MARS MAPPING FROM MARS-96 MISSION

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ABSTRACT

Expected results of Mars surveying from Mars-96 Mission by means of 3 cameras, namely HRSC, WAOSS and OMEGA are characterized. Mars mapping program on the base of this surveying is considered. One part of Mars images will be applied for cartographic support of regions which are selected as very perspective for further explorations. Another part will be used for various thematic mapping of Mars. A possibility of compiling Complex Mars Atlas on this base is discussed. Such an Atlas has to include different kinds of topographic and thematic maps of Mars, and also some reference information for the planet. Mars Atlas will have 12 parts, among which there are geologic-morphologic maps, maps of geophysical properties, maps of climate, maps of physical properties of the surface etc. All the maps will be represented on the separate sheets, collected in one portfolio. By compiling the common base-map in normal equivalent pseudocylindric Mollweide projection, the whole Mars surface is reproduced without breaks, that is very important for thematic mapping especially. It is also planned to include new cartographic products in Mars Database.

The next flight to Mars will start by PHOBOS type spacecraft in October 1996. One of the main tasks of this program is Mars surveying from the satellite's orbit. The images will cover a great part of the planetary surface with up to now unattainable precision, delivering three-dimensional contours as well as spectral information.

Mars surveying from MARS-96 mission is planned for 3 cameras, namely:

- HRSC (a multifunctional high resolution stereoscopic TV-camera for 0.4-1.0 mkm range and with resolution of 10 m/pixel)
- WAOSS (a wide angle stereoscopic TV-camera for 0.4-0.7 mkm range and with resolution of 100 m/pixel)
- OMEGA (a scanner mapping spectrometer for 0.35-5.2 mkm range and with spectral resolution 50 to 100 and spatial resolution of 0.4 to 4 km).

The surveying with high resolution has a stripe width about 62 km. Taking into account the orbit displacement during a month it is possible to receive images of separate regions for area 500x500 km (10x10°). The possibility of surveying is limited by possibility of data transmission. Using high resolution data it permits to compile a map at scale 1:100,000 for separate local

regions. On data base of mid and low resolution it is possible to compile various thematic maps at scales 1:1,000,000 and 1:2,000,000.

The particular regions for surveying will be defined only after orbit corrections and strongly depend on transmission ability. But it is clear that in parallel two kinds of surveying will be performed, namely, surveying of local regions (10x10°), and global surveying in various spectral bands. In the first case the main problem is a selection of local region because the total surveying with high resolution is not possible. For this purpose it is necessary to use Catalog of perspective sites for Mars scientific exploration (Greeley, 1990). This Catalog has about 100 Mars landing sites provided with descriptions and photomosaics. But often for detailed investigation it is necessary to have large scale images and corresponding maps.

In the second case it is possible to plan a compilation of global maps and maps of some interesting regions in small and mid scales. For planning this part of work it is necessary to remind shortly the present state of Mars cartographic study.

Within the recent years there have appeared a number of detailed reviews dedicated to various aspects of the Mars cartographic state of study (Blunck, 1993; Neukum and Tarnopolsky, 1990; Greeley and Batson, 1990; Atlas..., 1992). The results of an attempt to briefly sum up the data about cartographic support of Mars are given in the Table 1.

It results from the Table that there are still no maps on large scales (1:25,000; 1:10,000; 1:5,000) even for separate sites, and the number of maps on middle scales (1:500,000; 1:250,000) is very limited. The analysis of the catalog of potential sites for spacecraft landing on Mars (Greeley, 1990) has showed that the majority of the selected sites is not provided by the maps on middle and large scales. Regarding the mathematical basis of maps, at the present time a sphere of the radius 3,393.4 km or a spheroid with the polar radius 3,375.8 km and the equatorial radius of 3,393.4 km, are used as the reference surface for Mars. The Airy-0 crater serves as the coordinate origin. The reference system for longitudes has been accepted

Map scales	Number of map sheets	USA	Russia	Other countries
		Synoptic		
1:50,000,000	1	-	+	-
1:31,770,000	1	+	-	-
1:25,000,000	1;1	+	+	-
1:23,500,000	1;6	-	-	Germany, England
1:20,000,000	2;1	-	+	Swiss
1:15,000,000	3	+	-	-
		Quads		
1:5,000,000	30	+	-	-
1:2,000,000	140	+	-	-
		Miscellaneous special		
1:5,000,000	2;2	+	+	-
1:2,000,000	3;1	+	+	-
1:1,000,000	2;1	+	+	-
1:800,000	3	-	+	-
1:500,000	109;4	+	+	-
1:250,000	7	+	-	-

