JunoCam at PJ58: Part I: Io

John Rogers (BAA) (2024 Feb.9)

Juno's second close flyby of Io took place on 2024 Feb.3, immediately before Perijove-58. The lighting conditions were similar to PJ57 but closest approach was more equatorial, and the JunoCam team took more images, especially of Io's dark side which was mostly illuminated by Jupiter. The camera operated perfectly, and the resulting images greatly improve our maps of Io; they show three volcanic plumes on the limb; and they show specular reflections from several calderas. For parts of this report I am indebted to citizen scientists who have posted processed images and identified features of interest, especially plumes, at:
https://www.missionjuno.swri.edu/junocam/processing and unmannedspaceflight.com
-- notably Jason Perry, Brian Swift and Gerald Eichstädt.

From the PJ58 images of both sunlit and jove-lit sides, as processed and map-projected by Gerald, we have assembled the global map shown in Figure 1. The Jupiter-lit dark side was greatly brightened, especially in blue because jove-shine has a yellowish tone.
Figure 2 is the same map with some volcanoes labelled.
Figure 3 is JunoCam's global map of Io, combining maps from PJ55, PJ57 and PJ58. Both the sunlit side and the Jupiter-lit dark side are included.

It's fascinating to compare these with the Voyager/Galileo maps of Io:
https://astrogeology.usgs.gov/maps/io-voyager-galileo-global-mosaics
https://britastro.org/jupiter/moonmaps.htm
Caution must be taken because most of the differences are probably due to different angles of lighting and viewing, and different filters. However, definite changes can be seen in some volcanic centres. The JunoCam map has higher resolution in some regions, and is excellent for revealing rugged topography in regions that were previously only observed under high sun. One notable example is between the Tohil and Shamash calderas (Figure 4). There is a very dark patch not shown on the Voyager/Galileo map. It's possible that this is a new (or previously inactive) caldera that has recently opened up – but perhaps more likely that it is a shadow of a high mountain ridge, continuous with the 9-km-high Tohil Mons that overlooks Tohil Patera. There was a Galileo image that suggested such a shadow here.

It is common for calderas on Io to be adjacent to steep mountains; other examples are in Figure 6 (image 24). This beautiful image shows Io's jove-lit dark side at closest approach (1499 km). At the centre are Shamshu Patera and Montes, with Hi'iaka Patera and Montes on the limb beyond. (These were also closely imaged by Galileo on its I27 and I25 orbits respectively, and there are no obvious changes.)

Three limb plumes were detected (shown here with the sky background including the plume enhanced separately):

(1) In image 23 (Figure 5): the dark side of Io with a crescent lit by Jupiter-shine, showing the Masubi volcanic complex. The plume is probably from the *Kanehekili* complex which is some way beyond the limb.

(2) In image 25 (Figure 7): also on the jove-lit side, this faint but large plume is probably from *Masubi* (identified by Brian Swift). Masubi has been known as an active volcano showing a plume ever since the Voyager 1 flyby. This image also shows the Kanehekili complex better than ever before, revealing that it spans at least two volcanic centres. Kanehekili is a known active volcano but only seen at low resolution hitherto. Both volcanic

complexes include extensive dark lava flows, which have changed considerably in the 22 years since the Galileo maps.

(3) In image 26 (Figure 8), on the sunlit side, in Lerna Regio near *~297ºW, 58ºS*. This seems to be a new eruption, as no likely source is visible on the USGS maps, except a small dark spot on the Voyager map at 295ºW; however a bright hot spot has been recorded near here by JIRAM.

As Juno moved away and viewed the sunlit side of Io, JunoCam recorded the striking phenomenon of specular reflection of sunlight from the surfaces of several calderas – probably from smooth glassy basalt (Figure 9). This was most obvious on Loki, where the almost black surface turned bright as it glinted in the sunlight. It was also dramatic on Mazda (the northernmost caldera of the chain) and Gibil, and in tiny spots on two others, and less prominent in another two calderas. All these are marked on Figure 9. John Spencer points out that it had already been observed on Loki in crescent views from Galileo and New Horizons, and probably on Mazda (north) as "blue spots" in an image from Voyager 1.

