VOYAGER BASE MAPS OF THE ICY SATURNIAN SATELLITES

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ABSTRACT:
The Cassini spacecraft will begin its tour through the Saturnian system in July 2004. One major goal of the imaging instrument aboard Cassini is to complete the global coverage of the icy Saturnian satellites with a resolution better than 1 km/pixel. In preparation for this task, high precision base maps are needed. New digital maps of Mimas, Enceladus, Dione, and Rhea are presented in this paper. These maps were calculated from Voyager-1 and Voyager-2 data using newly developed image processing software and improved orbit and attitude data.

1. INTRODUCTION

Voyager-1 and Voyager-2 collected images from the icy Saturnian satellites during their journey through the Saturnian system in 1980 and 1981 (http://www.jpl.nasa.gov/yoyager). These data are still the highest resolution images available from these satellites and are the basis for the planning of the Cassini mission, which will begin its tour through the Saturnian system in June 2004 (http://saturn.jpl.nasa.gov). High resolution images and global coverage for all icy satellites with a resolution better than 1 km/pixel are important goals of the Imaging Science Subsystem (ISS) (Porco et al., 2003).

Airbrush maps of the Icy Saturnian satellites were released by USGS between 1982 and 1992 (e.g. Smith et al, 1982). First digital image mosaics of the Saturnian satellites were produced by Tayfun Oner (http://www.solarviews.com). Unfortunately, details of this work, as there are image processing or geometric and map projection reference systems are not available to us. Therefore, it was decided to generate a new set of base maps for the icy Saturnian satellites which can be used for planning purposes and as a starting point for the production of improved maps during the Cassini tour. Details of the data processing are described in section 2, maps of Mimas, Enceladus, Dione, and Rhea are shown in section 3.

2. DATA PROCESSING

All images taken by the Imaging Science Subsystems (ISS) aboard Voyager-1 and Voyager-2 are available online from the Planetary Data System (PDS) Imaging Node (http://pds-imaging.jpl.nasa.gov). The images have been acquired with narrow band filters but only clear filter images were used during the processing. The first steps of the data processing chain are the conversion from PDS format to VICAR (Video Image Communication And Retrieval, http://rushmore.jpl.nasa.gov/ vicar.html) format, followed by the radiometric, and geometric correction of camera effects using standard VICAR programs. The next step is to convert the raw images to digital maps, which requires precise orbit and pointing data for each image. We used the position and pointing data by Davies and Katayama (1983a,b,c, 1984) which were derived by block adjustment techniques, and delivered electronically in 1989 (Davies et al., personal communication). For other images improved pointing data were calculated using a limb-fitting technique developed at DLR (German Aerospace Center). Usually, spheres or rotational spheroids are used as reference bodies for map projections. However, this approach can not be applied to the inner Saturnian satellites since their bodies are better described by a 3-axial ellipsoid as defined in the report of the International Astronomical Union (Seidelmann et al., 2002). For better comparison and interpretation of the maps, a 3-axial ellipsoid was only used for the calculation of the ray intersection point, the map projection was done on a sphere with a mean IAU radius (Seidelmann et al., 2002). All projection parameters are described in section 3. The final step of the image processing is the combination of all map projected images to a homogeneous mosaic. Special care must be taken to the different ground resolution of the input images concerning the mosaicking behavior within the overlapping regions and to the extremely variable illumination conditions in the different images. Therefore, every single image and mosaicking step was checked carefully in order to minimize the loss of high resolution image information. Both, map projection and mosaicking software were developed at DLR originally for the Mars-96 and Galileo mission (Scholten, 1996), and are currently improved for the upcoming data processing of the Cassini-ISS images.

3. MAPS

All maps were generated in the simple cylindrical (equidistant) map projection, the mapping cylinder is tangential to the equator of the sphere. The prime meridian is in the center of the map. The longitude range is from –180° to 360°/0° to 180° W , the latitude range is from –90° to 90°.

3.1 Mimas

14 single images from both Voyager-1 and Voyager-2 images were used.
The resolution of the map is 5 pixels/degree (0.69325 km/pixel). The radii of the three-axial ellipsoid for the ray intersection point are 209.1, 196.2, and 191.4, the mean radius of the sphere used for the map projection is 198.6 km.

