LUNAR MAPS AND GLOBES COMPILED IN THE STERNBERG ASTRONOMICAL INSTITUTE

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ABSTRACT

This paper describes the specific features of creating maps and globes of the Moon prepared by the Department of Lunar and Planetary investigations of the Sternberg State Astronomical Institute jointly with other organizations.

INTRODUCTION

The Moon as the celestial body which is the closest to the Earth, has become the first object of extraterrestrial cartography. The experience accumulated in the process of creating lunar maps served as a basis for the development of planetary cartography. During the more than 40-year period of space flights the most valuable information of the solar system bodies was obtained. It surpasses in volume, quality, resolution and other parameters the data of telescopic observations conducted for about four centuries.
Within that historically short period of time many problems were solved: various modernized methods of obtaining and transmitting pictures of planets and satellites from spacecraft to the Earth were evolved and used, methods of deciphering and improving the quality of these photographs, methods of creating networks of reference points, ways of reflecting the topography on maps and generalizing the features of the surface were developed.

Work aimed at modern mapping planets and satellites is carried out most widely in the United States. Maps of the Moon on the scale 1:10 000 000, 1:5 000 000, 1:2 750 000, 1:1 000 000, 1:500 000, 1:250 000 and large scale maps for individual sections of the surface were compiled there. The map The Earth Moon on scale 1:11620 000 is of very high quality. It has been prepared by the Cartographic Department of the National Geographical Society of the USA. Modern maps of the Moon were published in Chekhoslovakia,, in Germany, France and UK in the middle of XX century.

MAPPING OF THE MOON IN THE USSR

In the Soviet Union the cartography of the Moon began with the launching of the Luna 3 space probe in 1959 which photographed for the first time ever the part of far side of the Moon. In 1960 the first Map of the Far Side of the Moon was compiled on the basis of this data on the scale 1:10 000 000. It was prepared by Sternberg State Astronomical Institute and the Central Research Institute of Geodesy, Aerial Photography and Cartography. The Globe of the Moon was also issued on the scale 1:13 600 000. The Complete Map of the Moon on scale 1:5 000 000 was compiled in 1966 with using Zond 3 pictures. This map was issued in several editions in 1967, 1969 and 1979 years. The Photographic Map 1:5 000 000 and The Map for the Equatorial Zone of the scale 1:1 000 000 were compiled for the Moon's visible hemisphere on the basis of the data of groundbased telescopic surveys.

The Geological Institute of the USSR Academy of Sciences compiled the Geological-Morphological Maps of the Moon, Maps of volcanic forms and the Structural - Geological Map. Maps of individual sections of the Moon of the scale 1:1 000 000 and 1:2 000 000 were issued on the basis of Zond 6 and Zond 8 data by the Moscow Institute of Engineers of Geodesy, Aerial Photography and Cartography. The Astronomical Observatory of the Kharkov State University has compiled the Photometric Map of the Moon, the Map of Albedo and the Map of the Colour for the visible hemisphere on a scale 1:5 000 000. The Atlas of Polarization Maps of the Moon on a scale of 1:10 000 000 has been prepared by the Abastumany Observatory

THE COMPLETE MAP OF THE MOON

The possibility of studying of the global features of the structure of the lunar surface became real after completing the global survey of the Moon in 1965. Using materials of photographing the far side of the Moon from the Luna 3 and Zond 3 space crafts the Sternberg State Astronomical Institute and USSR Topographic Service have compiled the Complete Map of the Moon on 9 sheets and the Globe of the Moon which reflect 95% of the lunar surface. For the map the arbitrary cylindrical projection plotted under the condition that the distortions of the angles did not exceed ± 5° in the region limited by parallels ± 50° was worked out specially. The areas of formations on extreme parallels ± 60° are - increased on the map by 100%, while in Mercator projection they would be increased 4 -fold. Polar regions are represented in equiangular azimuthall projection. The map also contains practically a full. list of lunar names in Russian and Latin transcriptions.

Thanks to the pictures taken from spacecraft Lunar Orbiters and space probes Zond 6, 7 and 8 which have provided scientists with qualitatively new material drafting of the topography of the lunar surface has been improved considerably on the Complete Map of the Moon of the 3-rd edition, issued in 1979. On the basis of the original of the relief shading of this map fair copies of the map on a scale of 1:10 000 000 were prepared on a single sheet. This map is complemented by data on the areas of mare formations, measured by J.Rodionova as well as the map of the distribution of lunar rocks compiled by V.Shevchenko and the list of main stages of lunar studies by space crafts and reference data.