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Figures (small copies):

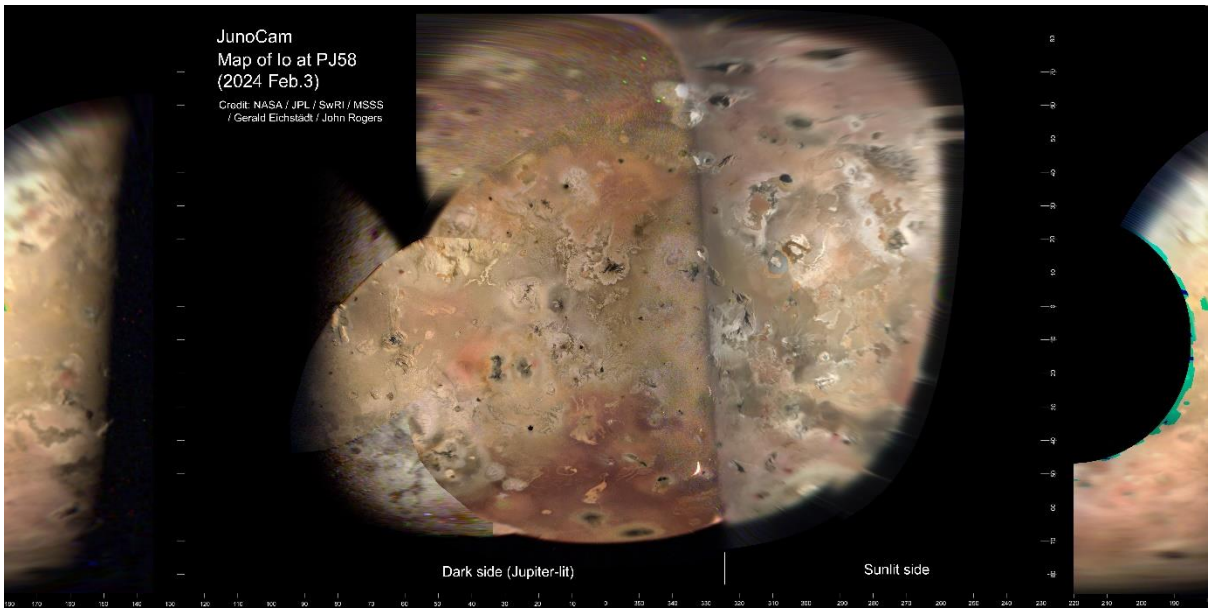


Figure 1. Global map of Io at PJ58, compiled from maps of all the individual images that were made by Gerald Eichstädt. Some scaling and shifting was performed in order to align the maps better with each other and with the USGS Voyager/ Galileo map. Colour and contrast were adjusted to improve visibility. The Jupiter-lit dark side was greatly brightened, especially in blue because jove-shine has a yellowish tone.

Figure 2. Global map as in Figure 1, with some volcanoes labelled. (Suffix "Patera" is omitted.) *[Not shown here as the labels are small]*

