Hypsometric Globe of Mars – 3D Model of the Planet

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Abstract. The new Hypsometric Globe of Mars is based on laser altimeter data of Mars Global Surveyor spacecraft. The diameter of the globe is 21 cm. Coordinates and the heights of 64 800 points on the surface of Mars were used for creating a 3-D Model of the surface of Mars.. A digital model of the relief was constructed with ArcGIS software. Contour lines were added together with hill-shading on the globe. The names of the main features – lands, plateaus, mountains, lowlands – plains and also some large craters are labeled. The places of landing sites of the spacecrafts are shown.

Keywords: Globe, Mars, Hypsometry

1. Introduction

The history of creation of martian globes has more then 150 years (Blunck 1993, Mokre 2005, Rodionova, 1991). A set of virtual globes of Mars - a topographic, a photomosaic (albedo) and a historic globe has been made in Hungary (Hargitai et al. 2009). Globes of the Earth and planets are widely used for demonstrations and for research. With the development of space activities globes have been used in a manned spacecrafts (Berlyant, 2007). Hypsometric map gives a geometrically accurate representation of planet's relief with contour lines and coloring altitude levels (as defined by the color scale). The Hypsometric globe of Mars (*Figure 1*) is based on our Hypsometric map of Mars, scale 1:26 000 000 (Ilukhina, 2004), compiled at the Sternberg State Astronomical Institute (SAI) in cooperation with the Department of Cartography and Geoinformatics Faculty of Geography Moscow State University. The heights on the map show the results of Mars Global Surveyor altimetry. Elevation is reckoned from a triaxial ellipsoid equipotential surface. The height scale contains 21 step heights. To a height of 8 km the contour interval is 1 km. Up to 12 km the interval is 2 km. Above 12 km the interval is given within 10 km.

Figure 1. Hypsometric Globe of Mars.

2. Technology

The technology to create the globe using thermoplastic materials provides for forming the hemispheres of the sheets with the printed image on them and gluing the hemispheres at the equator. The original hemisphere prepared with the image is placed in the plastic molding device, and at high temperature using a metal template the hemispheres are pressed. Western and Eastern hemispheres were recut as the northern and southern hemispheres in the azimuthal projection taking into account the law of deformation occurring during forming of the plane in the hemisphere. Transforming the original cartographic image on the plane into an undistorted image on the field in this way can only be done, if the distortion of the lengths of the meridians in the original projections will be constant equal to $m = 2/\pi$, and the distortion of the lengths of the parallels of latitude be a function of the form $n = (\pi-2\varphi):(\pi\cos\varphi)$ (Boginskiy 1990). This requirement corresponds to an azimuthal equidistant projection to the plane of section passing through the center of Mars. The projection is an orthogonal grid. The parallels are represented by equally spaced concentric circles, and meridians - the straight lines emanating from the center of the circles. When placing the original map, we took into account the fact that when forming the hemispheres the original image is stretched by more than half. As the tension is not even the names of relief forms were arranged parallel to the equator.

NAME OF	SPACECRAFT	LATITUDE	LONGITUDE	DATE
	MARS 3	45 ° S	158° W	2. 12. 1971
	MARS 6	23,9° S	19,4° W	12. 03. 1974
	VIKING 1	22,5° N	48,2° W	20. 07. 1976
	VIKING 2	48,2° N	225,6° W	3. 09. 1976
	PATHFINDER	19,1° N	33,6° W	4. 07. 1997
	SPIRIT	14,6° S	184,5° W	4. 01. 2004
	OPPORTUNITY	1,9° S	5,5° W	25. 01. 2004
	PHOENIX	68,2° N	125,6° W	25.05. 2008

	**CURIOSITY**	**4,5° S**	**222,6° W**	**6. 08. 2012**

Table 1. Landing spacecrafts to Mars

Table 1 shows the coordinates of sites of the spacecrafts on the surface of Mars. To construct the cartographic image software ArcGis10 was used. The final design was carried out in a graphics editor Coral Draw. Based on project data previously made in ArcGis hypsometric maps were made for the southern and northern hemisphere and redesigned at the azimuthal projection, prepared by the grid. Then the map images Eps format were transferred to Coral Draw, where the labels were made for landforms, map grids and prepared the layout for printing in accordance with the requirements of the publisher.

3. Conclusion

A preview sample image of the northern and southern hemispheres of Mars for the hypsometric globe is shown on *Figure 2*.

