

GEOLOGY OF THE SUBJOVIAN HEMISPHERE OF GANYMEDE AS REVEALED BY JUNOCAM. G.

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Introduction: On June 7, 2021 the *Juno* spacecraft passed close to Jupiter's moon Ganymede. During the brief flyby, the JunoCam instrument was able to capture four images of the subjovian hemisphere below the spacecraft [1]. The first two of these images offer significantly improved views of the regional geology in this hemisphere than were previously available. Here we report on new geological observations made possible by the newly released JunoCam imaging of Ganymede.

Comparison to previous image data coverage: Before the *Juno* flyby, complete image coverage of Ganymede's subjovian hemisphere was obtained by *Voyager 1*, and a handful of images on this hemisphere were obtained by *Galileo*. The best JunoCam imaging for geological mapping purposes was obtained at pixel scales of approximately 1 km, at moderate to high incidence angles and low emission angles, covering the region from 50°N to 10°S, 45°W to 10°E (Figure 1b). This region includes the central and eastern parts of the dark terrain of Perrine Regio, the light terrain of Sicyon Sulcus and Phrygia Sulcus as well as the eastern end of Nineveh Sulcus, and the bright ray crater Tros. *Voyager 1* data of this region was lower in resolution with a pixel scale of approximately 2 km, and was obtained in conditions of low incidence angles and moderate to high emission angles. These high-sun *Voyager* images are dominated by the bright rays of Tros, often obscuring albedo patterns and boundaries in the underlying geological units. The only *Galileo* imaging in this region was the G29 CAPCOL sequence, covering part of central Perrine Regio and Sicyon Sulcus at low incidence angle, and the C9 gapfill sequence, which has near-terminator imaging overlapping the terminator in the *Juno* images, but lit from the opposite direction (Figure 1a).

Regional geology: The new JunoCam data elucidates the relationships between light terrain units that converge near Tros. We have performed a preliminary remapping of the region, using the same unit definitions as the global geologic map [2], as elaborated in [3]. Figure 1c shows the original geologic map of this area, with a large area of undivided light terrain near the crater Tros and several stratigraphically recent light terrain units that abruptly end where they could no longer be confidently traced in the *Voyager* data.

Figure 1d shows the same region remapped with the addition of JunoCam data. In the new map, the large

undivided light terrain region surrounding Tros can now be confidently subdivided into many smaller units. The new map shows that many of the stratigraphically recent light terrain units can be traced much farther than before, forming an interlinked network similar to what is observed elsewhere on Ganymede. In particular, a few recent ENE-trending features previously observed in Babylon Sulci off the southwest corner of the map, can now be traced all the way into Phrygia Sulcus, where they merge with structures extending in from Nineveh Sulcus. On the other side of the map, the young structures extending from Phrygia and Sicyon Sulcus can now be more confidently traced to the northeast where they merge into Nun Sulci. One exception to the new confidence in interlinking young features is the large block of old grooved terrain to the east of Tros, which swallows up the main young E-W trending feature in the middle of the map. Though it can now be traced somewhat further, this young feature still disappears in the middle of the older grooves before being seen again on the other side.

In the center of the map, the western edge of a block of Perrine Regio is disrupted by a network of stepping bright bands, almost forming an *en echelon* pattern and perhaps showing left-lateral offsets. This may be further evidence of strike-slip behavior in Ganymede's light terrain [e.g. 4].

Paterae: The region contains ten paterae, or caldera-like features, eight of which are newly observed in the JunoCam data [5], shown with black arrows in Figure 1d. This represents about a quarter of all known paterae on Ganymede, an unusual concentration rivaled only by the cluster in Mummu Sulci, almost antipodal to this region. As seen elsewhere on Ganymede, the paterae are usually found adjacent to recent bands of light subdued terrain.

Craters: We identified three large (>30 km) craters in the JunoCam data which were not observed before in the *Voyager 1* data. Once the location and size of these craters was known, they can be faintly seen in the *Voyager* data. These newly observed craters include a 110 km diameter, highly relaxed crater centered at 3°N, 21.7°W; a 52 km diameter crater at 13.6°N, 31.5°W; and a 41 km diameter crater at 18°N, 27°W. Two other obvious craters in the JunoCam data (101 km at 21.6°N, 40.1°W; 47 km at 25.5°N, 14.6°W) were previously observed in *Voyager* data [6] but were not included in the global geologic map [2] due to poor confidence in

identifying them. One degraded crater southwest of Tros mapped on the 2013 global geology map was misidentified, and turns out to be a patera. The sensitivity to topographic shading at high incidence angles also reveals two possible large craters near 30°N, 30°W which are highly relaxed and extensionally strained by the grooved terrain structures.

