

NO. 4 RECTIFIED DRAWINGS OF THE LUNAR LIMB AREAS, I

by A. K. HERRING

December 11, 1961

1. Introduction

THIS paper is the first of six intended to present a total of 12 drawings of the limb areas of the moon, which are to supplement the *Photographic Rectified Lunar Atlas* now in preparation.

Details near the edge of the moon are never seen from the earth in their correct perspective. This is because our line of sight becomes more tangential as we approach the limb. As a result, we may observe in these areas a considerable distortion of detail; craters which we know to be nearly circular in outline become increasingly elliptical in shape, and on the extreme limb may lose their form completely. Other types of features, such as valleys, mountain ranges, and fault scarps, may also be seen imperfectly or become invisible. The adverse effects of the various librations are also most serious on the limb. Large portions of the libratory areas are normally hidden and may be brought into view only at infrequent intervals. Most lunar maps in the past have extended up to the mean limb, while those that have attempted to depict the outer librational regions have done so rather imperfectly. Our knowledge of this portion of the lunar surface is therefore deficient, and the compilation of an accurate map of the lunar limb regions is an important goal of selenography.

Short of photography from directly overhead by means of rockets the limb areas may be most readily mapped by projecting suitable lunar photographs onto a globe, which eliminates the general foreshortening toward the limb. Reference is made to Comm. No. 6 for a description of the globe method. The areas in question are examined visually on the globe or photographed from above, so that great circles through the center are shown as straight lines, and all azimuths are correctly represented. The method is not perfect, since depressed or elevated areas are displaced towards or away from the lunar center in proportion to their position above or below the mean level of the lunar surface and the proximity to the limb. This displacement also

leads to loss of detail that is hidden behind elevated regions. This latter effect becomes severe at the extreme edge; the projected image can of course never show more detail than is recorded on the original photograph. The method of spherical projection has therefore limited value, but within its limits it is useful.

The limitations of the projection method may be overcome in part by combining the evidence in several limb photographs with different illuminations and librations, and synthesizing the evidence into a single hand-drawn map of the limb areas. For this purpose the most suitable rectified photographs, selected for clarity, illumination, and favorable libration, are being used as a basis for providing accurate positions of major details. The areas are then drawn, using the best available photographs, both rectified and direct, as supplementary reference material. The necessary corrections in the positions of details displaced because of elevation differences are made at the same time. The drawings are refined and improved until the limit of the combined photography is reached.

While this approach has certain distinct advantages over previous efforts, it has its own limitations. The problems of interpretation are great, and it is often difficult or impossible to decipher the shape or nature of some detail shown. For example, a bright spot may be a bright crater, a bright peak, or something else. Even if the nature of the detail can be detected, we may be able to discern little else, e.g., we may be able to recognize a crater form, but may be unable to determine whether it is deep or shallow, or whether other features such as interior mountains or craterlets are present. At such times the draftsman has no choice but to resort to a stylized symbol to represent the feature. The frequency of these symbols will naturally increase near the limb where the problems of interpretation become most difficult. Questionable features for which an identification cannot be made with reasonable assurance are simply omitted from

the drawings. Some appreciation of the problems involved may be obtained from an examination of Plates 4.2 and 4.3.

The final step in the reconstruction of these areas must be a visual check at the telescope, which will be made whenever instrumentation is available and the requisite observing conditions exist. Because of the greater resolution inherent in visual observations, significant additions and corrections to the maps may be made at these times. Thus the drawings will probably never be considered to be completely finished, since they will be subject to revision whenever favorable opportunities present themselves.

2. Description of the Rectified Drawings

The limb areas of the moon are divided into twelve areas, as shown in Plate 4.1, each encompassing an arc of 30° measured along the lunar limb. These sections correspond in number with the equivalent sections of the Photographic Rectified Atlas, to be issued separately, with the exception that Area 2 is divided between 1 and 3, and Area 29 between 28 and 30.

The direction from which the illumination appears to originate will in part depend upon the position of the observer relative to the moon. For the equatorial and temperate regions the direction chosen was such that geocentrically the illumination appears to come from behind the limb, but for the polar areas the direction is represented as being from the east or west. Since the majority of the reference photographs available were made under these conditions of illumination, the consolidation of the polar areas greatly simplifies the problems of interpretation and representation. A camera or observer in a polar orbit around the moon would of course see the illumination as coming from the east or west at all times.