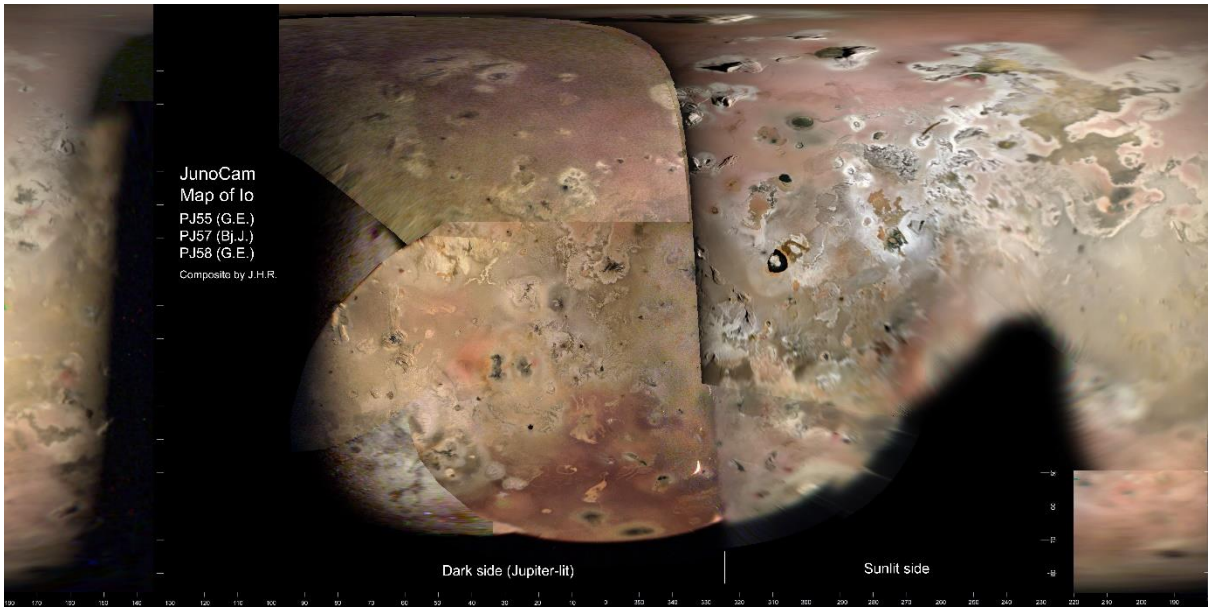
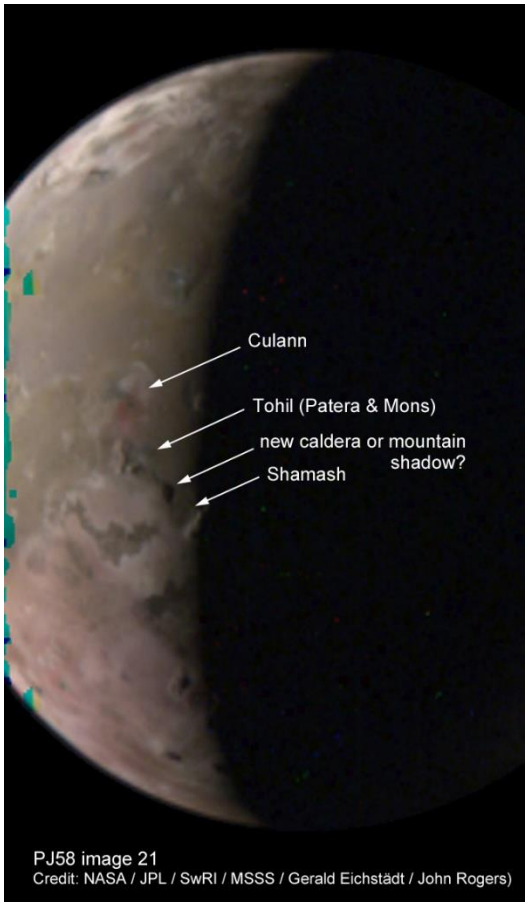
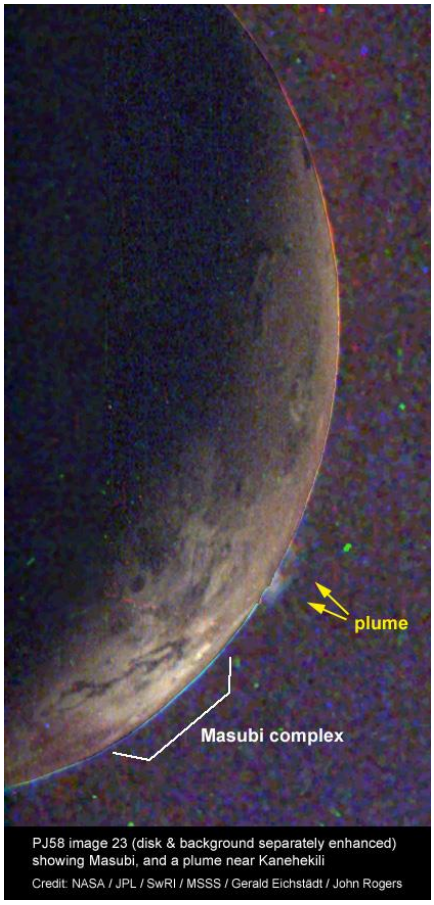


Figure 3. JunoCam's global map of Io, combining maps from PJ55 by Gerald Eichstädt; PJ57 (by Jason Perry), and PJ58 (by Gerald Eichstädt and John Rogers). Both the sunlit and jove-lit sides are included. Some scaling and shifting was performed in order to align the maps better with each other and with the USGS Voyager/Galileo map. Colours were adjusted for better compatability.





