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The Phobos information system

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ABSTRACT

We have developed a Geo-information system (GIS) for Phobos, based on data from the Mars Express and Viking Orbiter missions, which includes orthoimages, global maps, terrain- and gravity field models, all referenced to the Phobos coordinate system. The data are conveniently stored in the ArcGIS software system, which provides an environment for mapping and which allows us to carry out joint data analysis and miscellaneous data cross-comparisons. We have compiled catalogs of Phobos craters using manual and automated techniques, which includes about 5500 and 6400 craters correspondingly. While crater numbers are biased by available image data resolution and illumination, we estimate that our catalog of manually detected craters contains all Phobos craters with diameters $D > 250$ m which is a total of 1072 and catalog of automated detected craters are complete for craters $D > 400$ m (360 craters). Statistical analysis of these large craters reveals a surplus of craters on the anti-Mars hemisphere, whereas differences in crater abundance between leading and trailing hemisphere cannot be confirmed. This in contrast to previous papers, where no such asymmetry was found (Schmedemann et al., 2014). But we cannot rule out remaining biases due to resolution, viewing angles or illumination effects. Using digital terrain model (DTM) derived from photogrammetry image processing we estimate depths of 25 craters larger than 2 km using geometric and dynamic heights (for discussion of Phobos crater morphometry see Kokhanov et al., 2014). We also have compiled catalogs of lineaments, and boulders. In particular, we mapped 546 individual grooves or crater chains, which extend in length from 0.3 km to 16.2 km. We identified and determined the sizes and locations of 1379 boulders near crater Stickney. Cross-comparisons of gravity field models against distribution patterns of grooves and boulders are currently under way and may shed light on their possible origins. Finally, we have developed a Geo-portal, which allows the science community to conveniently search for, analyze, and download data of interest from our system. Additionally we provide access to color electronic maps (e-maps) with support for layers based on Phobos geodatabase and ArcGIS tools.

1. Introduction

Planetary cartography projects benefit very much from support by GIS (Geographic Information Systems). These are very helpful for integration of the types of raw data from different spacecraft and instruments or various derived data generated by different teams, for example, PIGWAD (http://webgis.wr.usgs.gov/) or PILOT (http://pilot.wr.usgs.gov/). GIS effectively manages data, descriptive information and links spatial data and non-spatial information. GIS possibilities can be used for a variety of practical tasks, for general science applications, for thematic mapping and cartography (Nass et al., 2010), for planning of orbital imaging and for landing site selection (Schulz et al., 2009). The basis for such goals is the consistent and coherent storage of data within a geospatial context.

For effective management and operation of the GIS, spatial data must be properly organized using data relationships and topology constraints in a geodatabase model. The conceptual approach and design of databases for celestial body have been proposed for the Moon (Cherepanova et al., 2005) based on ArcGIS capabilities (http://esri.com). Conceptual and logical models, including metadata templates of