3.2 Enceladus

9 single images from Voyager-2 were used.
The resolution of the map is 10 pixels/degree (0.43529 km/pixel). The radii of the three-axial ellipsoid for the ray intersection point are 256.3, 247.3, and 244.6, the mean radius of the sphere used for the map projection is 249.4 km.

3.3 Dione

13 single images from both Voyager-1 and Voyager-2 were used.
The resolution of the map is 10 pixels/degree (0.97738 km/pixel). The radius of the sphere used for the map projection is 560.0 km.

3.4 Rhea

37 single images from Voyager-1 images were used.
The resolution of the map is 20 pixels/degree (0.66672 km/pixel). The radius of the sphere used for the map projection is 764.0 km.

4. FUTURE WORK

The next steps in this work are to finish the maps of the missing satellites Tethys and Iapetus, to finish the software for the conversion of the maps from VICAR into PDS format, and to create a web page for the distribution of the maps in digital form.

5. ACKNOWLEDGEMENTS

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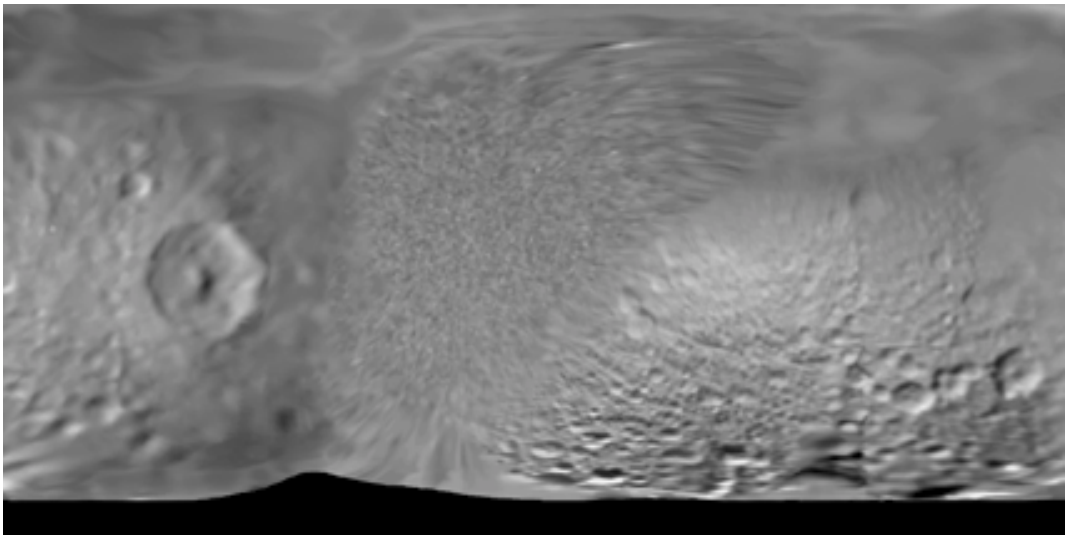
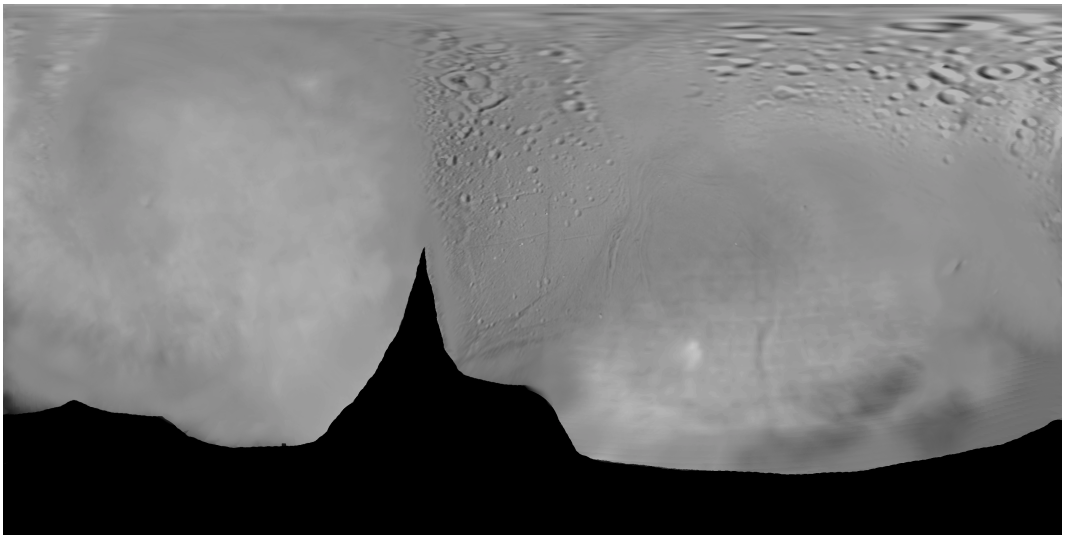