Left: **Figure 4** (image 21). One of the first images of the series.

Right: **Figure 5** (image 23). View of the dark side of Io with a crescent lit by Jupiter-shine. The background was enhanced separately (from Gerald's 'draft' image). The Masubi volcanic complex is seen on the crescent. Beyond the limb is a volcanic plume, probably from the Kanehekili complex.

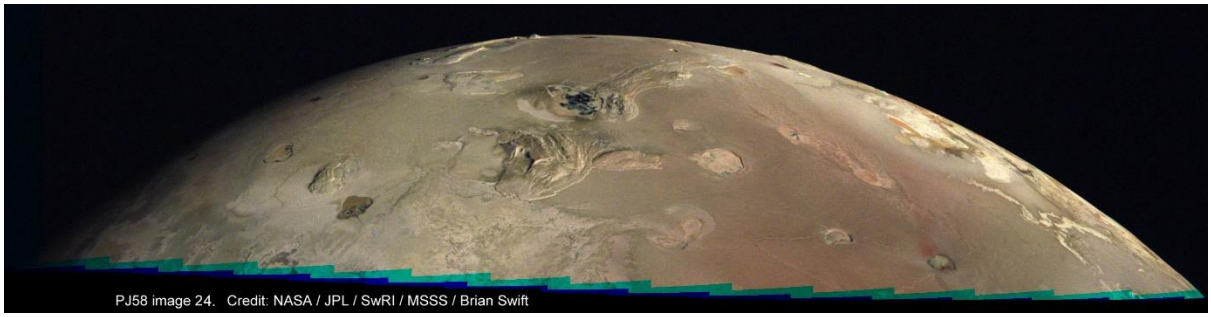


Figure 6 (image 24). This beautiful image shows Io's jove-lit dark side at closest approach (1499 km) At the centre are Shamshu Patera and Montes, with Hi'iaka Patera and Montes on the limb beyond.

