JUNOCAM IMAGES OF IO. M. A. Ravine[1], C. J. Hansen[2], M. A. Caplinger[1], P. M. Schenk[3], L. Lipkaman Vittling[1], D. J. Krysak[1], J. E. Perry[4], D. A. Williams[5], J. Radebaugh[6], M. Pettine[7], J.T. Keane[8] and S. J. Bolton[9]. [1]Malin Space Science Systems, CA (ravine@msss.com), [2]Planetary Science Institute, AZ, [3]Lunar and Planetary Science Institute, TX, [4]University of Arizona, AZ, [5]Arizona State University, AZ, [6]Brigham Young University, UT, [7]Cornell University, NY, [8]Jet Propulsion Laboratory, California Institute of Technology, CA, [9]Southwest Research Institute, TX.

Introduction: On 30 December 2023 during PJ57, the *Juno* spacecraft, in a polar elliptical orbit around Jupiter, made the first of 2 close passes by Jupiter's moon Io. *Juno's* JunoCam visible imager [1] took four close and two more distant color images of Io with coverage from the North Pole to just below the equator, from the terminator at 30°E to 100°E. JunoCam images in the earlier PJ55 encounter over similar areas were acquired at ~8-to-14 km pixel scales. Attributes of the images are listed in Table 1. Resolution is better than previous *Galileo* and *New Horizons* coverage (poorer than 10 km in this region), except south of ~55° N which *Voyager* 1 viewed at 1 km/pixel or better. The first image was acquired at a phase angle of ~90°, excellent lighting for discerning topography along the terminator.

Mounted on a spacecraft spinning at 2 RPM, JunoCam pushframe red-green-blue images are acquired as the spacecraft rotates and the field of view sweeps across the target. Due to the low altitude (~1,500 km closest approach) this pass was rapid and just a sector of Io was imaged at low emission angles. The mosaic in Figure 1 is of the first three images.

JunoCam Images: The JunoCam field of view is 58°, 1600 pixels across in the cross-rotation dimension. Data were acquired over scans of 120°. The spacecraft was so close to Io that only the area from ~90°N to ~10°S is covered by this set of images. The start time of the first image was 2023-12-30T08:37:44.6. Acquisition of the images were separated by one minute.

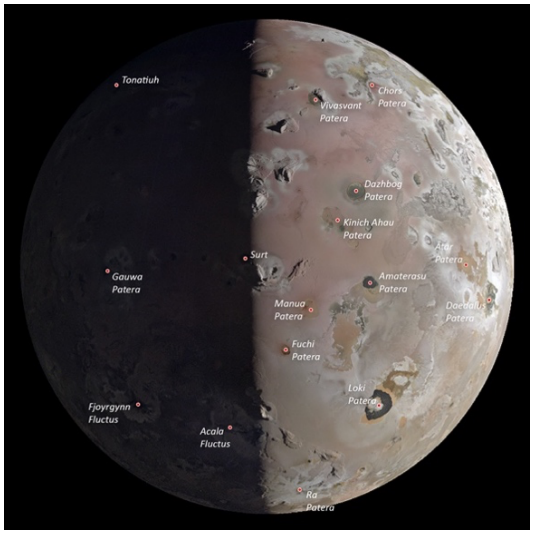

Figure 1. A mosaic of the first three JunoCam PJ57 images of Io.

Table 1. *JunoCam PJ57Close Io image attributes*

Image	Altitude (km)	Scale (km/pix)	Sub-S/C Lat (°N)	Sub-S/C Lon(°E)
1	2732	1.8	61.5	11.5
2	4122	2.8	50.6	23.9
3	5712	3.8	43.6	28.7
4	7392	5.0	39.0	31.2

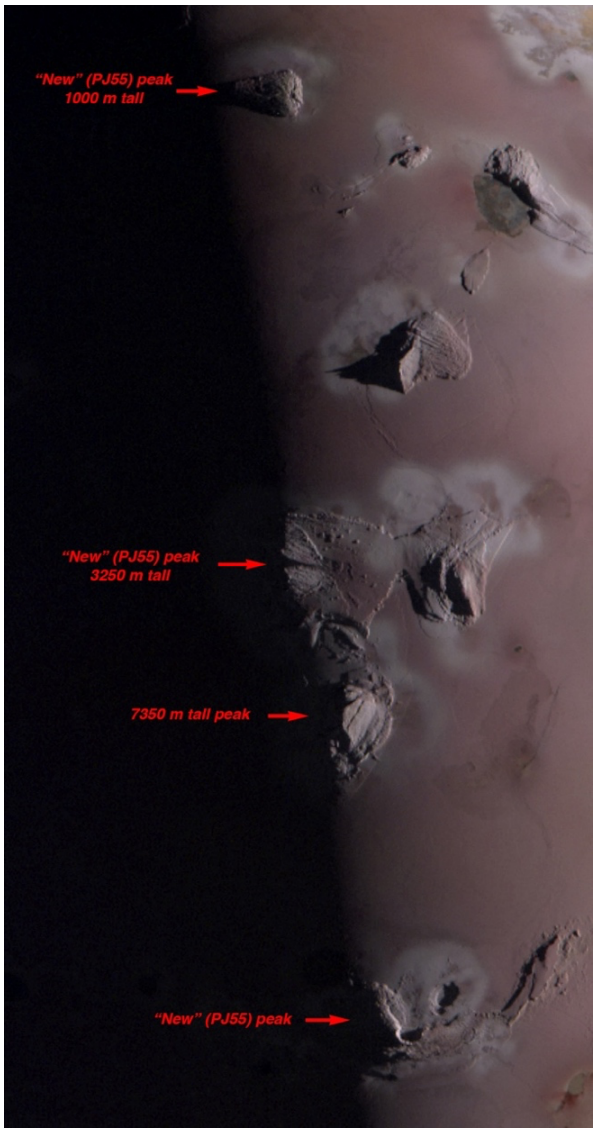

Figure 2. Io's high northern latitude peaks. The North Pole is near the uppermost peak near the terminator. The two unlabeled peaks near top are between ~5.0 and 6.7 km in height.

