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PERSPECTIVES OF AREOGRAPHY
BASED ON PHOTOGRAPHIC DOCUMENTS
AND ON VISUAL OBSERVATIONS

by

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GENERAL INFORMATION

On the occasion of the work of cartographic synthesis¹ based on international photographic documents at the *Centre de documentation sur les planètes* [Planetary Documentation Center] at Meudon organized by the U.A.I. and within the framework of collaboration between the Milan and Paris observatories, we have had the opportunity of examining at length a wide range of documentation of great areographic interest, covering a period of several decades and having thousands of photographs.

On the basis of the synthetic [compiled] maps previously made, we have recently been able to start a comparison for the purpose of locating not only *seasonal* variations, but also *secular* variations that have taken place on Mars during two defined periods of time (see *Figures 1, 2, 3*).

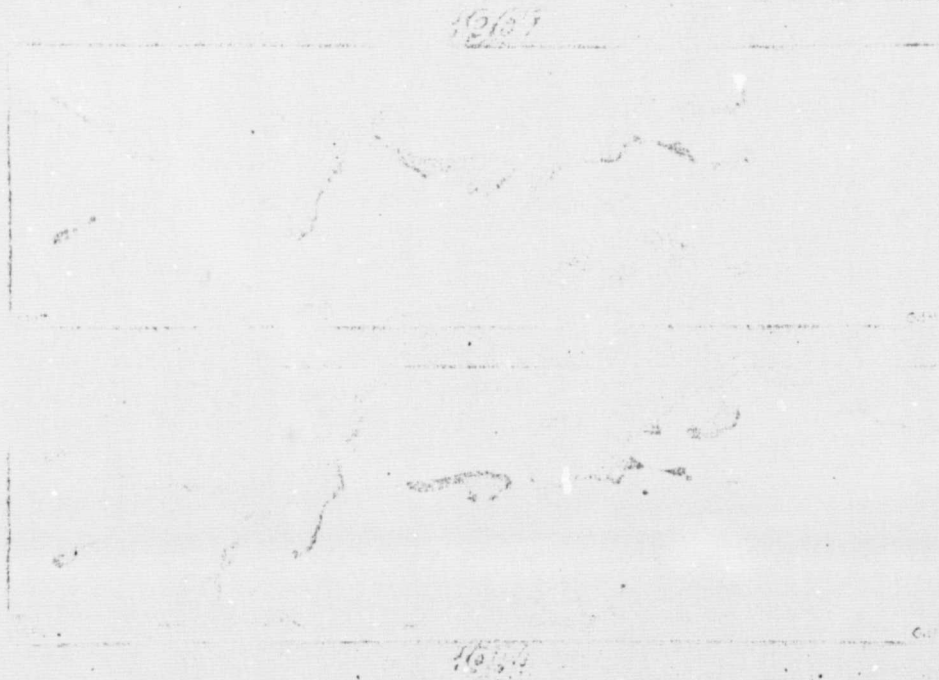


Figure 1

¹Cf. *Cartografia del pianeta Marte basata su documentazione fotografica internazionale, a partire dal 1907* [Cartography of the planet Mars based on international photographic documentation starting from 1907]. Publi-

- From 1907 to 1920 during seven successive oppositions showing the planet pass through all possible seasonal conditions.
- From the three oppositions of 1907-1909-1911 to the three oppositions of 1954-1956-1958, separated by a span of 47 earth years (corresponding to 25 Martian years), but whose oppositions were respectively [two by two] under identical seasonal conditions.

The first of these comparisons makes it possible to bring out in evidence mainly "seasonal" variations, while the second shows variations essentially of the "secular" type.

Naturally, to assure that the two types of phenomena could be clearly distinguished, it would have been necessary that no other disturbing cause of a recurring type occur in the climate of the planet even in an irregular fashion.

Now, at least one such cause can be discerned; this is solar action at the distance of the planet which, as is known, is an alternating recurrence even if it is not a true and proper regular periodicity.