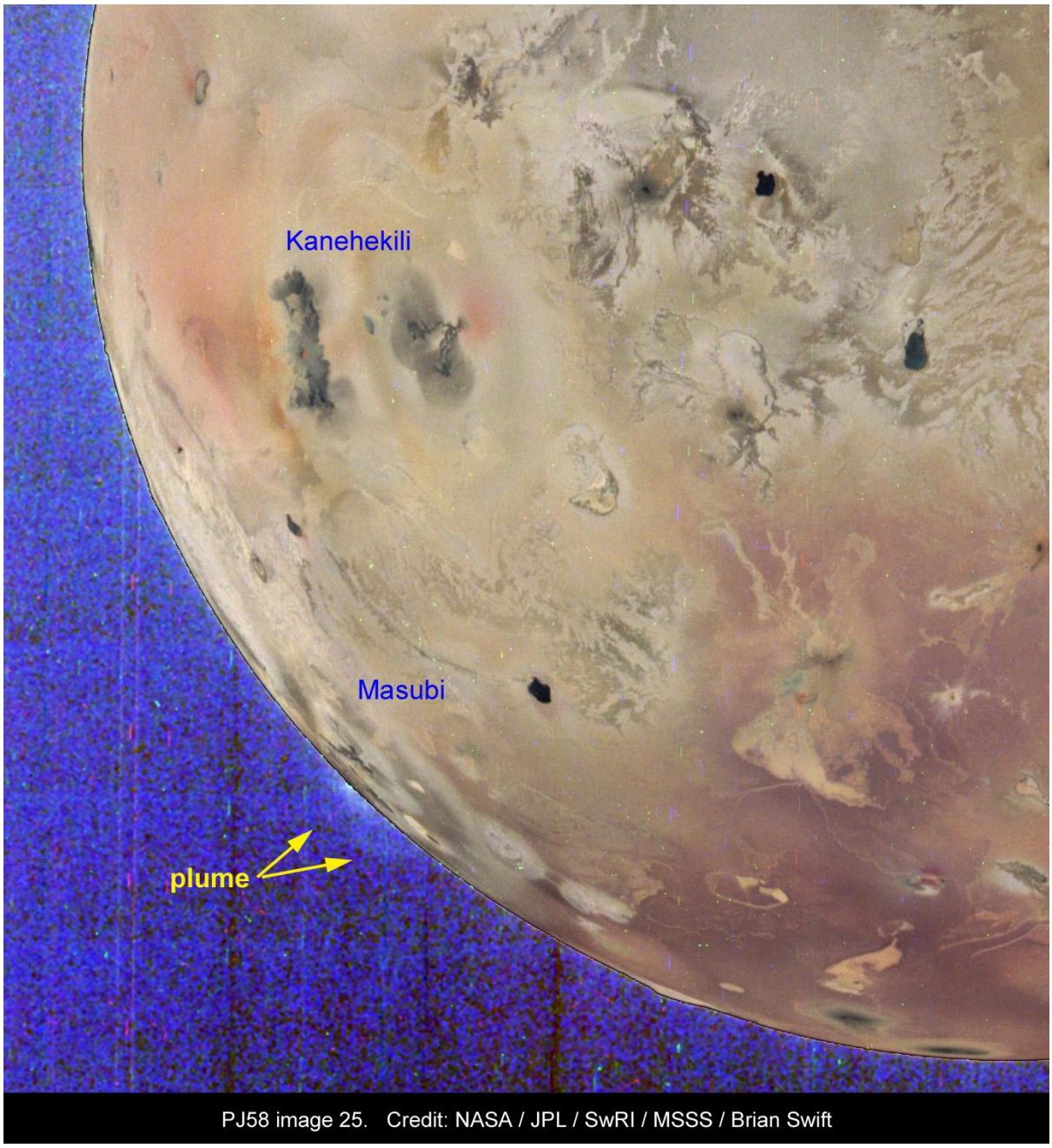


Figure 7 (part of image 25). View of the dark side (image processed by Brian Swift; he enhanced the background with the plume separately). The Masubi complex is visible on the surface, seen from the opposite side to Fig.5. A very faint plume is probably from Masubi; it seems to have a partial outer arc which, if completed, would match the dark ring around that volcano. The Kanehekili complex is well shown (note that a little red dot possibly marks one vent but is a hot-pixel artefact!).

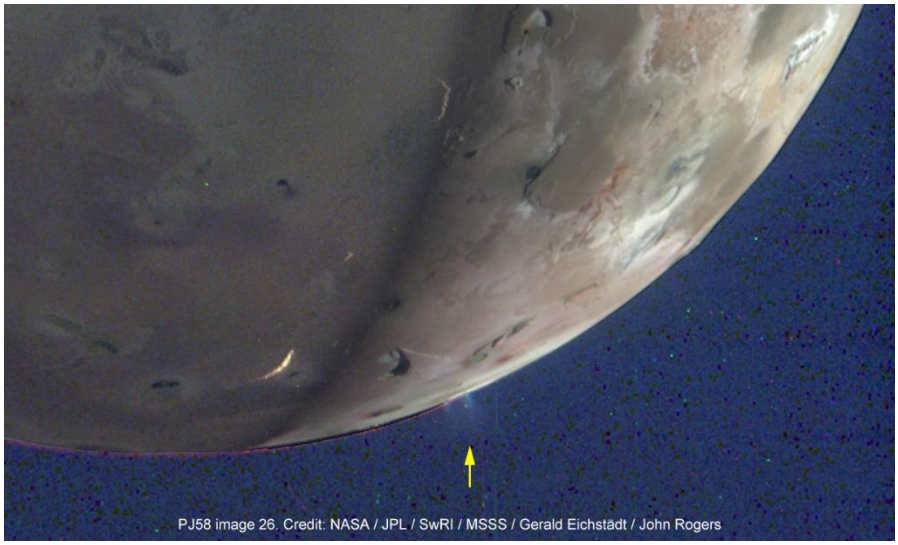


Figure 8 (part of image 26). This includes part of the crescent sunlit side. The background has been enhanced separately (from Gerald's 'draft' image); it shows a volcanic plume, apparently in Lerna Regio near ~297ºW, 58ºS.

