MORPHOLOGICAL STUDY OF PHOBOS SURFACE AND MAPPING OF THE GROOVES. C. A. Lorenz[1,2], A. A. Kokhanov[2], I. P. Karachevtseva[2], [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin St. 19, 119991, Moscow, Russia c-lorenz@yandex.ru, [2]Moscow State University of Geodesy and Cartography (MIIGAiK), MIIGAiK Extraterrestrial Laboratory (MExLab), Gorokhovsky per., 4, of. 155, 105064, Moscow, Russia.

Introduction: A Martian moon Phobos has an irregular shape, and similarly to the other stony bodies of solar system, is intensively cratered. However, a presence of several sets of the grooves, crossing each other and forming a frequent network is the unique Phobos feature, which is not known somewhere else among the small stony worlds. An origin of the grooves remains unclear; their detailed measurements and analysis carried out in this research contribute to understanding of their nature.

Results: Analyzing individual images of Phobos, obtained from "Mars Express" and "Viking orbiter 1" spacecrafts and orthomosaics of the images we have created the new GIS-catalog of the Phobos grooves.

Measurements of grooves: Using the new GIS-based map of the Phobos grooves we plan to perform the detailed measurements of the length, width and orientation for all identified grooves. Preliminary measuring grooves in GIS we have obtained the following parameters: width varies between 30 – 500 m, length – from 1100 m to 18000 m. Depth of several grooves was measured by detailed DEM, obtained by photogrammetric image processing [1]. Results of these measurements changes from 20 to 80 m.

Morphological features: All grooves in the catalog were divided into three morphological types: gutters (seen as simple linear depressions), chains of the overlaying funnels and chains of separated funnels. The grooves of varuing morphology were classified by dominant morphological type.

The spatial orientation of individual grooves was estimated. It allows impartially grouping them into the sets. The sets of grooves crossing each other with small angle and comparable oriented relative to the main Phobos directions, in turn, could be grouping into the bands – the preferable directions of the plains crossing the Phobos body (Fig. 1). Current version of our map contains the most of grooves sets and bands identified before [2, 3], and several new groove sets were detected. As is seen (Fig. 1), there are two matured, globally traced bands crossing the Phobos equatorial plain at ~ +/-25° (1 and 2 on Fig. 1); two interrupted bands crossing the equatorial plain at ~ +/-45° (3, 4, Fig. 1); one developed band occupying the north polar area, oriented at small angle to the polar axis (5, Fig. 1); and at least three less developed, interrupted bands located in the south hemisphere (6, 7, 8, Fig. 1). The grove sets parallel to the equatorial plains are poorly developed. Each band includes one most developed and at least one less developed grooves sets. Several local sets of grooves are oriented quite different from the bands; a number of the grooves seems not belonging to any of the established grooves sets.

Morphological zoning of Phobos: The grooves and the impact craters are main relief-forming factors on the Phobos. Focusing on a combination of different grooves sets and the craters, we have divided the Phobos surface onto 15 morphological regions. Each region is an area differs from surrounding areas by the presence, orientation and spatial relations of grooves sets and the large craters (over 3 km). Thus, each of established regions should have its own geological history.

Discussion and conclusions: The grooves are unevenly distributed and mostly occupy the north hemisphere of the Phobos. The north polar band includes the sets of most narrow and frequent grooves, that could indicate a relatively late formation of the band. Our recent study had showed that the sites of large-scale downslope movements of the regolith, probably the yangest features on the Phobos exept small craters, are also located mostly in the northern hemisphere [4]. This observation could indicate the mechanical instability of the internal structural elements of the Phobos that is undergoing the increasing tidal stresses during an attraction to the Mars [5]. However, all structures of the Phobos surface including the grooves sets looks very old and should be formed long before an escalation of tidal stresses. Thus, uneven distribution of the grooves awaiting the explanation and could shed light to their origin.

The grooves catalogue and the scheme of the morphological regions of the Phobos will be available through MExLab Planetary Data Geoportal [6]. Based-on results of the research a geomorphological map of Phobos grooves has been compailed (Fig. 2), it has been included in a new Phobos atlas [7].

Acknowledgment: This work was supported by Russian Science Foundation, Project №.14-22-00197.

References: [1] Nadezhdina I., Zubarev A. (2014), *SSR 48 (4)*, 269-278. [2] Thomas P. (1979), *Icarus, 40*, 223-243. [3] Murray J., Heggie D. (2014) *Planet. Space Sci. 102*, 119-143. [4] Basilevsky A. et al. (2014) *Planet. Space Sci., 102*, 95–118. [5] Hurford et

al. (2015), *GSA Ann. Meet.*, Abstract #340-1. [6] http://cartsrv.mexlab.ru/geoportal/. [7] Karachevtseva et al. (2015), *Planet. Space Sci.*, *108*, 24-30.