Topography and Landscape: The polar landscape imaged here is characterized by smooth plains punctuated by mountains and lava flows surrounded by SO_2 frost blankets. The high latitude coverage of the first JunoCam image [Figure 2] provides > 5x improvement over existing imaging of this area. Further improvement in surface discriminability is provided by the low sun along the terminator, accentuating the topography associated with the series of seven peaks distributed from the North Pole down to 40°N. Three of these peaks were newly discovered by JunoCam during the PJ55 flyby. Heights of some of the peaks were estimated from shadow lengths. New details visible in this image include structure in the possible debris aprons associated with the middle four peaks and a previously unrecognized patera (tectono-volcanic depression) associated with the southernmost mountain. Other paterae show a range of activity demonstrated by dark centers and red S deposits and can cluster into patera complexes. Because of the changing geometry of the Io flyby, most of area covered was imaged with multiple look angles, providing stereo. DEMs are being generated for features of interest, especially the high latitude peaks.

Loki: The second, third and fourth JunoCam Io images include coverage of Loki Patera, comparable to the highest resolution image from *Voyager* 1 (1979). While major changes were observed in Loki from *Voyager* to *Galileo*, initial analysis has found no major structural or albedo changes in the ~25 years between the *Galileo* and *Juno* images [Figure 3]. More detailed investigation is in-process.

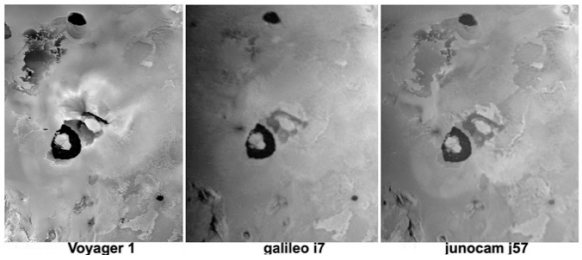

Figure 3. Changes observed in Loki, by Voyager 1 (1979), Galileo (1997) and JunoCam (2023).

Plume: A faint plume was detected in the vicinity of the volcanic center Xihe (56° S, 69° E) in the two later, more distant JunoCam images (the second one is shown in Figure 4).

Color features: Overall, the JunoCam images provide high-quality color and show substantial variation from reddish to yellowish to white. Particularly striking is the very red annulus around Chors Patera with a coma-like tail.

Improved mapping: JunoCam images of Ganymede showed that even when resolution is similar to previous coverage, the high quality of JunoCam images enables vastly improved identification of surface features, especially at high-incidence angles along the terminator [2]. JunoCam's northern latitude coverage of Io has this advantage as well has much higher resolution. Work to revise the Io geologic map in the high latitudes is in-process and we already anticipate significant refinements.

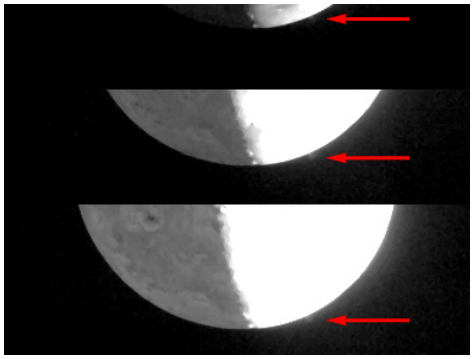

Figure 4. A plume shown here in the raw JunoCam framelets, indicated by the red arrows: blue (top), red (middle) and green (bottom).

Dark side imaging: Jupiter-shine coverage of Io's northern sub-Jovian hemisphere also provides opportunities for change detection, particularly when image-stacking is used. This region covered the largest surface change seen in PJ57 images: a new 500-km-long lava flow and related plume deposits at Tonatiuh.

Juno PJ58 encounter: *Juno* will fly by Io at a closest approach of ~1,500 km on 3 February 2024, with imaging starting at 3,000 km, providing similar resolution and quality coverage of a lower latitude section of Io with a similar range of longitude. These images will also be incorporated into the analysis effort presented here.

Summary: during the PJ57 Juno encounter of Io, JunoCam provided high-resolution, high-quality color images of a significant section of Io's high northern latitudes, substantially improving the coverage. The *Juno* PJ58 encounter is expected to provide more of the same for a lower latitude section of Io. Together, these images enable the investigation of new aspects of Io geology and potential changes in Io geology over the last twenty to forty years (since *Voyager*, *Galileo*, and *New Horizons*).

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References: [1] Hansen, C.J. *et al.* (2017) SSR 213, 475–506. [2] Ravine, M. *et al.* (2022) *GRL* 49:e2022GL099211.