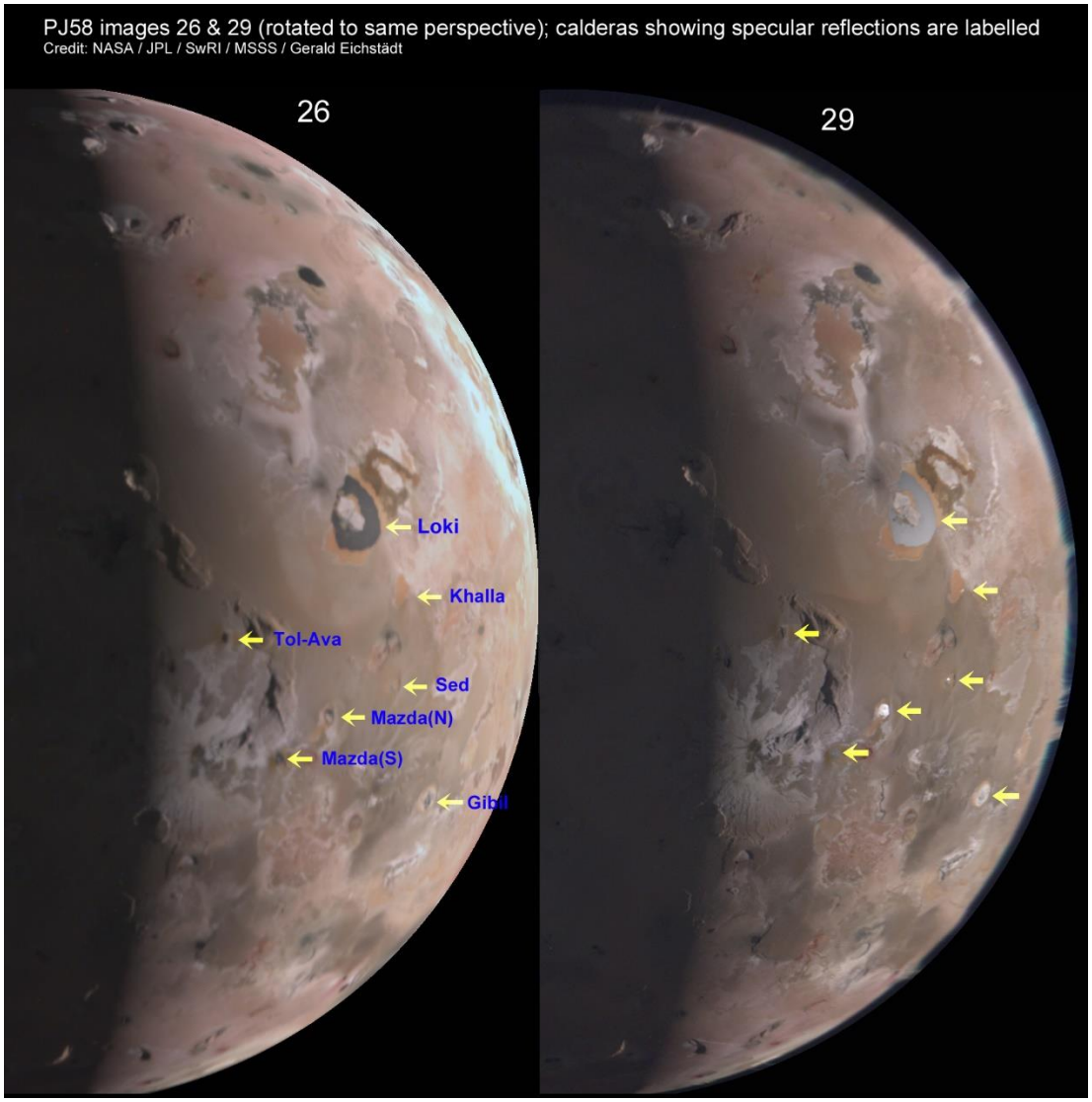


Figure 9 (images 26 & 29). Two images reprojected to the same viewpoint by Gerald, to show the brightness changes due to specular reflection of sunlight from the surfaces of several calderas, arrowed and named in image 26. (Bright "limb projections" in image 29 are artefacts of reprojection.)