filters: 15, 25, 22, 30. D.C. Parker.
Bright streak running from Tempe to Arcadia; brighter in yellow than in red or violet. Evening cloud/haze over Xanthe-Chryse. Small yellow clouds in Candor. Phasis noted.

1984 MAY 30, 03:45.
Ls 156°. CM 070°.
De +17°. k 0.98.
Dia. 17".3.
25-cm. N.
Filters: Orange, Yellow.
J. Olivarez.
Tempe streak bright in yellow light.

1984 JUN 03, 04:00.
Ls 158°. CM 038°.
De +18°. k 0.97.
Dia. 17".0
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Numerous morning and evening limb clouds. Clouds in Tempe.

1984 JUN 04, 03:04.
Ls 158°. CM 016°.
De +18°. k 0.97.
Dia. 16"9.
32-cm. f/6.5 N.
D.C. Parker.
Red-light (W23A) photograph. Ismenius Lacus, Deuteronilus, and Oxia Palus conspicuous. Tempe dull in red; brilliant in yellow and blue light.

1984 JUN 09, 03:15.
Ls 161°. CM 333°.
De +18°. k 0.96.
Dia. 16".5.
25-cm. N.
Filters: Orange.
K. Rhea.
E. border of Syrtis Major obscured.

1984 JUN 08, 22:12.
Ls 161°. CM 259°.
De +18°. k 0.96.
Dia. 16".5.
20-cm. N.
Filters: Orange, Blue.
M. Legrand.
Bright streaks in Libya-Crocea and crossing Elysium. Trivium Charontis-Cerberus very weak.

1984 JUN 09, 04:00.
Ls 161°. CM 344°.
De +18°. k 0.96.
Dia. 16".5.
20-cm. N.
Filters: 25.
G. Rosenbaum.
N. Polar Cap brilliant. S. Polar Hood larger, bright in violet light. Bright limb clouds in Isidis Regio and Tempe.

1984 JUN 10, 01:40.
Ls 161°. CM 301°.
De +18°. k 0.96.
Dia. 16".4.
32-cm. f/30 C.
Filters: 25.
J.D. Beish.
See next observation for meteorological notes.

1984 JUN 10, 02:00.
Ls 161°. CM 306°.
De +18°. k 0.96.
Dia. 16".4. 32-cm. f/30 C. Filters: 47, 47B, 38A. J.D. Beish.
Evening limb clouds extend into Libya-Crocea. Evening limb haze; N. and S. Polar hazes. Intricate morning limb clouds. Discrete clouds in Deucalionis and Aeria.

1984 JUN 10, 20:25.
Ls 162°. CM 215°.
De +18°. k 0.96.
Dia. 16".4.
35.5-cm. SC.
J. Dragesco.
NOTE: New dark feature in Aetheria (Morpheos Lacus) and angular appearance of Elysium. See next observation.

1984 JUN 10, 20:33.
Ls 162°. CM 217°.
De +18°. k 0.96.
Dia. 16".4.
35.5-cm. SC.
J. Dragesco.
Photograph. Arrow indicates darkening and expansion of Hyblaeus into Aetheria.

1984 JUN 11, 01:50.
Ls 162°. CM 295°.
De +19°. k 0.95.
Dia. 16".3.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Very large number of discrete and limb clouds seen in violet light..

1984 JUN 12, 02:50.
Ls 162°. CM 300°.
De +19°. k 0.95.
Dia. 16"2.
32-cm. f/6.5 N.
Filters: 47.
D.C. Parker.
Numerous discrete clouds in Libya and Aeria; polar and limb clouds.

1984 JUN 13, 05:50.
Ls 163°. CM 335°.
De +19°. k 0.95.
Dia. 16".1.
15-cm. N.
Filters: Yellow.
M. Wills.
Morning and evening limb clouds. Note bright streak over Crocea.

1984 JUN 15, 20:25.
Ls 164°. CM 170°.
De +19°. k 0.94.
Dia. 15".9.
35.5-cm. SC.
J. Dragesco.
IL Photograph. Propontis I and Euxinus Lacus very dark; Amazonis dusky.