Mimas



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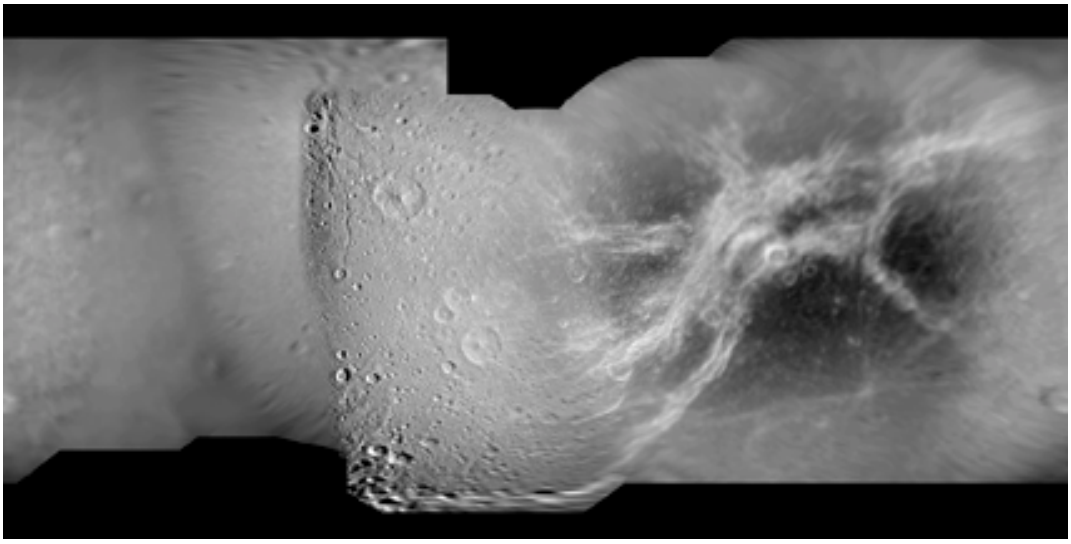

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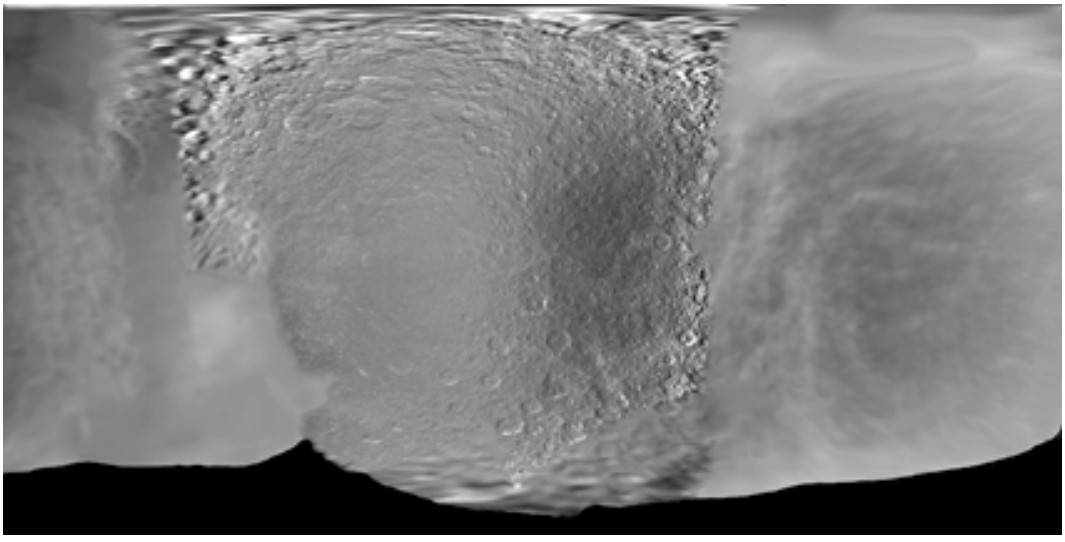

Rhea