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Cartography of the Galilean Satellites in preparation of the JUICE mission

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Abstract

In the past, the Voyager and Galileo missions visited the objects of the Jovian System a couple of times and delivered plenty of image data. JUICE (JUpiter ICy moons Explorer) will continue that survey and lead us to new knowledge about Jupiter, its rings and satellites and the complex coupling processes within the system. The camera system JANUS (Jovis, Amorum ac Natorum Undique Scrutator) [1] will deliver new high-resolution image data of Ganymede, Callisto, and Europa, which will be the baseline for new and improved orthoimage mosaics and maps of the moons.

1. Introduction

Voyager 1 and Voyager 2 encountered Jupiter in 1979. They took more than 33,000 images of Jupiter and its four major satellites – Io, Europa, Ganymede, and Callisto. Galileo entered orbit around Jupiter in 1995 and flew by Io 7 times, Europa 11 times, Ganymede 8 times, and Callisto 8 times. In 2003 the spacecraft plunged into Jupiter's atmosphere after eight successful years. Both missions delivered a wide set of image data at various resolutions. JUICE will be launched in 2022 for a 7-years journey to the Jovian System to study the Galilean moons, in particular. It will become the first spacecraft to orbit a moon in the outer solar system, Ganymede. Secondary targets will be Callisto and Europa (Fig. 1).

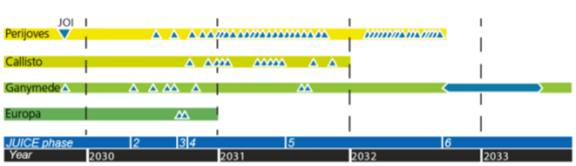

Figure 1: Adapted illustration of the ESA JUICE mission timeline based on CReMA 3.2. The triangles mark mission events, where the camera performs high-res observations of the given Jovian object.

2. Status quo

By combining the image data sets of Voyager and Galileo the US Geological Survey produced almost globally covered low resolution orthoimage mosaics of Ganymede (1 km/pxl), Callisto (1 km/pxl), and Europa (0.5 km/pxl) [2]. Each icy moon contains numerous remarkable geologic features, which are named after places and people or gods from the ancient Fertile Crescent, the Far North or Celtic myths, respectively. The process of naming a surface feature always follows various rules and conventions of the International Astronomical Union (IAU) e.g., a feature has to have special scientific interest and has to be useful to the scientific and cartographic communities. Thus, Europa's surface yields 111 approved names, mostly lineae (45), regions (8) and craters (41). Whereas Ganymede, the largest of the Galilean moons, has 196 approved names, including 35 sulci, 129 craters and 13 faculae. The old surface of Callisto is heavily cratered (141 names) with some outstanding, large ringed features (4), 8 catenae and a facula [3].

3. Objectives

One of the goals for the 2030s is to receive higher resolution orthoimage mosaics from images taken by JANUS/JUICE, especially from the Ganymede orbit, but also for Callisto and for some regions of Europa. These mosaics will provide more detailed information for scientific investigations, which will lead to new nomenclature proposals, for example. Also, improved cartographic products like atlases and geological maps are expected.

4. In detail

Onboard of the JUICE spacecraft will be the visible framing camera JANUS, which is equipped with a filter wheel hosting 14 multispectral filters. These filters range from 350 to 1080 nm with a clear filter centered at 650 nm and a field of view of 1.72° across track by 1.3° along track. The orbital tour around Ganymede is expected to last about eight months and will result in a global coverage of the moon with about 150 m/pxl resolution from the panchromatic filter. The highest regional resolution will be 7.5 m/pxl from 500 km altitude. The global coverage and high resolution will allow us to create a 62-tiles atlas of Ganymede with a map scale of 1:1,000,000 (Fig. 2).

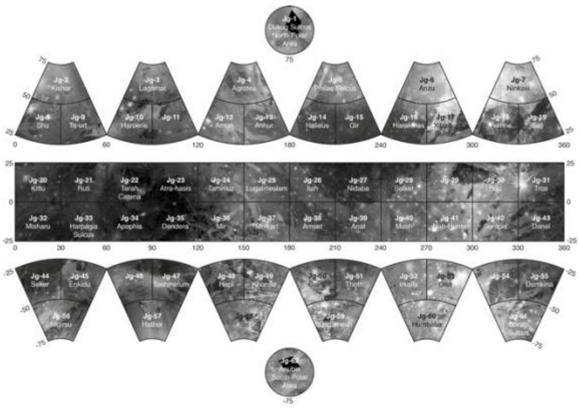

Figure 2: Ganymede atlas schema conform to that proposed by Greeley and Batson [4].

JUICE will fly past Callisto eight times at altitudes between 400 km and 200 km at closest approach. This results in a 36% coverage with better than 1 km/pxl resolution and in a new global orthoimage mosaic with about 500 m/pxl. An atlas consisting of 30 tiles will be possible. During two Europa flybys at mid latitudes over both hemispheres, several targets will be observed, which allows us to create an improved global orthoimage mosaic with 500 m/pxl resolution and a 15-tiles atlas.

5. Regions of interest (ROI)

To fulfil the JUICE science goals with respect to the satellites' geological and geophysical evolution, potential target areas on Ganymede and Callisto have been chosen (Fig. 3). These targets offer a baseline for planning activities and working group discussions of what could be observed with the given flyby geometries and instrument capabilities. Many unnamed features lay within that ROIs. So, it is useful to name the most prominent of them, which was already done for crater Laomedon (Ganymede), centered at 20.9° N and 282.1° E and crater Vili (Callisto), centered at 32.6° N and 144.1° E [3]. Seven categories for surface features and/or surface processes have been selected based on the current knowledge of the two moons and the science objectives of the mission [5]:

1 – potential cryovolcanic regions
2 – polar deposits
3 – dark ray, floor, and halo craters
4 – impact crater morphologies
5 – bright ray craters
6 – bright terrain
7 – ancient dark terrain

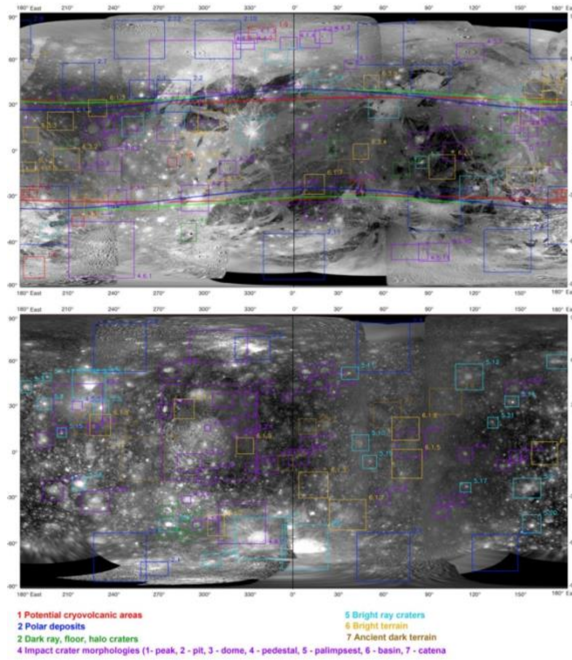

Figure 3: Ganymede basemap (above) and Callisto basemap (below) with ROIs.

Acknowledgements

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References

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