The width of each section makes it impossible to select an angle of illumination that will be uniform for the entire area. It is therefore necessary to assume a fictitious solar elevation that will allow the light to fall at a grazing incidence to the slope of each individual crater or mountain wall. This not only avoids the use of full shadows, which are objectionable, but it also permits the detail to be shown in greatest relief.

The longitude and latitude grids are approximations, since an insufficient number of measured point was available. Some distortions will have

been introduced by limitations in the accuracy of the projections. An effort will be made to improve the accuracy of these grids by successive approximations as the work progresses.

3. Notes on the Accompanying Plates

Area 15 (Plates 4.2, and 4.3) covers the west limb (astronomical direction) from the equator to 30° north latitude. The drawing shown in Plate 4.3 was made with Yerkes photograph No. 686 (rectified) as a base. Other reference photographs were unrectified copies of Yerkes No. 482, 686, 688, and McDonald No. 33 and 479; as well as rectified prints of Yerkes No. 556, 686, 781, Lick No. 172, 175, 186, 237, and McDonald No. 33 and 479. An article with a drawing by Ball (1937a) on Mare Marginis was also consulted.

Area 21 (Plates 4.4 and 4.5) covers the west limb (astronomical direction) from the equator to 30° south latitude. The drawing shown in Plate 4.5 was also made with Yerkes photograph No. 686 (rectified) as a base. Other reference photographs were unrectified copies of Yerkes No. 349, 355, 356, 358, 369, 484, 686, 688, 928, and 1174, and McDonald No. 479 and 480; as well as rectified prints of Yerkes No. 445, 556, 686, 781, and Lick No. 175 and 189. An article with drawing on the Mare Smythii by Ball (1937b) was also consulted.

Plates 4.6 and 4.7 are key charts to Areas 15 and 21. They are inserted primarily for identification and comparison and serve three purposes: They have an approximate longitude and latitude grid in intervals of 10° , the nomenclature of named features is given, and the shadings of dark floored areas are enhanced to show distribution.

Area 15 was examined visually with a 6-inch telescope on January 15, 1962, (U. T.). The librations were excellent, with the extreme western edge of Mare Marginis inside the visible limb. Despite the almost vertical illumination and poor seeing, a number of large rings and small bright craters could be discerned in this normally hidden region (See Plate 4.8).

REFERENCES

- Ball, L. F., 1937a, *J. B. A. A.*, 47, 7.
 Ball, L. F., 1937b, *J. B. A. A.*, 48, 4.
 Kuiper, G. P., Arthur, D. W. G., and Whitaker, E. A., 1960, *Photographic Lunar Atlas*, (Chicago: University of Chicago Press).