While this action has varied within usual limits, between 2 and 3 conventional units,² during the 13 years of the first period of comparison, this factor, no doubt relevant for Martian atmospheric phenomena, has instead shown abnormal behavior by reaching quite exceptional values in the month of August 1956, to be exact, around the 20th of the month.



Figure 2.

cation of the Milano-Merate Astr. Observatory, No. 17 and 18 NS

²Cf. *Attività solare e fenomeni atmosferici su Marte nel 1956* [Solar activity and atmospheric phenomena on Mars in 1956] Rend.; Acc. Naz. Lincei, Vol. XLII, fasc. 4 (1967).



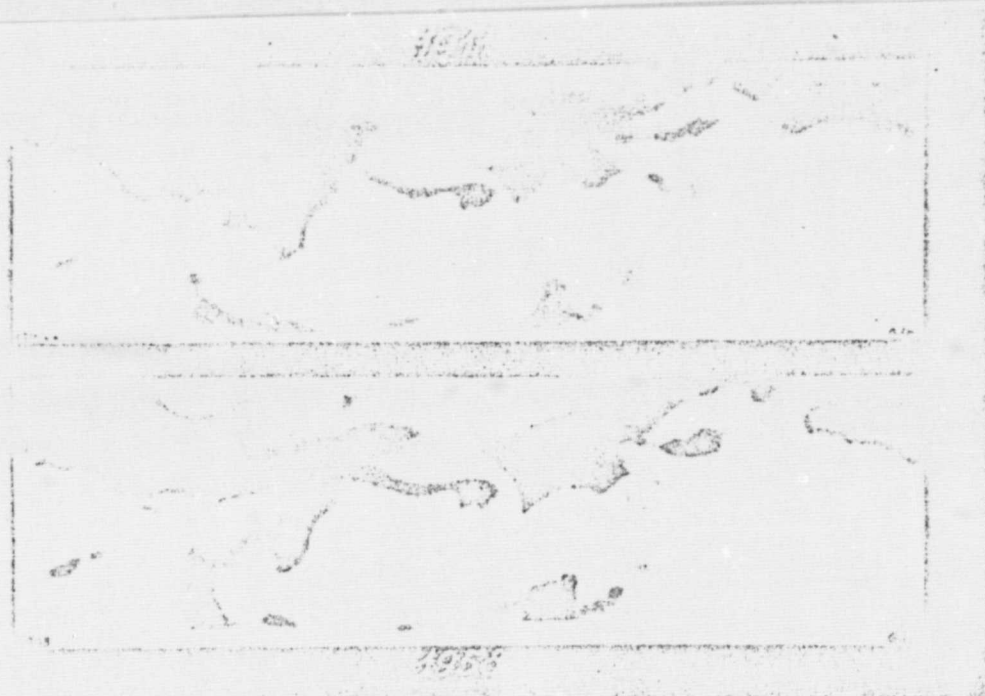


Figure 3

During those days, highs of 91 units were reached, not previously reached since 1877, that is since Schiaparelli began with his systematic and brilliant observations, modern Areography.

Now, a very singular case has been verified which could hardly have been due to a coincidence that just during those days of August there occurred a combination of atmospheric turbulence on Mars of a depth and extent that were exceptionally great, so much as to be able to alter the appearance of very vast regions in a manner never before observed.

From these facts it must be concluded that even those phenomena which initially seem to be of a "secular" type, as was the case in 1956, may in reality be subject to some recurrence, even if it is not a true and real regular periodicity, along with phenomena which may be called impressive but destined to be rapidly exhausted and, therefore, with a character quite different from true and effective "secular" variations.

SEASONAL VARIATIONS

With the above premise, we now come to the first type of changes that could be noted by comparing the appearances of the Martian surface in the period from 1907 to 1920. To be noted is the fact that our maps are all based on photographs in red or yellow light which do not show phenomena located in the medium or in the upper atmosphere, but rather what takes place on the ground [surface] or the phenomena of lifting of desert dust to a low altitude caused by the aerial currents which, however, are not very frequent.

Now, in order not to dwell on phenomena that are generally known, we shall confine ourselves to reporting on one aspect [appearance] that is definitely unusual, shown by the northern point of the Mare Sirenum, the Titanum Sinus, which is one of the characteristic points of the Martian surface, mainly because it retains its triangular shape and its sharp point has been quite dark now for a long time.