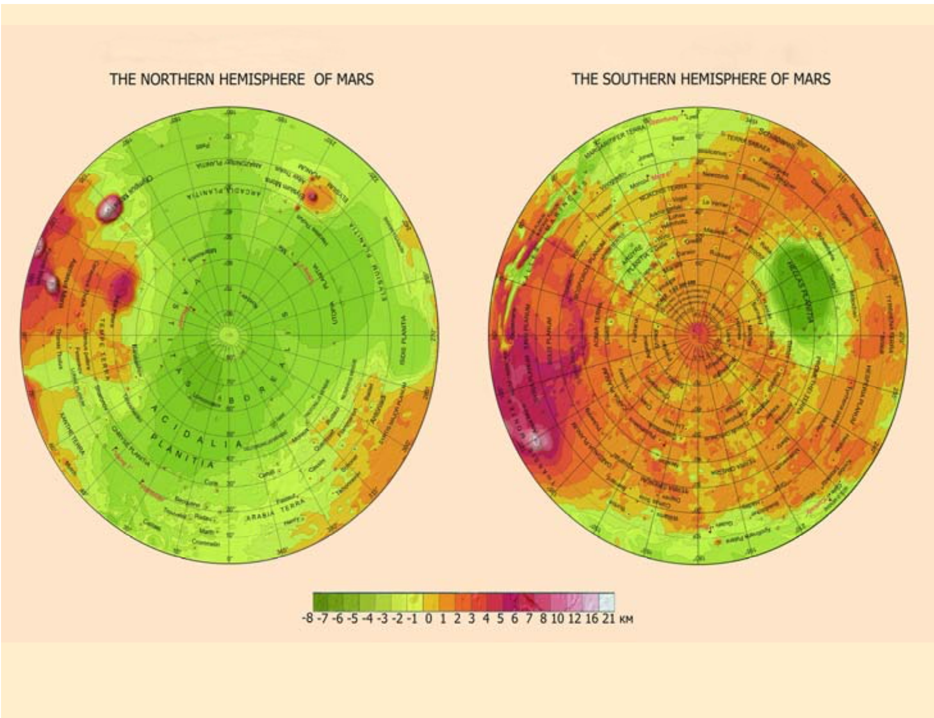

Figure 2. Northern and Southern hemispheres of the Hypsometric Globe of Mars.

Most of the northern hemisphere of Mars is occupied by a relatively smooth plains For example, Vastitas Borealis has a depth of -4 - 5 km as Utopia Planitia and Acidalia Planitia. Arcadia, Chryse, and Amazonis Planitiae are higher by 1 km. In the southern hemisphere the plains are relatively few. There are Hellas Planitia, 2300 km in diameter, and a depth of -8 km and 800 km in diameter Argyre Planitia and with the depth of about 3 km. The average height of the highlands of Mars are 3-4 km. Syria Planum is located on the plateau heights of 5 - 6 km, and Sinai Planum at 3 to 5 km, Solis Planum is at 3 to 4 km, Hesperia Planum and Syrtis Major Planum at 1 to 2 km. At the equator, is the largest mountain – Tharsis Montes with a diameter of about 6000 km and a height of 9 km. Three extinct volcanoes tower above it: Ascraeus, Pavonis and Arsia Mons located on the same line. The volcanoes have height of 14-18 km. The highest volcano on Mars - Olympus Mons. Its height is 21 km. In the equatorial zone of Mars is a giant system of faults with steep slopes – Valles Marineris. It has a maximum depth of 6 km and the width at the widest part is about 700 km. Names of parts of the relief on the globe are given in the Latin version published by the International Astronomical Union (http://planetarynames.wr.usgs.gov).

References

Berlyant A.M. (2007) Globusy. GEOS. Moscow, 80 p.

Blunck J., Jons H.P. (1993) Der Rote Planet Im Karten Bild. Staatsbibliothek zu. Berlin. 1993, 132 p.

Hargitai H., Gede M. (2009) Three virtual globes of Mars: topographic, albedo and a historic globe. EPSC Abstracts, Vol. 4, EPSC2009-47.

Mokre Jan (2005) The Globe Museum of the Austrian National Library. Bibliophile Edition. Vienna, 72 p.

Rodionova Zh.F. (1991) Space achievements and maps and globes of planets//Geodesy and Cartography, Moscow, N 7, p. 15-22

Ilukhina J.A., Rodionova Zh.F. (2004) Gipsometricheskaya karta Marsa.

1:26 000 000. Moscow, Nauka.

Boginsky V. M., Rodionova Zh. F., Myshetskaya E. N. (1990) Opyt sozdaniya globusa Luny na termoplastichnom materiale//Geodezy and Cartography., Moscow, № 6, p. 28-34.