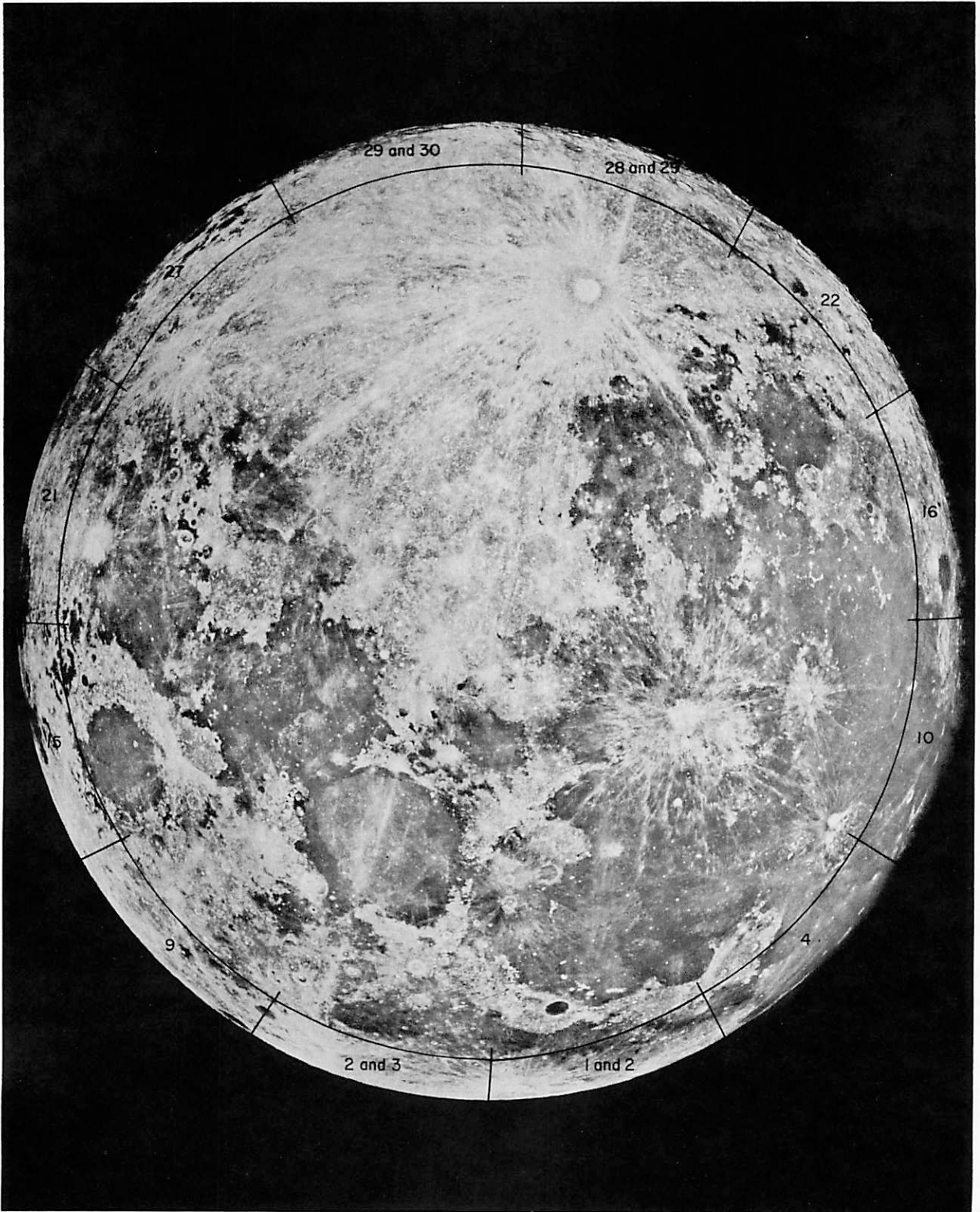


Plate 4.1. Key chart of limb areas.