In 1907 as well as in 1954, at the start of the local spring, this point appeared almost all faded out, as though it were truncated at the height of the 25th parallel (see *Figure 4*). At that point in the seasons, the zone was going through the beginning of spring, not yet restored by the aerial currents bearing the moisture liberated by the melting of the southern snows, currents which were still very distant toward the south



at that time of year. On the other hand, the sun was already relatively warm and it was radiating at least 90 per cent of its maximum heat flux, being close to its minimum distance from the planet.

The region of Sirenum and, particularly its advanced point in the heart of the adjacent deserts of Memnonia and Zephyria must have been in a climate of maximum dryness. This condition may, in our opinion, be related to the abnormal appearance described above, which we do not think has been previously observed.

Only once do we find an analogous variation, but quite different; this is where Schiaparelli noted in 1890 that the interior of the Sirenum appeared noticeably clearer [lighter] even though the perimeter and the northern point remained dark. It should be noted that then the region was also in spring which began a few days before.

To verify the above described hypothesis, it will be interesting to repeat the observation of the region when the same seasonal conditions again occur; this will take place in July 1969.

SECULAR VARIATIONS

Coming now to the second comparison, we shall briefly cite among the appearances of the Martian surface after 47 years the principal modifications that have developed slowly, documented by our maps that combine [synthesize] several hundreds of photographic documents.

1) "*Iani Fretum*." This is a large dark bridge that has been connecting the head of Sinus Sabaeus (Meridiani Sinus) with Margaritifer Sinus since 1864, joining them into a single blackish mass. Still evident in the maps of 1907, 1909, and 1911, this dark band is completely absent on those of 1954, 1956, and 1958, while from the western head of Sinus Meridiani we note an elongated shadow which extends towards Oxia Palus but without reaching it; this shadow is visible even now

2) "*Nilosyrtis*." This is a large dark rope that in the past century constituted the main artery of the planet. This "canal" [channel], already faded at the beginning of this century, appears in 1907 (see Figure 5) subdivided into two parallel bands, by now very faint and broken. In 1909 it is reduced to a single band, very pale, while it reappears but with less contrast and obviously because it is affected by the influence of the season which, e.g., in 1914 obscured [cancelled] its northern extremity.

After 47 years, in 1954, we find it reduced to a thin and pale thread without any obviousness and almost totally faded at the north [end] and it remains like this in the two subsequent oppositions with a minimum of variation. Even today this vestige of a great past is barely visible, and it often shows a strange duality [duplicity] as in the oppositions of 1946 and 1948 when it was observed at Pic-du-Midi to have split into two thin curved lines, approximately 5° from one another.

3) "*Cyclopia*." This is a great "lake" over 1000 km long and 600 km wide, which grew [developed] under our own eyes in the desert area of Aethiopia parallel to the northern edge of Mare Cimmerium, occupying a region that several times had shown considerable changes in tonality.