The fixing of pictures taken by Zond 3, 6, 7, space crafts Apollos was carried out by means of the unified multiplex designed at the Sternberg State Astronomical Institute. This multiplex makes it possible to restore optically the bundles of projecting rays which existed at the moment of photography. Using the unified multiplex it is also possible to obtain photographic images corrected for curvature and inclination. The coordinate fixing on the map is improved as compared with previous editions, especially in the central part of the far side of the Moon and in near polar areas. In the course of the relief shading wide use was made of photographs of individual regions projected onto the spherical screen and photographed from points chosen by the artist-cartographer. Thus, the blank spot in the southern polar area was decreased. On the map 99,5% of the entire surface is reflected.

The appearance of the lunar surface on the photographs varies to a great degree with the change of lighting conditions. To correctly convey all specific features of this or that region it is necessary to have photographs obtained both in case of the low incidence of sunrays and in case of their high incidence. While for the visible side of the Moon there are detailed atlases of photographs taken in different lighting conditions, for the far side there are not such atlases at the present. Moreover, for some regions of the invisible hemisphere there are only pictures

with considerable distortions in perspective or taken near the terminator when many details are hidden by the shadow.

On the maps of the Moon the difference of two basic types of the surface is well reflected: the highland type which occupies 83% of the surface characterized by the high albedo, considerable roughness and a large number of craters and the mare type (17%) which is characterized by the low albedo, the low, relatively smooth relief and a smaller number of large craters (Fig.1). Along with these widespread types of formations of the lunar surface are shown: craters with morphological features inherent in them, massifs, crests in maria, hills, domes, faults, valleys, rills, cracks, chains and bright ray systems. Over 20 000 formations are shown on the map. Typical features of craters, such as terraces and landslides, central peaks and mountains on the floor and lava effusions are shown for craters more than 25 km in diameter. Most of young craters with the clearly outlined rim have terraces and central peaks. In old craters they are found less frequently.

The relief of the lunar surface is shown by the relief shading of the half tone drawing in oblique lighting conditions. But in some cases the map shows features which are visible only in lighting conditions close to full moon conditions, for instance, ray systems of craters, lava flows, at the same time rills, crevices, folded veins can be distinguished only near the terminator. Both these extreme cases of lighting were artificially combined on the map.

The brightness features of the lunar surface are indicated on the map by variations of the tone of colour relief shading. With this aim in view the makeup of the boundaries of the areas of various albedo was preliminary constructed. Data on the brightness features of the surface enhances the information value of the map. It has been established that the brightness of lunar material is determined by the chemical composition of rocks. The value of the albedo of the lunar surface can be used as a preliminary indication of the type of rocks having the predominant spread in a specific region.

Large ring structures which are often called basins such as Mare Orientale, Hertzsprung, Apollo, Korolev, Mare Moscovience, Poincare and others have not only the external rim, but also the internal rim the diameter of which is twice smaller than the external diameter. Sometimes inner rings are greatly damaged. Mountain formations on the Moon are parts of rings bordering circular maria. The Alps, the Caucasus, the Apennines, Carpathians and the Jura surround Mare Imbrium, the Altai, Pyrenees surround Mare Nectaris. The Cordilleras and Rook surround Mare Orientale.

Maps of the Moon are widely used for solving important scientific tasks. They have been used for obtaining such quantitative indices as the areas of the maria, large basins and craters, for zonning on the basis of one or several sighs, for revealing spatial regularities, as well analysis of the distribution of typical topographic forms in comparative planetology on the surface.

GLOBES OF THE MOON

All the specific features of the Moon's relief described above are also reflected in detail on globes at a scale of 1:10 000 000. The originals of the globe of the Moon were prepared in the form of 12 segments imbracing zones of 30° longitude and ± 80° in latitude, as well as two near-polar regions of the direct azimuthal equidistance projection. The original technique of transformation by means of the spherical screen (18) was used in the process of preparing segments for the far side of the Moon. Negatives of individual sections of the map were put

into the cartographical projector and were projected onto the spherical screen divided by network of parallels and meridians. The optical image of each 10 degree trapezium of the map was combined with the corresponding trapezium on the sphere by the motion and inclination of the camera. Thus, the transformation of 10-degree trapezium of the map was carried out into the corresponding trapezium on the surface of the globe. As the result of the exposure of corrected images on the thin photographic paper photo images of individual trapezium in the globe projection were obtained. The mounted 30-degree segments were than used for making the originals of the relief shading (Fig.1)

CONCLUSION

Over the past few decades thanks to flights of space crafts to the Moon and planets extensive data has been accumulated. It is needed for mapping celestial bodies. Along with the preparation of special maps for popularizing new scientific data on the solar system it is reasonable to prepare and publish a series of maps of the hemispheres of the Moon and terrestrial planets on a global scale. Such a series of maps reflecting all the newest results of exploring the planets and satellites by spacecraft will be very useful for astronomy amateur, students and schoolchildren.