Furrows and lighting effects: Though the furrow map in figure 1d is unchanged from the map shown in 1c, there are some interesting observations to be made. It has been a mystery since the *Galileo* mission why the prominent E-W trending furrows of northwestern Perrine Regio seen in the G29 CAPCOL images do not appear in the C9 gapfill images covering the same territory. In the JunoCam data, these furrows also disappear (instead, some smaller groove structures are seen, going in a slightly different direction). However, these E-W furrows can also be faintly seen, near the limb, in the *Voyager 1* images. This shows the

unfortunate effect of lighting on recognizability of geologic structures. The furrows disappear in both of the image sequences taken near the terminator, but reappear in both of the image sequences taken near mid-day. A similar effect can be seen in the way that some patches of subdued light terrain have been remapped as grooved, when near-terminator imaging revealed that some of the terrain only observed before at very low incidence angles is, in fact, covered in grooves.

Conclusion: The newly released JunoCam data reveals several previously unobserved craters and paterae, as well as clarifying the relationships among terrain units in the subjovian region. Future integration of this data into the global image mosaic of Ganymede would be worthwhile, to enable a more complete view of this region in preparation for future observations by the JUICE mission.

References: [1] Ravine, M. A. et al., this meeting and manuscript in prep.; [2] Collins, G. C. et al., USGS SIM-3237, 2013; [3] Patterson, G. W. et al., Icarus 2010; [4] Cameron, M. E. et al., Icarus 2018; [5] Schenk, P. M. et al., this meeting; [6] Schenk, P. M. et al., in *Jupiter*, Cambridge 2004.

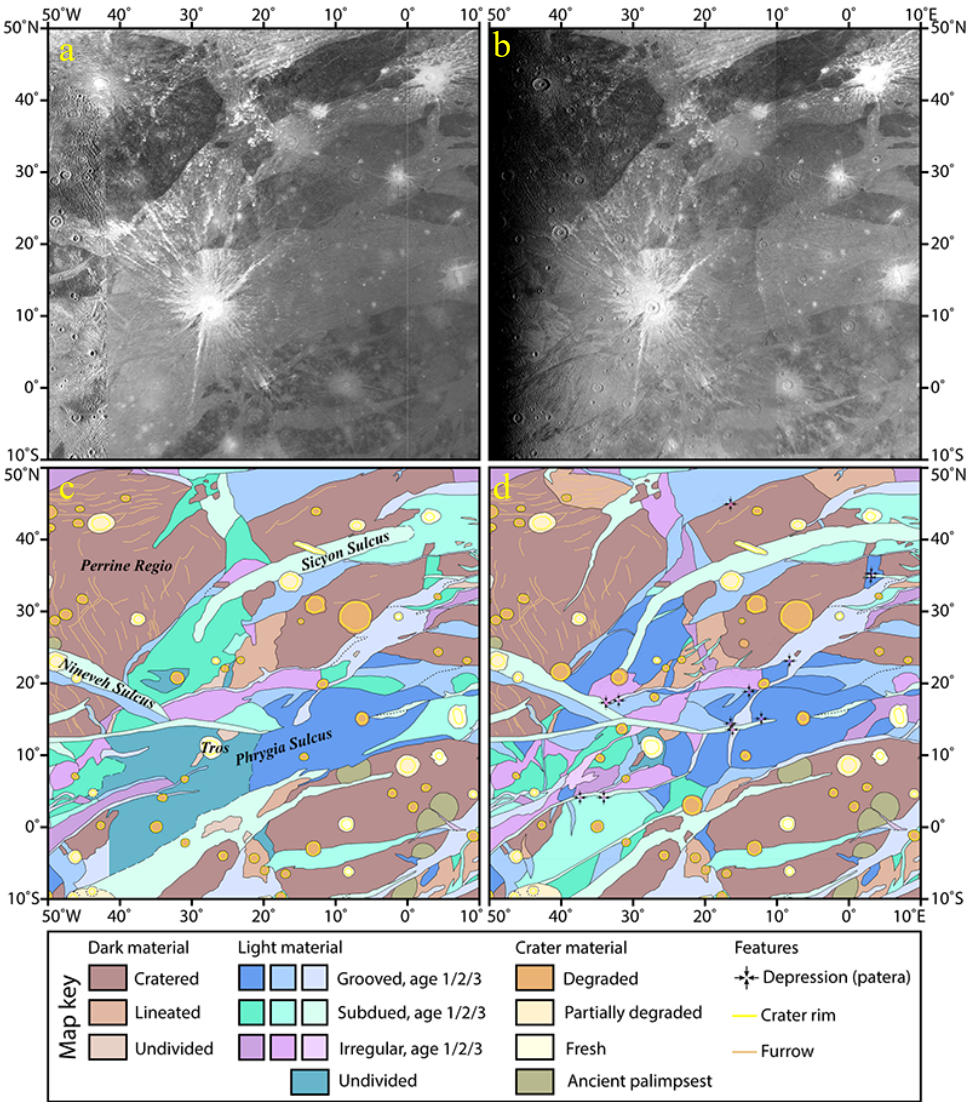


Figure 1:
(a) Galileo / Voyager imaging coverage of the study region (USGS mosaic).
(b) Mosaic of the first two JunoCam images from the Ganymede flyby covering the same area as part a.
(c) Portion of the global geologic map [2] based on Galileo / Voyager data.
(d) Preliminary reinterpretation of the geologic map based on JunoCam data.