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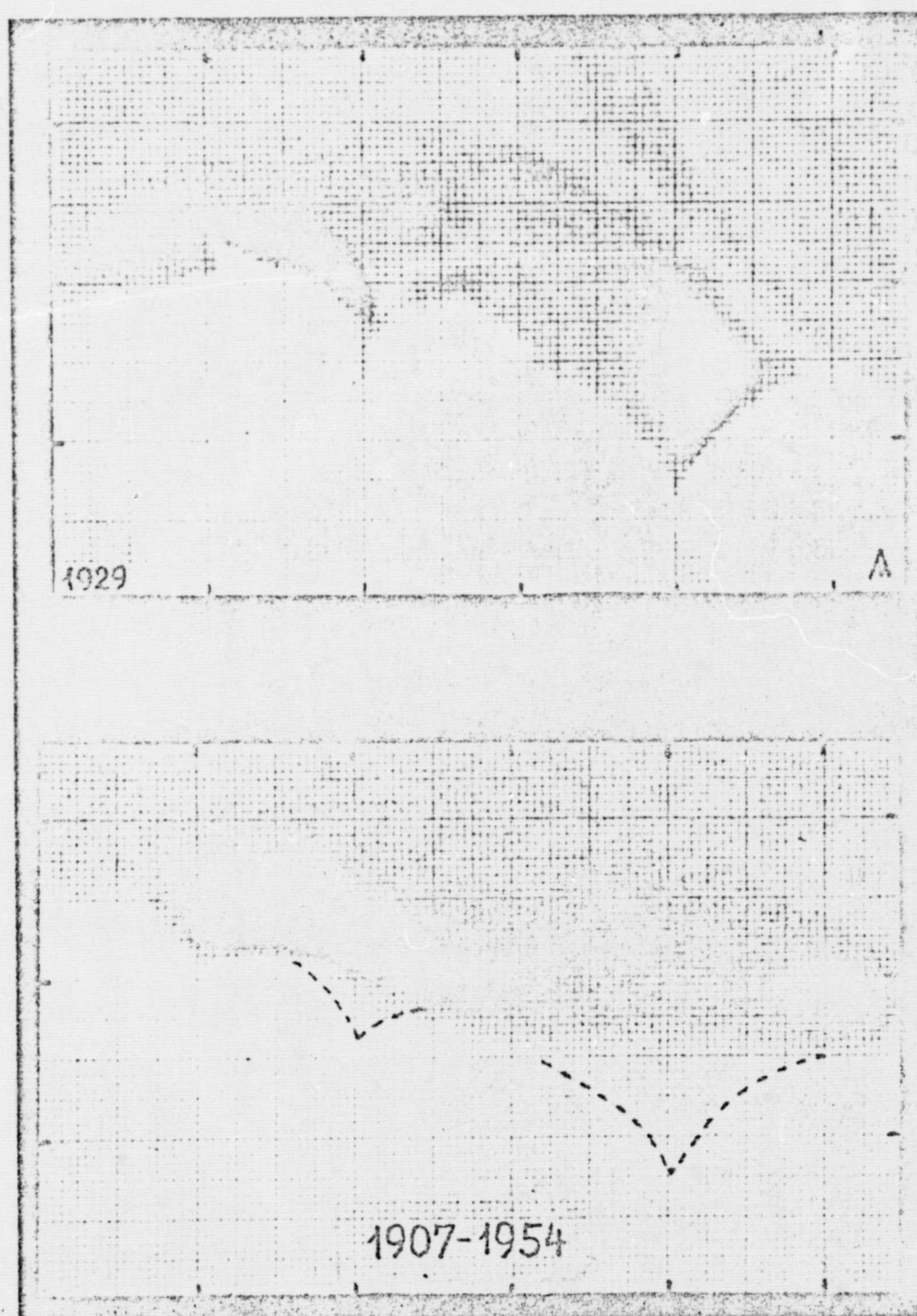


Figure 4

Until 1907 the edge of that "mare" had been fixed on the -10° parallel between the 220° and 240° meridians as Schiaparelli had always drawn it. Later on, the edge started to move longitudinally until it reached and passed the equator, but always without any lateral movement toward the desert. However, in subsequent oppositions, those of 1909 and 1911, a partial darkening of the tone in the region is already seen, with alternating phases until 1920. However, photographic documents of that period were not very numerous due to the war.