Table 1. State of Mars mapping.

from 0° to 360° (from the East to the West from the standpoint of terrestrial understanding) and for the latitudes ±90°. There are several reference catalogs significantly differing in the accuracy. Today on the whole the control network of Mars consists of 9,292 control points which have been identified in 2,479 images of the planet. The accuracy is 3÷6 km for plane position and 0.25÷2.1 km - for elevations (Neukum and Tarnopolsky, 1990; Atlas..., 1992). Only classic projections are used for the maps. The map arrangement is rather diverse, and especially for the maps with the global coverage. As for their content it is possible to subdivide the already available maps in topographical maps, photomaps (photomosaics), outline maps, synthetic maps, maps with the relief presentations by shading technology, thematic (e.g. of albedo, geophysical maps and others) and special maps. For Mars there exist digital cartographic products as well. Those are developed within the framework of the Planetary Data System (PDS).

A scheme of the map support of the MARS-96 mission given in Fig.1 has resulted from the analysis of the available information. We mark out three main trends and, namely, the science, education and formation of the public opinion. For their development the creation of certain cartographic products is required. Both the fundamental and the applied research are required for the science including presentation of the level of the cartographic state of study. For the education, delivery of corresponding information to such groups of users as students, pupils and amateurs should be foreseen first of all. Finally to form the public opinion that plays a considerable role when defining the financing of space projects, the necessity to advertise not only the project itself but to promote the results obtained within its implementation should be

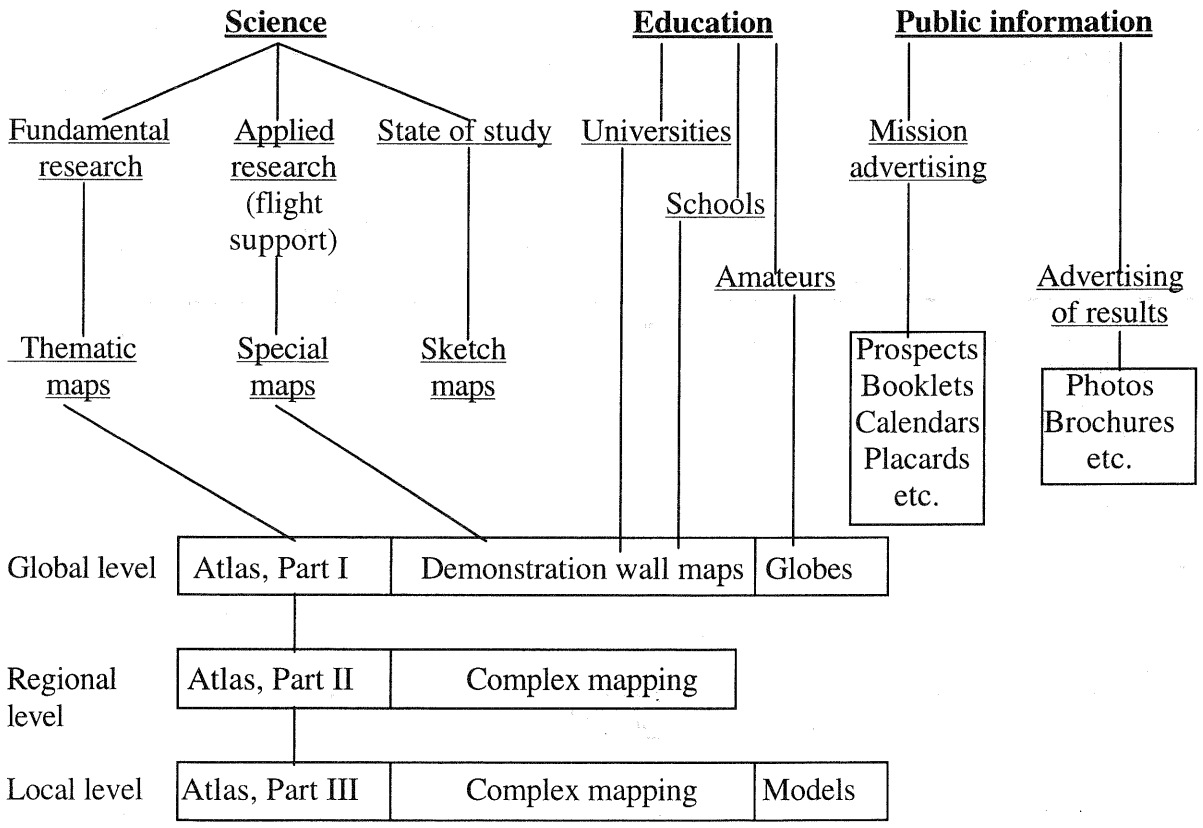

Fig.1. A scheme of cartographic support

considered. For this purpose booklets, placards, calendars, separate photos and brochures should be used.

