

New Large-Scale Topographic Maps of Planet Mars

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Introduction: The *High Resolution Stereo Camera* (HRSC) instrument is well suited for the special demands of stereophotogrammetry and cartography as well. Thus, color orthoimages, Digital Terrain Models (DTM), and – based on these two data sets – high quality topographic and thematic map products are generated, mainly in standard scale 1:200,000, i.e. the new *Topographic Image Map Mars 1:200,000* map series. For supporting such a challenge and also aiming for automation of the mapping process, the cartographic software package *Planetary Image Mapper* (PIMap) has been developed at *Technische Universität Berlin*. Besides an overview of the cartographic concept and map generation, two recent projects – the mapping of the Iani Chaos region in three different scales and the generation of the first map sheets of the standard series for the north polar region – are described.

The Cartographic Concept: The *Topographic Image Map Mars 1:200,000* is defined as the standard map series of the *Mars Express* mission. In general, all map sheets are based on HRSC orthoimages, supplemented by contour lines derived from HRSC DTMs, topographic names, grids, and marginal information.

The planet Mars is covered by 10,372 individual sheets in equal-area map projections, i.e. 10,324 of them within the $\pm 85^\circ$ latitude zone in *Sinusoidal Projection* and 48 around the poles in *Lambert Azimuthal Equal-area Projection*. While each of the quadrangles spans 2° in latitude, longitudinal extents increase from 2° near the equator up to 360° towards the poles in order to keep the mapped area approximately constant. The Martian reference body is the *IAU 2000 Ellipsoid* with an equatorial axis of 3396.19 km and a polar axis of 3376.20 km. Both Martian coordinate systems – i.e. the standard consisting of eastern longitudes and planetocentric latitudes as well as the formerly used system of western longitudes and planetographic latitudes – are shown within the map sheets. An areoid, i.e. the Martian geoid, is defined as the reference surface for heights (ALBERTZ et al., 2004). The sheets of the *Topographic Image Map Mars 1:200,000* standard series can be subdivided into quarters and sixteenths for systematic mapping in larger scales 1:100,000 and 1:50,000, respectively. In principle, the cartographic concept perfectly meets all requirements for mapping features or regions of interest as well as particular HRSC orbits that don't fit with the standard sheet line system.

Map Generation with PIMap: The *Planetary Image Mapper* (PIMap) is a cartographic software package for the generation of planetary topographic maps. The entire map content – orthoimage basis, contour lines, grids, frame lines, map titles and sheet designations as well as typical marginal elements can be automatically generated with the PIMap software system. Any map sheet coinciding with latitude and longitude lines is producible by free definition of its center point, dimensions, and map scale. The software is designed for the operational production of the *Topographic Image Map Mars 1:200,000* series but – due to its flexibility regarding reference body definitions, map projections, scales, and layout specifications – PIMap is broadly applicable in planetary cartography (GEHRKE et al., 2005).

Iani Chaos in Three Scales: For the illustration of both the quality of *Mars Express* HRSC imagery and the cartographic concept, two regular map sheets of the Iani Chaos region and several subdivisions in larger scales have been produced at the *Technische Universität Berlin* in cooperation with the *German Aerospace Center (DLR)*. Iani Chaos is of special geological interest, since it likely has been formed by flowing water. This area has been observed by HRSC with the best possible ground resolution of approximately 12 m/pixel. Based on these data, two adjacent map sheets within the regular sheet lines of the *Topographic Image Map Mars 1:200,000* standard series, as well as several subdividing sheets in larger scales, i.e. 1:100,000 and 1:50,000 have been produced. Following the mapping concept as described, the general layout appears very similar for all map sheets. For the map production in different scales, the equidistances of contour lines have been adapted depending on the individual surface properties in order to present the terrain topography adequately.

Standard Map Sheets of the North Polar Region: While since 2004 several map sheets in sinusoidal map projection have been generated, since recently the first standard sheets of the polar regions – by definition based on *Lambert Azimuthal Equal-area Projection* – are available. These show the Planum Boreum and the northernmost part of Chasma Boreale. This Martian surface feature is altogether some 300 km long and almost divides the polar ice cap in two parts.

Conclusion: While several map sheets of the *Topographic Image Map Mars 1:200,000* have been produced in the past two years and this series was already shown to be a useful and guide lining standard (ALBERTZ et al., 2004), especially the generated map sheets of the Iani Chaos region confirm the flexibility of the mapping concept. Scales up to 1:50,000 could be accomplished in combination with high quality HRSC data in best possible resolutions, which are acquired under optimum conditions, particularly high resolution and little atmospheric disturbance, and adeptly processed. The first standard maps in *Lambert Azimuthal Equal-area Projection* have been generated.

References:

Albertz, J., Gehrke, S., Wählisch, M., et al., 2004: Digital Cartography with HRSC on Mars Express. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Istanbul, Vol. XXXV, B4, pp. 869-874.

Gehrke, S., Neukum, G., 2005. Das Kartographische Softwarepaket „Planetary Image Mapper“ (PIMap). Photogrammetrie – Fernerkundung – Geoinformation, 5/2005, pp. 417-422.