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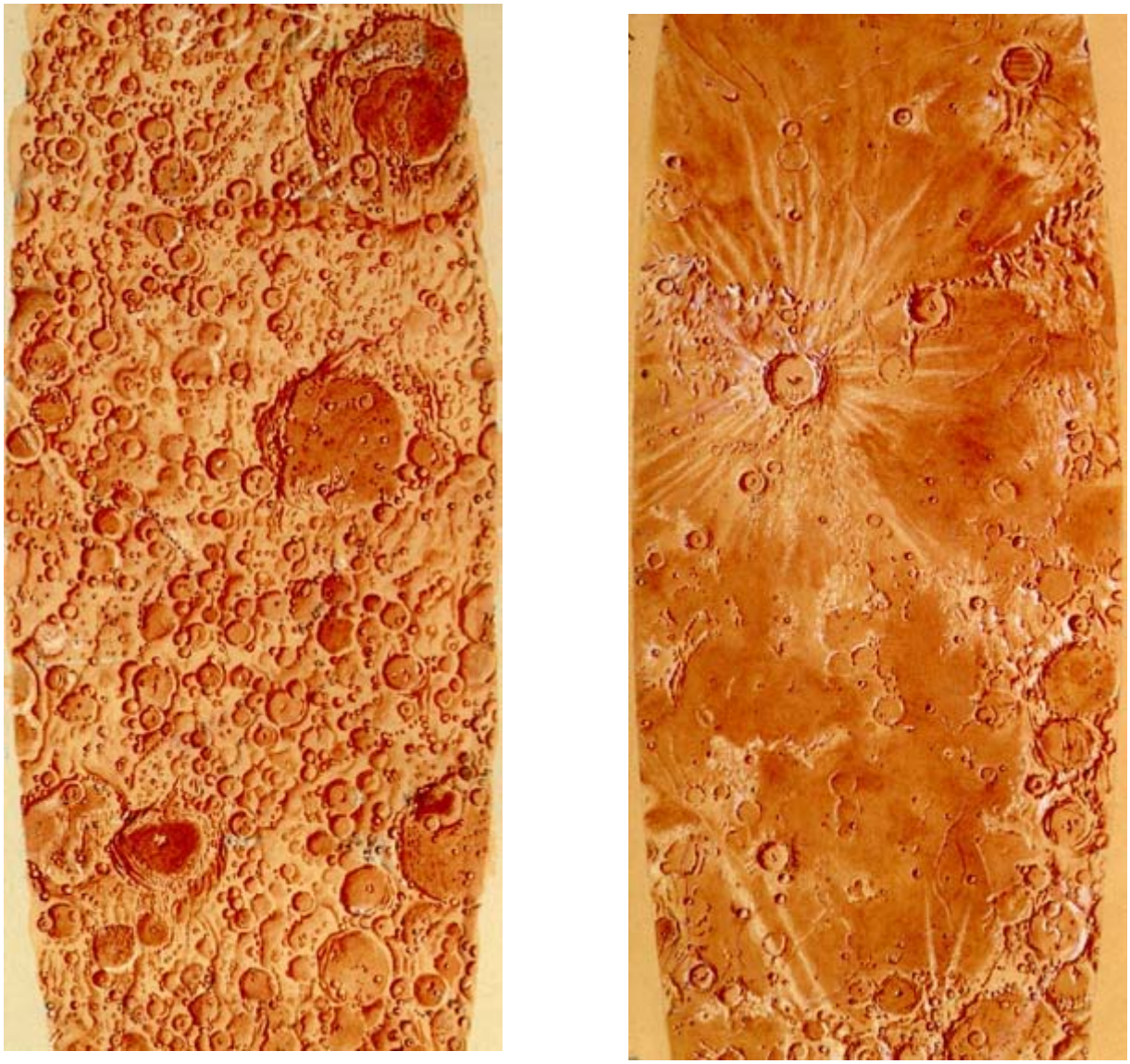

Fig.1 The frames of segments of the Lunar Globe. (on the left - far side, on the right - near side).