GEOGRAPHICAL MAPS OF SMALL CELESTIAL BODIES: THE STYLES AND METHODS OF PRESENTATION, THE WAYS OF USE

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Abstract. Modern Cartography appears in many different fields of life. We may see cartographical images everywhere in traditional paper map sheets or Atlases, in magazines, books, advertising, and on Internet sites etc. Cartography has undergone a large transition from traditional paper forms of map to digital forms. The example of small celestial bodies (SCB) maps shows the way of progress in cartography because this type of map shows very clearly the use of new and different types of information, technologies, equipment etc. The production of these maps begins with data obtained from satellites (sometimes from deep space), transferred from the data receiving centre to customers through high speed information channels, then processed into cartographical form on high-performance computers.

Because of the complexity of the “space imagery to map” process, SCB maps are very different in their styles and methods of presentation. Cartographical information can be presented as non – transformed image with interpretations of basic features overlaid, or images transformed into a cartographical projection or 3D visualization etc. In some cases they may be presented as an image or mosaic without any cartographic additions, but useful for scientific investigations. The variety of forms these maps may take influences the ways they are used. The person who is involved in the process of studying of SCB has different ways of using a map. There is a possibility to start an investigation using a paper map but today most information about SCB has digital form. There could be gazetteers, databases, space images on Internet sites etc. In addition, the problem of viewing a map on a computer display as compared with a traditional map has certain features. This paper describes the styles and methods of presentation of geographical SCB maps and the ways of their use.

THE STYLES AND METHODS OF PRESENTATION OF SMALL CELESTIAL BODY GEOGRAPHICAL MAPS

Making a geographical map of a small celestial body with space images

Initial information about SCB can be taken from space images. To get the information we have to have certain knowledge about name of space mission to the celestial body, instruments, spectral bands of imaging, scales of images, coordinates of investigated region etc. Often the images are raw or not transformed (Fig. 1). The easiest way to find interesting images is to start search through Internet. Many missions have personal sites, for example, NEAR Shoemaker mission to Eros asteroid. From this source, there is possibility to take up-to-date information. The information is complex: basic features of space missions, scientific information about celestial bodies, pre-processed images, rough maps etc. The problem is “we have what we have” (WHWWH). In other words, we have no images from other locations except those published on the site. There is also the possibility to order them from images database, for example, from PDS (Planetary Data System) site. In the way of ordering, we must input basic information as mentioned before. The success of useful image depends of its quality, file size, and bandwidth of Internet channel. There is another possibility to order images for example from NASA on CD or DVD – Rom also. The European Space Agency will soon distribute its data in the same way.
When we have the images we need it is possible to start the mapping process. First, raw images must be transformed and referenced to the appropriate coordinate system. Second, if the SCB has an irregular shape it is necessary to choose one of two mapping techniques to take into account that irregular form. According to the first technique the regular surface of a sphere, ellipsoid or triaxial ellipsoid is used as a reference surface and applied to conventional cartographical projections without taking into account the irregular shape of the body (Fig. 2). According to the second technique modified conventional cartographical projections taking into account the irregular surface of a body are used [Fig. 5]. The modified conventional cartographical projections are Projections of irregular surfaces of small celestial bodies [2] or Morphographic (shape-drawing) projections [4]. In the third step, space images are transformed onto cartographical grid with use of special techniques and software, for example, PCI or ENVI. The result of this process is the geographical map of small celestial body with space images describing features of the surface.

![Figure 1: Not – transformed and georeferenced Viking images of Mars satellite Deimos [5]](image1)

![Figure 2: Planetary map compiled with images transformed and georeferenced onto equidistant along meridians square cylindrical projection and Galileo spacecraft images. [Mosaic by P. J. Stooke and M. Arntz, 1999]](image2)
The geographical map of small celestial body with relief shading

In case when space images have low resolution, but still useful, and they are not to be transformed there is a possibility to use relief shading to draw the surface of celestial body (Fig. 3). Using images as original information of the topography we make relief shading cell by cell of cartographical grid (Fig. 4). If we have a digital elevation model (DEM) of the small celestial body then computer relief shading can be created in the software (Fig. 5). The result of this processing can more correctly be named a visualized DEM. There are three ways of computer relief shading. The first way is to use GIS products, for example, special module Arc Info. The advantage of this method is a quick result, the disadvantage is a lack of expressiveness and plasticity of the relief design. The second way there is another method where both GIS products and raster software, for example, Adobe Photoshop are used. Relief shading is created by GIS and converted into Photoshop that is a powerful toolkit. A third method is to use raster software Adobe Photoshop only, which has a special filter for plastic relief representation. The way has some strong point, the quality of relief shading, but its shortcoming is the lack of georeferencing for the pictorial relief image made. This leads to conversion problems while transforming relief shaded maps from one cartographic projection to another. In addition, it is impossible to accurately overlay a raster image through coordinates onto vector cartographic information. [3]. The result of this technique is a geographical map of a small celestial body with relief shading describing basic features of body.