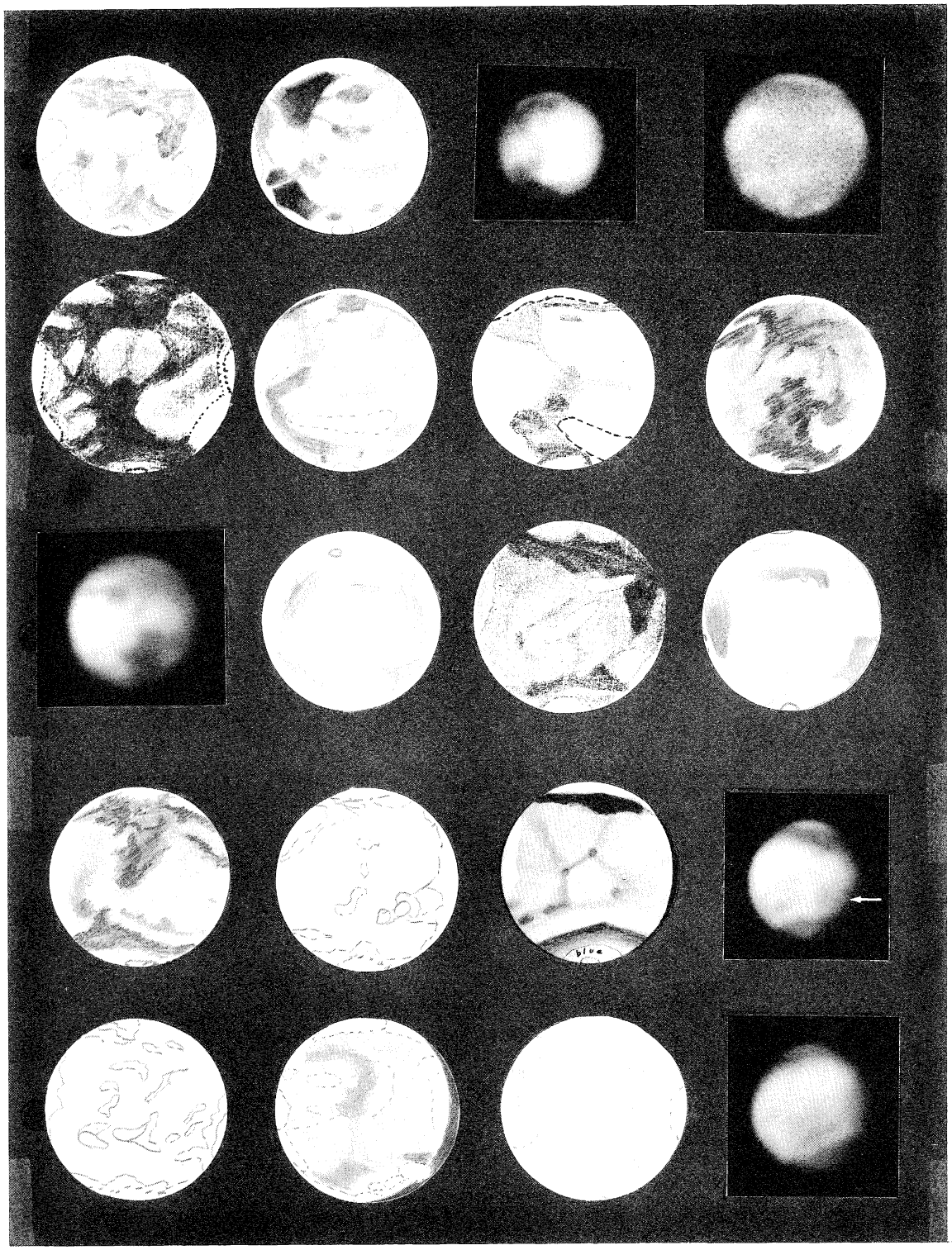

Figure 25 (facing).

1984 JUN 16, 11:30.
Ls 165°. CM 031°.
De +19°. k 0.94.
Dia. 15".8.
20-cm. N.
M. Nakajima.
Evening limb haze over Meridiani Sinus. N. Polar Cap remnant bright.

1984 JUN 17, 02:30.
Ls 165°. CM 250°.
De +19°. k 0.94.
Dia. 15".7.
20-cm. N.
Filters: IL.
M. Daniels.
New darkening in Morpheos Lacus very pronounced. Hyblaeus darkening now extending across Aetheria. Cebrenia appears as a light streak.

1984 JUN 19, 02:50.
Ls 166°. CM 237°.
De +19°. k 0.94.
Dia. 15".5.
32-cm. f/30 C.
Filters: 25, 15.
J.D. Beish.
Hyblaeus-Aetheria dark. Alcyonius Nodus-Nubis Lacus - Nepenthes-Thoth more conspicuous than previously.

1984 JUN 19, 03:15.
Ls 166°. CM 243°.
De +19°. k 0.94.
Dia. 15".5.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Equatorial cloud banding. Numerous discrete clouds. S. Polar Hood and Arctic hazes, indicating formation of N. Polar Hood.