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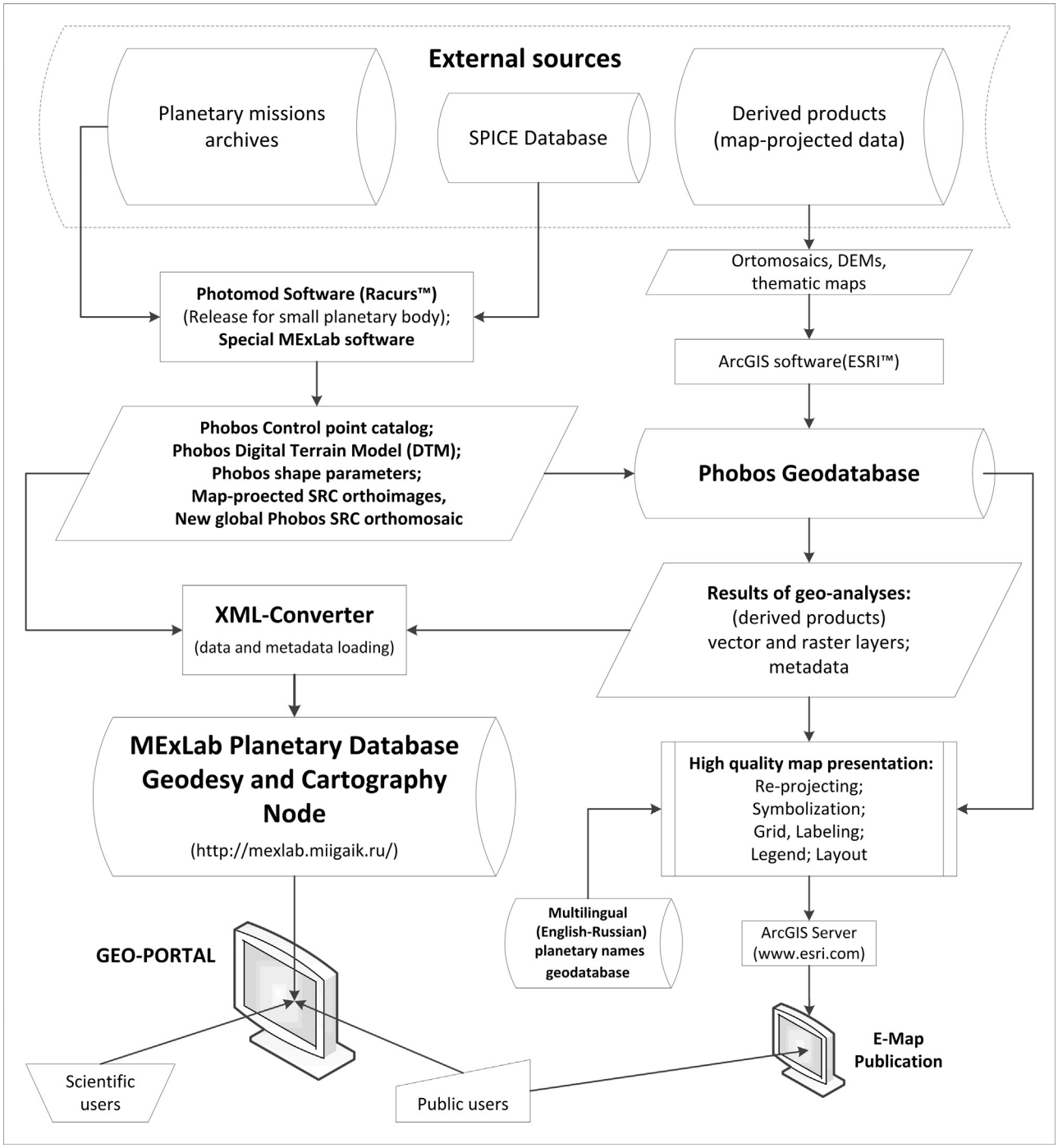

Fig. 1. Scheme of the Phobos information system.

planetary data, were developed for the geological and geomorphological mapping (van Gasselt and Nass, 2011).

Here we present practical realization of development of the geospatial information system for the Martian satellite Phobos. The main our goals are (Fig. 1): (1) to hold a variety of Phobos-related raw data and derived data products, (2) to offer various tools for semi-automated mapping and data geo-analyses, (3) to provide access to the system to public users via geospatial and web-technologies. In this paper, we also present typical applications of our GIS which include the detection and statistical analysis of craters as well as data cross-comparisons, relevant to Phobos.

2. Data sets

Our development of a Phobos GIS is motivated by the availability of large volumes of remote sensing data provided by Mars Express. Due to moderate size of Phobos and the uniqueness of the data set, we have developed a standalone geodatabase within the commercial software ArcGIS 10 (ESRI™) for data storage, data analyses, production of derived data and for mapping (Karachevtseva et al., 2012a).

Two important data sets, derived from Mars Express (MEX) SRC, Super Resolution Channel (Jaumann and Neukum, 2007; Oberst et al., 2008) and Viking Orbiter (VO), provide base layers

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