![Image of small celestial body](image1)

Figure 3^ Low resolution, not – transformed and georeferenced Voyager images of Saturn satellite Epimetheus [5]

![Image of Epimetheus](image2)

Figure: 4 The hemispheres maps of Epimetheus satellite of Saturn in morphographic projection with relief shading. [P. J. Stooke, 1993].
THE DIGITAL AND PAPER MAPS OF SMALL CELESTIAL BODIES

Traditional paper maps are in general use but they are not ideal for small celestial bodies because so much information about them is in digital form. Paper maps are very convenient for users as maps do not demand any specific conditions like the use of a computer. We place small celestial bodies paper maps in atlases like Atlas of planets of terrestrial group and their satellites [1] (Fig. 6 a) and wall maps, for example Multilingual map of Mars satellite Phobos [in production] in morphographic projection. Mostly these are cases of small celestial bodies maps reproduced from digital form to hard copy (to paper). Digital maps of small celestial bodies have different media types. They can be maps and atlases on CD or DVD-ROMs, maps in World Wide Web as on www.solarview.com or Web atlases like Web version of small celestial bodies atlas by Philip J. Stooke (Fig. 6 b). Let us name them Internet Atlases and Internet maps. To compile maps of small celestial bodies the additional information is in digital form also. These are space images, databases with scientific information, gazetteers etc.

The ways of use of small celestial body maps

The form of presentation of small celestial body maps influences the ways they are used. For traditional paper maps of small celestial bodies, there are two ways of use - wall map and desktop map. For digital maps, it is the third way – the use of map on electronic visualization device – display. This introduces some problems. The first problem comes from display technology. It is no secret that LCD displays are not very useful for processing of air and space images because of incorrect colour and optical density, contrast and brightness presentation. As a result, we can miss some important features of the celestial body surface on the images. Only the most advanced models of LCD
displays are equal to CRT displays in quality. However, for processing of images it is better to use CRT displays.

The problem of contrast is especially troubling in the case of raw images. Many details are impossible to see without adjustment of brightness and contrast (Fig. 7 a, b). The second problem is that the user of a digital map must have certain skills to use the map effectively. A digital image has a specific resolution and geometric size. The same image in different resolutions has different sizes. This is how computer graphics work. With increasing resolution, the image becomes smaller but more observable and loses small details (Fig. 8 a). Logically the geometrical size should not change but resolution would (Fig. 8 b). The user should be aware of this characteristic when printing a hard copy of a digital map or image. The third problem is that a digital map is compiled in a certain scale and resolution. When ‘zooming’ (enlarging the map in software) the scale changes, but the user does not get that information about changing scales. The fourth problem is that when zooming in to a small area at high resolution the user can not see the whole map, whereas on a paper map the whole map and small details can be seen at the same time. This is because of the limited size of computer displays. These are only a few problems that the user faces during computer reading of small celestial body maps.

Figure 7 a: The image of asteroid Ida before brightness and contrast correction [P. Stooke, Small World Atlas website]

Figure 7 b: The image of asteroid Ida after brightness and contrast correction

Figure 8 a: The images of asteroid Ida (1200 x 588 pix) with resolution 72 ppi, 144 ppi, 288 ppi and, 360 ppi and different geometry size

Figure 8 b: The images of asteroid Ida (1200 x 588 pix) with resolution 72 ppi and 360 ppi and the same geometry size

REFERENCES

5. Stooke, P.J., Small World Atlas website
BIOGRAPHY

Maxim V. Nyrtsov was born in 1975. He graduated from the University of Geodesy and Cartography (MIIGAiK) in 1997. His major is engineer-cartographer. He is doing his PhD and nowadays teaching students at the Department of Graphics and Cartographical Design of the University.

In 1999, he participated in the 19th International Cartographic Conference in Ottawa, Canada, as travel award winner, where he has oral presentation on the topic “Mathematical planetary cartography basis for non-spherical celestial bodies”

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Fields of interests: Mathematical Cartography, Planetary Cartography, GIS, Cartographic design.