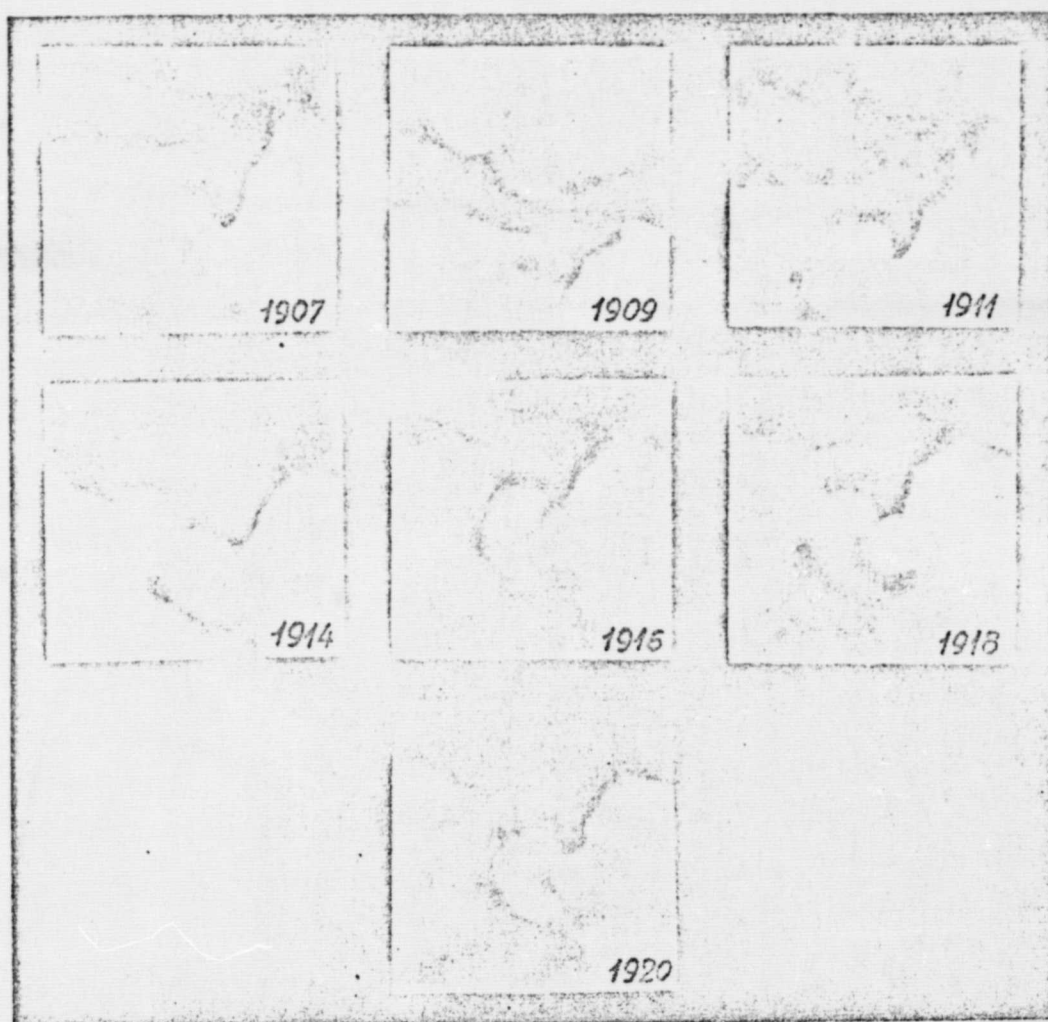


Figure 5

In the time span from 1920 to 1954, the photographs taken at Flagstaff by Slpher help insofar as they show even in 1922 the great new dark spot (the "Sinus Gomer" of the Japanese) clearly discerned. This will always remain visible from then on even if with noticeable variations in shape and tone, evidently being composed of an enormous agglomeration of minute formations subject to individual variations and may also be related to climactic factors.

On our maps of the 1954-1958 period, the great lake of "Cyclopia" is easily defined and its shows the tendency to extend slowly towards the NW in the direction of Nepenthes, but without actually reaching it with more than a tenuous tentacle, easily visible on the photographs of 1956.

This phenomenon of slow transformation of a "sub-desert" region into a "lagoonal or lagoon-like" zone (to use the water analogy) has evidently a secular character, but it nevertheless shows an evident seasonal relationship too. In fact, Sinus Gomer has shown itself to be very dark at perihelion, paler and sometimes invisible near aphelion. Therefore, it appears clear that the intensity of its color increases during periods of strong solar radiation. Vice versa, it does not appear that the hygrometric factor has a significant effect on this phenomenon, judging from the appearance of this object in the years 1922, 1924, 1939, and 1954 when its very dark tone occurred without the wave of southern



darkening having yet reached the region. Inversely, the tone weakened noticeably several times in periods during which the wave, coming from the northern regions, reached and passed the zone in question.