1984 JUN 19, 03:24.
Ls 166°. CM 245°.
De +19°. k 0.94.
Dia. 15".5.
32-cm. N.
Filters: Rd4 (red).
A.K. Herring.
Trivium Charontis-Ceberus very washed out. Hephaestus Nodus now enlarged and dark. Aetheria dusky. Compare with Daniels view of JUN 17.

1984 JUN 20, 01:45.
Ls 167°. CM 212°.
De +19°. k 0.93.
Dia. 15".4.
32-cm. f/30 C.
Filters: 25, 58, 64.
J.D. Beish.
Ceberus weak but Trivium Charontis-Hades-Propontis I dark. Unusual appearance due to streak bright in green and blue-green light S. of Panchaia and S. into Elysium.

1984 JUN 20, 02:30.
Ls 167°. CM 223°.
De +19°. k 0.93.
Dia. 15".4.
15-cm. N.
Filters: IL.
R. Robotham.
Streaks in Cebrenia and into Elysium similar to JUN 19 Herring observation.

1984 JUN 20, 02:58.
Ls 167°. CM 230°.
De +19°. k 0.93.
Dia. 15"4.
32-cm. f/6.5 N.
D.C. Parker.
IL Photograph. Hyblaeus extension and Propontis I dark. Trivium Charontis-Hades moderate in tone. Elysium angular in shape.

1984 JUN 24, 19:25.
Ls 169°. CM 074°.
De +19°. k 0.92.
Dia. 14".9.
35.5-cm. SC.
J. Dragesco.
Yellow cloud in Thaumasia obscuring Nectar, E. Solis Lacus, and Agathodaemon. Bluish haze in N. Polar region—early N. Polar Hood.

1984 JUN 24, 19:36.
Ls 169°. CM 076°.
De +19°. k 0.92.
Dia. 14".9.
35.5-cm. SC.
Filters: IL.
J. Dragesco.
Photograph showing with arrow yellow cloud across E. Thaumasia.

1984 JUL 02, 01:19.
Ls 173°. CM 095°.
De +19°. k 0.91.
Dia. 14"1.
32-cm. f/6.5 N.
D.C. Parker.
IL Photograph. Yellow cloud resolved. Solis Lacus-Thaumasia region back to normal.

1984 JUL 02, 13:09.
Ls 174°. CM 268°.
De +19°. k 0.91.
Dia. 14"1.
(No telescope data).
M. Adachi.
Elysium dull; Aetheria dusky; Amenthes prominent.

1984 JUL 12, 21:00.
Ls 179°. CM 290°.
De +18°. k 0.89.
Dia. 13".0.
20-cm. C.
Filters: IL.
R. de Terwangne.
Nepenthes-Thoth now faintly visible. Tiny N. Polar Cap surrounded by polar haze (early N. Polar Hood?).

1984 JUL 14, 00:30.
Ls 180°. CM 331°.
De +18°. k 0.89.
Dia. 12".9.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
Detailed surface features. See next observation for meteorological notes.

1984 JUL 14, 00:50.
Ls 180°. CM 336°.
De +18°. k 0.89.
Dia. 12".9.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
AUTUMNAL EQUINOX. N. Polar Hood growing bright. S. Polar Cap not visible. Numerous discrete clouds. Eve. limb haze.

1984 AUG 14, 11:00.
Ls 198°. CM 190°.
De +13°. k 0.85.
Dia. 10".4. 20-cm. N.
M. Nakajima.
S. Polar Cap brilliant; snow-white. First appearance of S. Polar Cap clear of hazes. N. Polar Hood bright. Olympus and Biblis Montes bright near evening limb.

1984 OCT 08, 23:35.
Ls 232°. CM 202°.
De -03°. k 0.86.
Dia. 7".7.
15-cm. R.
Filters:23A, 21, 8.
C.L. Evans.
S. Polar Cap brilliant.

1984 DEC 04, 00:50.
Ls 268°. CM 030°.
De -19°. k 0.89.
Dia. 6".0. 25-cm. N.
Filters: 25.
D. Troiani.
S. Polar Cap brilliant. Xanthe bright in red and yellow. N. Polar Hood large, bright in violet light.

1985 MAR 20, 01:05.
Ls 331°. CM 061°.
De -20°. k 0.96.
Dia. 4".2. 25-cm. N.
Filters 12, 23A.
D. M. Moore.
S. Polar Cap small, bright. Noachis bright on SE. limb.