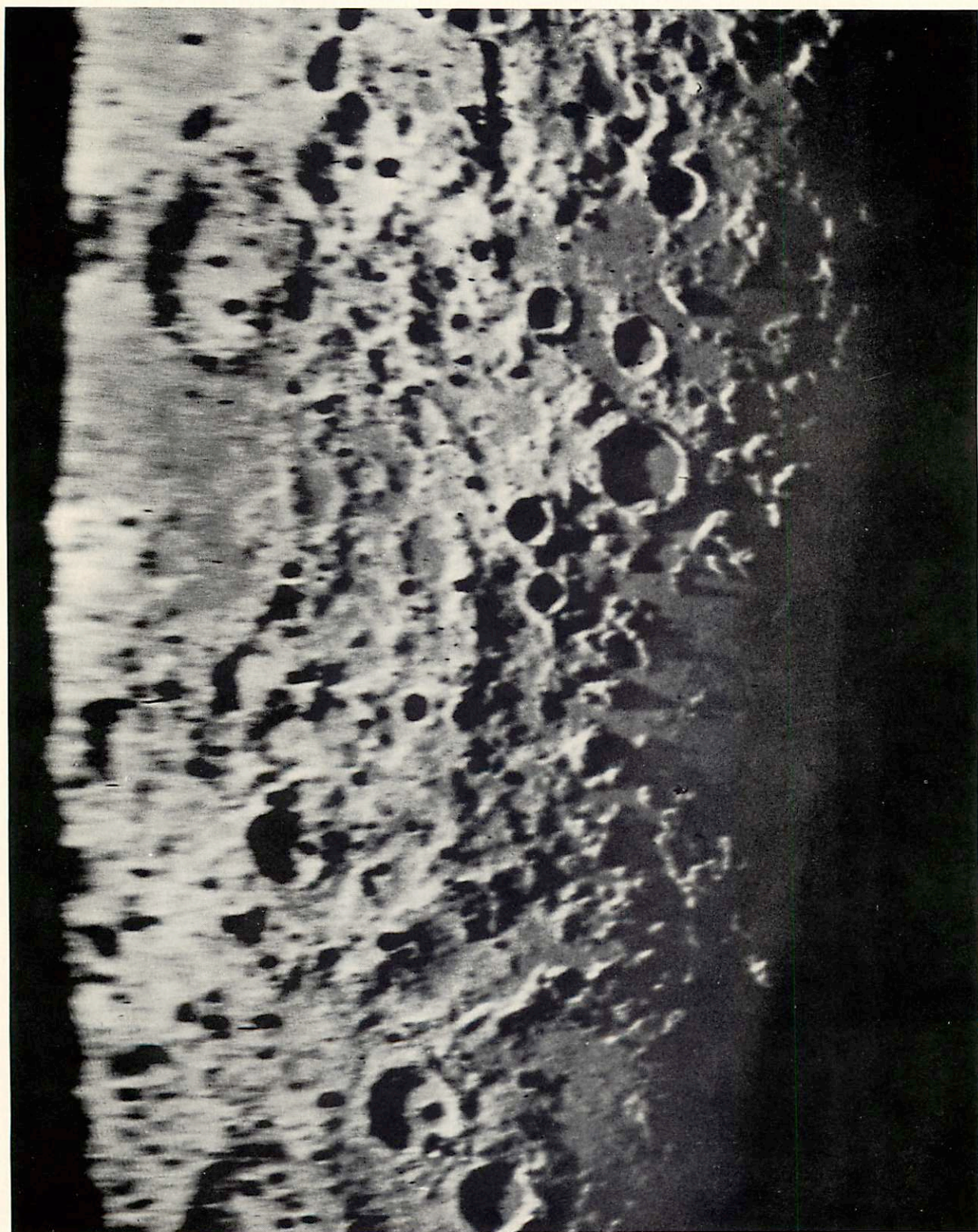


Plate 4.2. Rectified photograph of limb area No. 15.