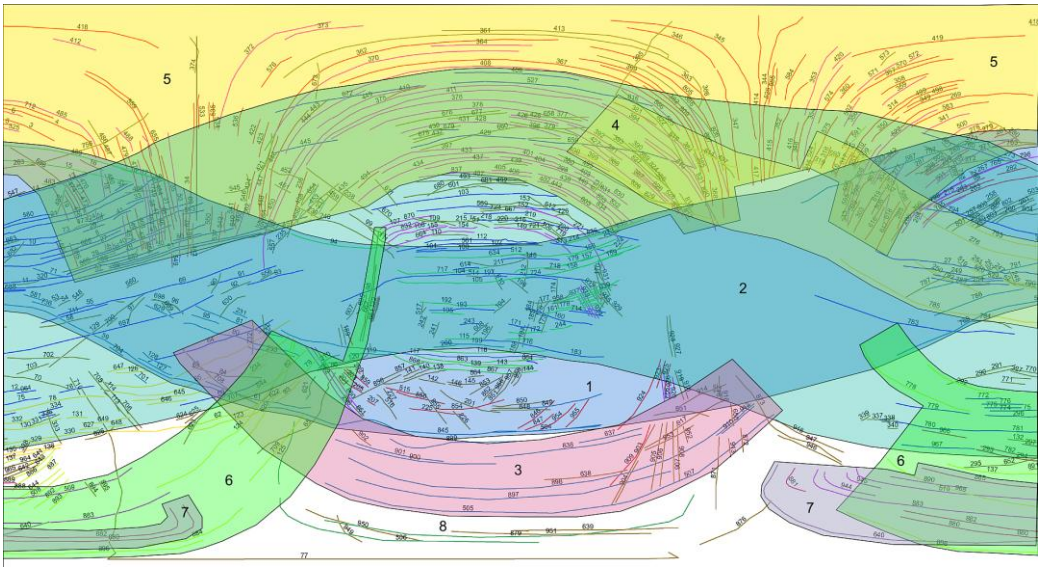

Figure 1. The scheme of the Phobos grooves, based on the GIS; the colored areas are the groove bands (see text).

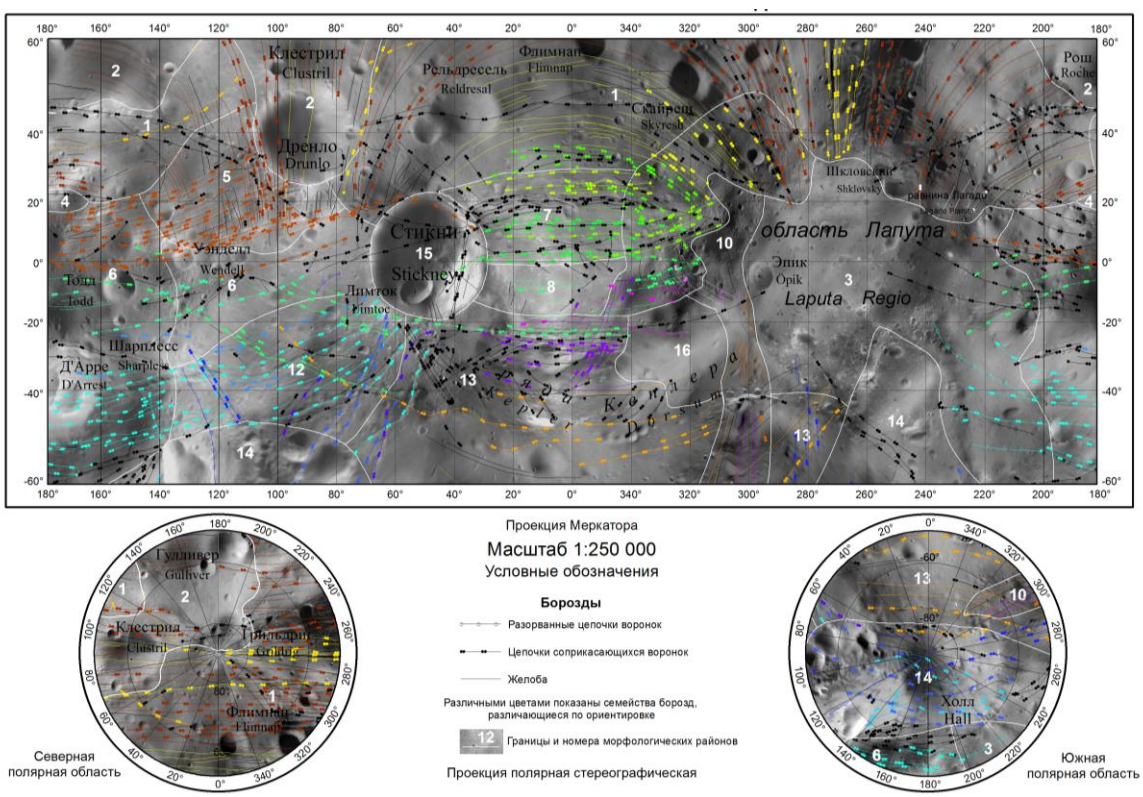

Figure 2. Layout of a new Geomorphologic map of grooves