We may therefore conclude that the dark tone of this formation (totally non-existent before 1922) is excited more by the solar action than by the moisture content in the atmosphere. At the next perihelion opposition in 1971, it will be interesting to learn whether this interpretation will be confirmed.

4) "Moeris Lacus-Nepenthes-Thoth-Casius"

We end this brief review with a few words about the great dark arc which, starting from the eastern edge of Syrtis Major, reaches the ancient Coloe Palus (see *Figure 5*).

In the 1907 photograph of this gigantic formation, visible today even with the most modest instrument, only a rudiment existed at the southern extremity of the arc, where Moeris Lacus was forming at the junction with Syrtis. In the next representation, the eastern part of this "lake" was already formed, while another year later, in 1911, Nepenthes was born and so on until the entire impressive arc appeared in 1918.

In 1920 the middle part, between the $+15^\circ$ and $+30^\circ$ parallels, doubles, splitting into two parallel lines having a distance of 5° between them. These lines remained visible in practice for several years, often also doubling part of Moeris Lacus and Thoth, even Casius.

This situation as well as a certain variability in the distribution of the darkness maxima in single features [traces] of the arc is obviously reflected in the maps of 1954-1958.

FUTURE PERSPECTIVES

Disregarding many other modifications of minor consequence although they show some interesting aspects that we do not think should be enumerated here, we shall pass now to a word regarding the perspectives that are opened to modern descriptive Areography by the systematic study of photographic documentation.

Although it is just the beginning, our work of graphic synthesis already makes it possible to see the lines which, in our opinion, will be worth following to give this branch of Planetary Astronomy a development [growth] and efficiency commensurate with the interest it now sparks.

We are well aware, for instance, that while photography makes it possible to fix the total appearance of the Martian surface in relation to time with satisfactory precision, it shows a rather modest degree of resolution which even under the most favorable conditions does not appear adequate to allow the systematic study of the more minute formations, which are instead accessible to visual observations.

Well aware of this, in this same publication³ since 1959 we have expounded

³Cf. *Nuove carte del pianeta Marte sulla base dell' fotografi del Pic-du-Midi* [New maps of the planet Mars on the basis of photographs of Pic-du-Midi] Atti convention of Venice-Naples S.A.I. September 1955-September 1957.



the results of a first attempt to "integrate" a photographic map by inserting the most minute details supplied by visual observation. This was done in the case of the 1948 opposition and with drawings made by Dr. A. Dollfus with the 600-mm refractor of the Pic-du-Midi Observatory in the Pyrenees.

The experiment was successful and other "integrated maps" of this type have been and are now being constructed at the request of the Meudon Planetary Studies Center [Centro Studi Planetari di Meudon] like the one almost completed relating to the appearance of 1946 (see *Figure 6*).

The examination of these maps rich in a surprising amount of minute details and in delicate shades of tone, makes us think that this is undoubtedly the best way to resolve the problem of descriptive Areography.

If this seems the best solution, we are nevertheless still far from the goal, because photographic documentation still suffers from some improvisation and is lacking in uniformity and continuity. This is because it is being done at too small a number of stations and not all of them suitably located and equipped, especially as far as their distribution in the two hemisphere is concerned.

Moreover, visual observations are furnished by too small a number of observers who do not always operate under the best conditions, especially for the perihelion oppositions which should be followed by stations located in the southern hemisphere.

Naturally, in indicating these perspectives of areographic development by means of a rational use of the photographic method as well as by visually performed study, we cannot forget that just recently another powerful investigative method has joined those considered traditional: direct automatic astronautic exploration of the bodies of the solar system. This has already yielded a first, very interesting result with the memorable feat of the American probe "Mariner IV" the first results of which we have had the opportunity of studying in detail.⁴

In this way it will no doubt be possible, shortly, to obtain information absolutely unattainable with the telescope; however, the systematic study of Mars will for a long time remain still confined to the telescope, at least for the part that requires continuity of observations. Naturally, the search for the most favorable conditions for observation will lead, perhaps soon, to the organization of telescopic stations placed outside the earth's atmosphere, either in orbit or on the surface of the moon. These stations will make it possible to exploit the optical qualities of large instruments in full which are seriously impaired on earth by the insurmountable obstacle of our atmosphere.