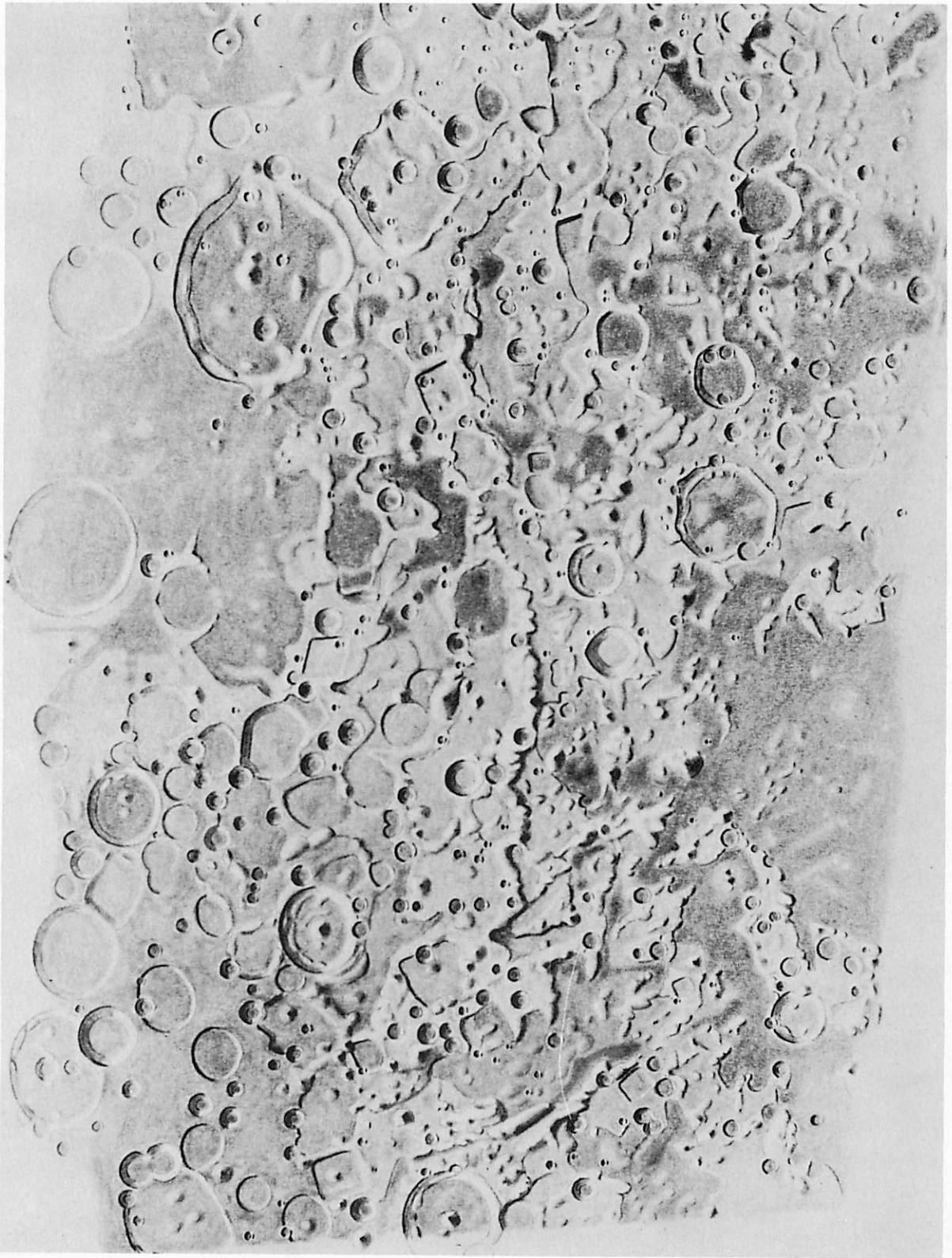


Plate 4.3. Drawings of limb area No. 15.