The scheme marks out three levels of cartographic information support. They are related first of all to the area of coverage and namely global, regional and local. The first level includes small-scale mapping, the second - mapping of separate regions and the third one - mapping of separate local sites on large scales. Consequently we relate the creation of globes and demonstration wall maps to the first level, and complex mapping and surface modeling - to the second and third ones. We consider the scales of 1:2,000,000, 1:500,000, 1:100,000 and 1:25,000 to be the major scales. Mapping on a scale of 1:2,000,000 provides for the updating of the already compiled map.

It should be reminded that the updating of this map in particular was among the tasks of the surveys planned for the Mars Observer station. As it is known, its flight has not provided the expected results, however, it will be possibly repeated in 1996. Regarding the MARS-96 mission, its information is also supposed to be used for updating the map on a scale of 1:2,000,000. In addition these data are considered for regional mapping on scales of 1:500,000 and 1:100,000 and for thematic mapping as well.

The Atlas of Mars is included at every level. We consider this publication to consist of three parts. The first part is the review containing the general information about the planet and small-scale maps. The second part should be dedicated to the information about the regions and the third one - to separate local sites (both reference and anomalous).

We have begun to create the Atlas of Mars, Part I. The maps will be plotted in separate sheets collected in a portfolio. Numbering of sections allows adding sheets in a section as far as new information becomes available. That is of especial importance for the sections containing various thematic maps. Preliminary the following sections will be included in this Part: introduction, geographical maps (surface map, basic map for thematic mapping and hypsometric map), geophysical, geochemical, geological, morphological and climatological maps, maps of the surface physical properties and others.

The first Part of the Atlas presents various thematic information characterizing the planet as a whole. This data is given in a small-scale map chosen as a unique basic map to show the entire planetary surface in a single sheet without breaks. The scale of 1:40,000,000 has been specified for the basic map. Choice of this scale is explained by the aspect that a scale of 1:20,000,000 was used for an analogous basic map in the prepared for publication "Complex Atlas of the Moon". Consequently comparison of certain characteristics becomes easier, because these maps have the same dimensions. Additionally the scale chosen is convenient for the reference desktop usage.

Regarding the projection, the equivalent elliptical Mollweide projection was chosen. Also the same choice as for the Atlas of the Moon.

In general to present the surface of a celestial body as a whole in small-scale maps we usually use classic pseudocylindrical equivalent projections. The Sanson (sinusoidal) projection and the Mollweide (elliptical) projection are concerned first of all. The Sanson projection preserves length along the mean meridian and along all parallels. The other meridians of this projection's normal grid excluding the rectilinear mean one, are sinusoids. For Mollweide projection it is typical to preserve length along the equator. The meridians at ±90° from the mean one are shown by a circle. The other meridians are presented by ellipses with one constant semi-axis and the other semi-axes varying (Gazetteer..., 1988). The latter depends on the longitude. Both projections are symmetrical.

The Sanson sinusoidal projection and its modification (the Ekkert projection) are convenient for the presentation of the near-equatorial zones. However, from the ±60° lati-

tudes there is an abrupt increase of the scale distortion. Consequently it is preferable to use the elliptical Mollweide projection for the presentation of the surface of a body approximated by a sphere as a whole. This projection provides surface presentation that is easier for interpretation. In the Western and Eastern European countries this projection is widely used for presenting the globe of the Earth as a whole. America prefers the Sanson projection. However, recently they have begun to use the Hammer projection being an average between the isocylindrical projection and the sinusoidal one.

Today the basic map is compiled using Mollweide projection for the first Part of Mars Atlas. The map presents relief by contours and a system of conventional signs which was developed by compiling "Atlas of Terrestrial Planets and their Moons" (1992). Such a relief presentation makes it possible to reference thematic (special) information to the real relief. At the same time it does not prevent from perceiving this information. Besides this map, a series of Mars thematic maps is prepared for Atlas.

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