⁴Cf. *Sulle fotografie di Marte ottenute dalla sonda automatica "Mariner IV"* [On the photographs of Mars obtained by the automatic probe "Mariner IV"] Publication of the Milano-Merate Astr. Observatory, No. 15 NS



Integrated maps

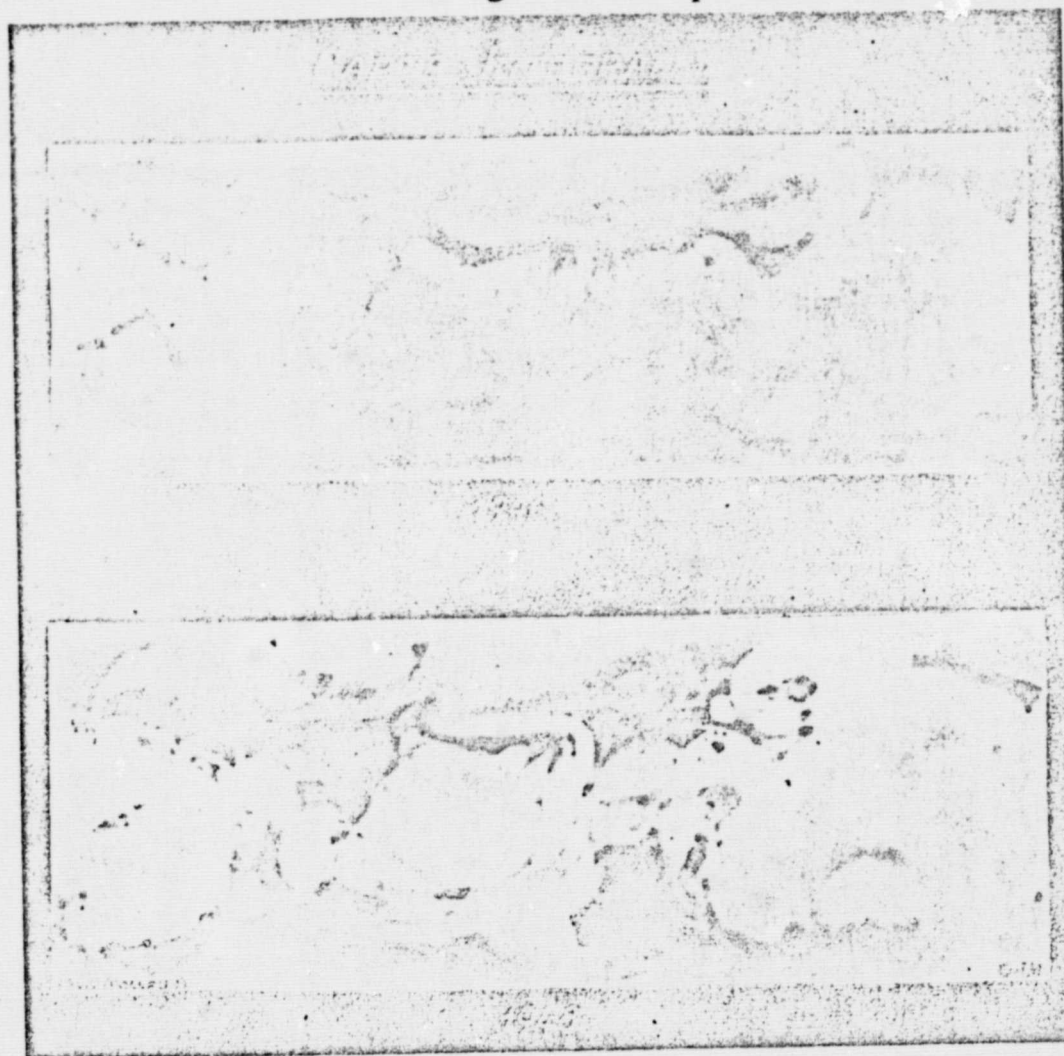


Figure 6