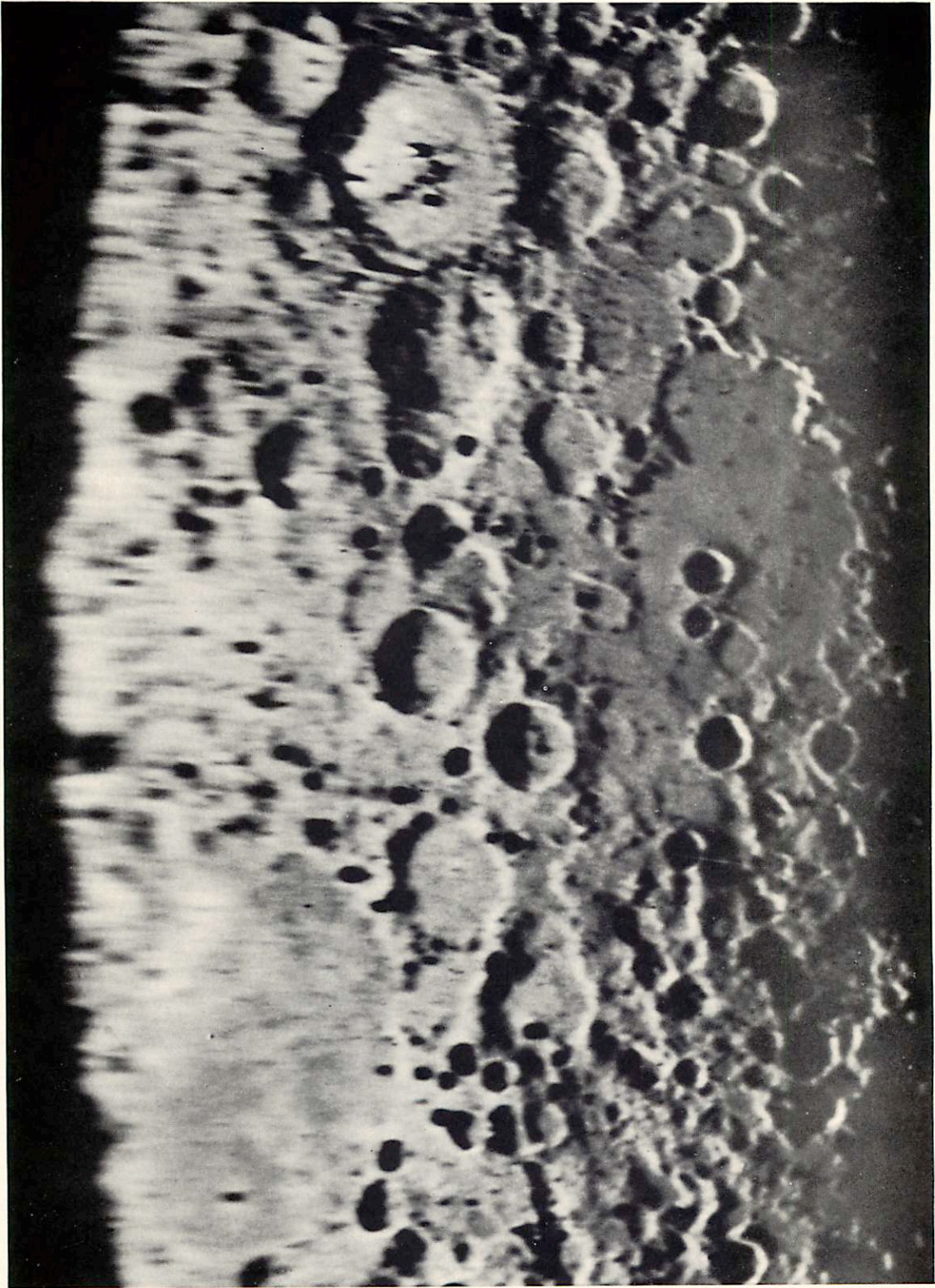


Plate 4.4. Rectified photograph of limb area No. 21.

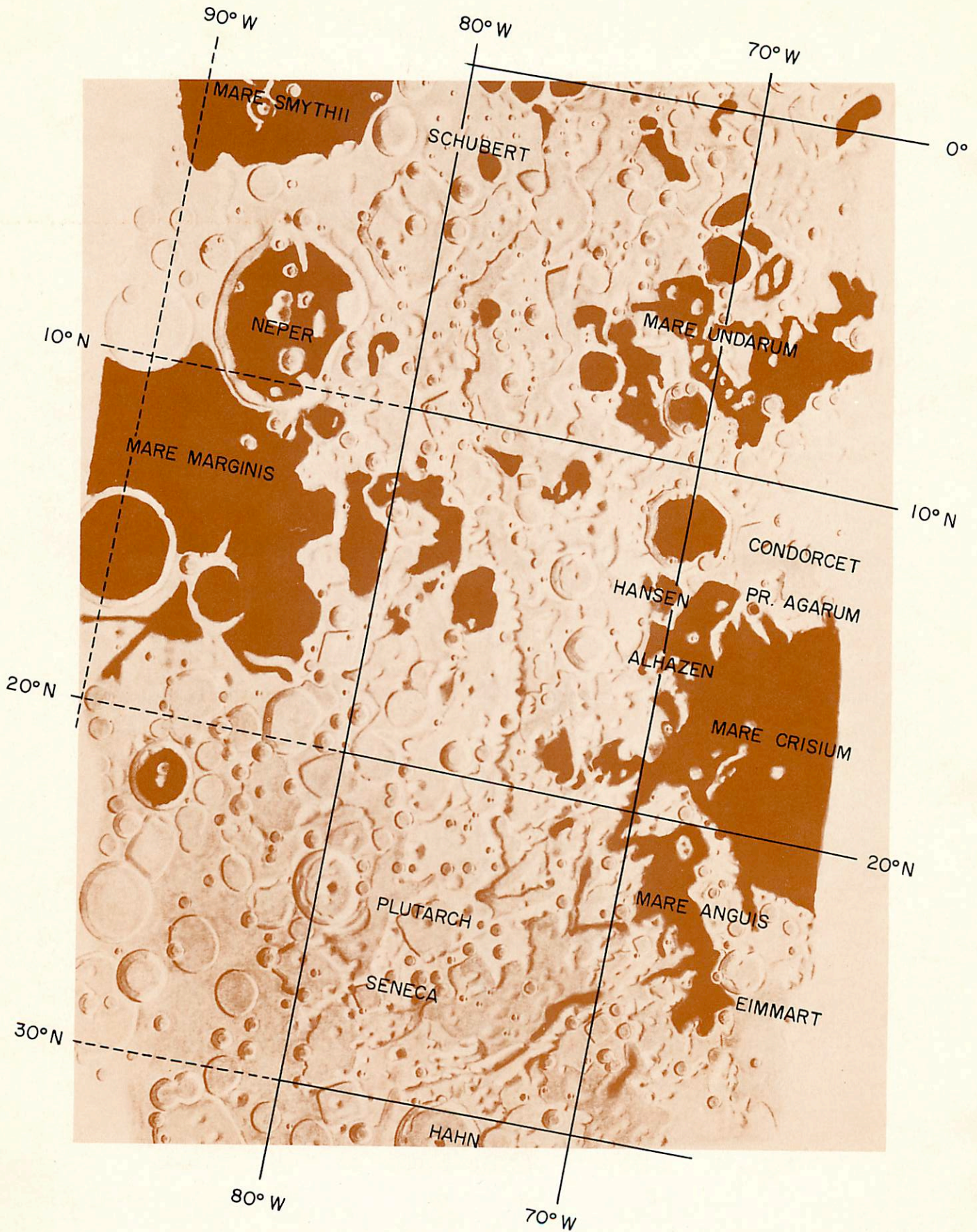


Plate 4.6. Area 15. Drawing showing named formations with latitude-longitude grid. Contrast of dark-floored areas is enhanced.



Plate 4.5. Drawing of limb area No. 21.



Plate 4.7. Area 21. (See legend for Plate 4.6.).

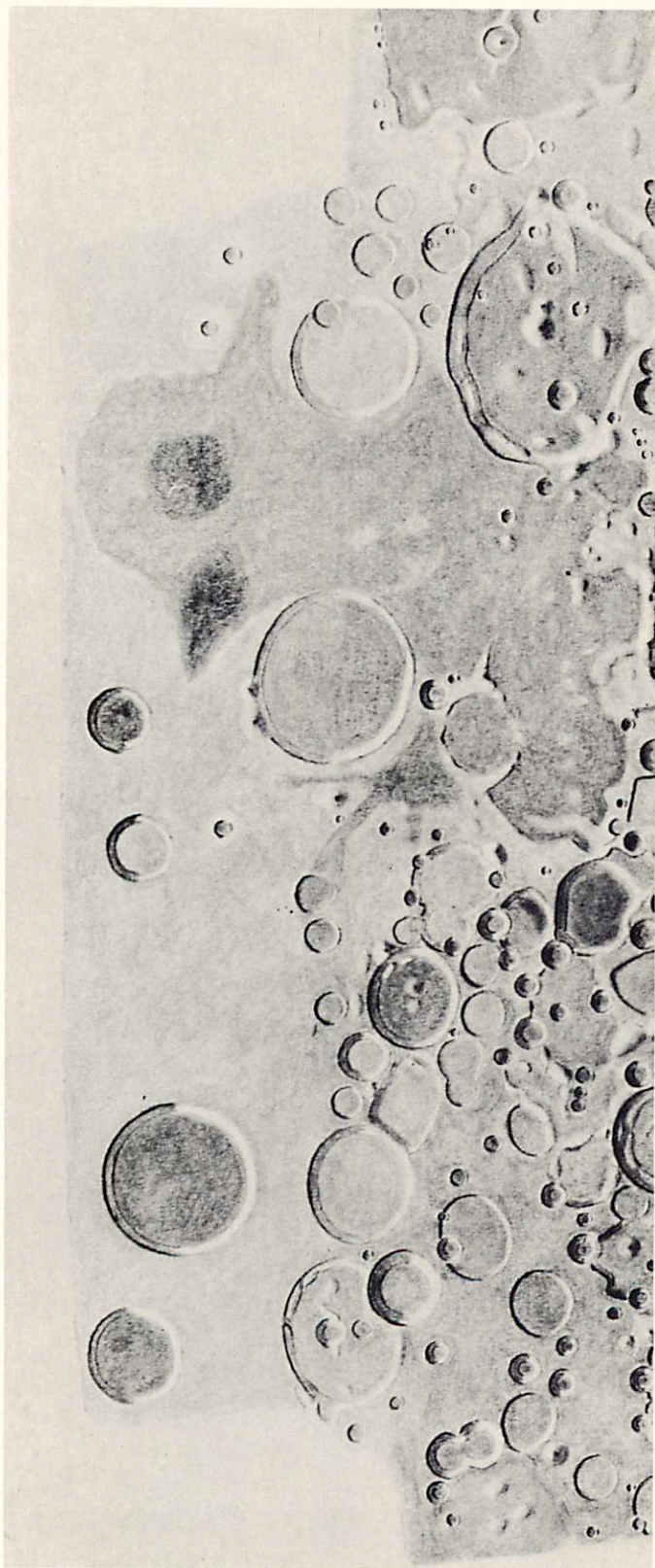


Plate 4.8. Area 15.