

CLASSIFICATION OF IO'S PATERAE: ACTIVE VS INACTIVE. B. Barth, J. Radebaugh, and E.H. Christiansen, Department of Geological Sciences, Brigham Young University, Provo, UT 84602

Introduction/Problem: It is known that Io is the most volcanically active planetary body in the solar system. The level of activity of a volcanic center on Io is often determined based on whether it is a thermal hotspot observable from Earth and from orbit [e.g., 1, 2, 3]. In addition, the level of volcanic activity is determined on the basis of color, particularly the presence of dark deposits, which indicate relatively recent silicate lava that has not yet been covered by SO₂ frosts, and red deposits, which indicate current elemental sulfur emplacement [1, 4, 5]. Some of the most significant morphological features on Io associated with active volcanism are the paterae. A patera is defined as "an irregular crater, or a complex one with scalloped edges" and is similar in form to a volcanic caldera [6]. Within these paterae there are often large amounts of dark material on the basin floors indicating active volcanic regions. Over 400 of these paterae, with an average diameter of 41 km, pockmark the entire surface of Io [6]. Paterae also make up an area covering 1.05×10^6 km², which is a total of 2.5% of the entire surface [7] making these morphological features significant in terms of denoting the locations of active volcanism.

This project reports a global classification of paterae on Io, subdivided by color as indicators of volcanic activity. This work enables us to easily discern where the volcanically active regions of the moon are located within these paterae and make inferences about the geologic history and internal mechanics of this planetary body. We hypothesize that there would be more active paterae in the sub-jovian longitudinal band and the anti-jovian longitudinal band, based on previous studies [1,6,7].

Methods: We have analyzed the surface of Io using the USGS combined color image from the Voyager and Galileo spacecraft [8] to trace out Io's ~400 paterae. This image is a Mercator projection centered at 0 degrees longitude. We initially traced out the paterae in Adobe Illustrator and classified them based on amount of black fill, as black is related to recent volcanic activity (**Figure 1**). We divided the surface into 12 regions each 30° wide to examine longitudinal variations in volcanic activity (**Figure 1**). We show results for the number of each type of patera by region (**Figure 2a**). We did not measure dark materials outside paterae, such as lava flows related to paterae.

Some of the difficulties encountered were determination of patera boundaries due to the lower resolution of some portions of the basemap (~80% is mapped at 2 km/px or better). Also, it was difficult to distinguish between dark green or black in some regions.

Distinctly green areas were classified as having no black material.

Results: Of the 356 paterae classified thus far, 39 paterae have floors that are >50% black, 70 paterae have <50% black material, and 247 paterae have no black deposits. The greatest numbers of all paterae are in regions 7 (between 330° and 0°) and 12 (between 210° and 180°); region 7 contains 42 paterae and region 12 has 45 (**Figure 1**). Region 7 has 10 <50% black and 2 >50% black (the rest were devoid of black material). Region 12 contains 5 <50%, 3 >50% black, and the others have no black material. Furthermore, all 12 regions contain at least one patera with > 50% black fill and one patera with < 50% black fill, except for region 5. This region contains no paterae with any black fill. There are, however, ~13 paterae with no black deposits.

There is a correlation between size and amount of black material. Paterae with > 50% black fill are generally much smaller than those with no black fill, which are the largest of the three types. Those paterae exhibiting <50% black fill are commonly intermediate in size. This could be related to the supply of lava; large paterae require a much greater volume of lava to completely fill than small paterae.

The number of paterae that show signs of activity varies in concert with the total number of paterae found in that longitudinal region (**Figure 2a**). This implies that the number of active paterae is related to tidal flexing just as the total number is. The regions with more paterae are found around the sub- and anti-jovian regions (0° and 180° longitude).

Finally, preliminary analyses indicate that the total number of paterae is somewhat similar in both the sub-Jovian and anti-Jovian hemispheres of the moon, although there are more active paterae on the anti-jovian hemisphere by ~10% (**Figure 2b**). The sub-Jovian hemisphere has 12 paterae that have > 50% black deposits and 34 with < 50%. The anti-Jovian hemisphere has 27 paterae that have > 50% black deposits and 36 with < 50%. Also, there were 122 paterae on the sub-Jovian hemisphere and 124 on the anti-Jovian hemisphere that exhibited no black material within their margins.

Discussion/Implications/future work: Of the paterae classified thus far, 30% show signs of activity. These paterae represent a major portion of Io's hot spots. The number of paterae that exhibit activity varies directly with the number of inactive paterae. Additionally, paterae with any activity (**Figure 2b**) are found dominantly at the regions centered on 330° and

150° longitude (Regions 7, 8, and 9 and 1, 2, and 3 respectively). This corroborates previous work finding higher than average numbers of all paterae and all hot-spots [1,6]. The offset from purely sub- and anti-jovian locations has been hypothesized as being related to nonsynchronous rotation of Io's crust [6].

In future work, we will compare the area of black material in each active patera with the size of the patera itself. Also, we will study what each category implies about the patera's relation to the active resurfacing of the moon. These results will all continue to be a part of determining where the active regions on Io

are and how they play a role in the release of the internal heat built up within the mantle of this tidally locked moon.

References: [1] Lopes *et al.* (1999) *Icarus*, 140, 243-264. [2] Marchis *et al.* (2005) *Icarus*, 176, 96-122. [3] Spencer *et al.* (2007) *Science*, 318, 240-243. [4] Geissler *et al.* (1999) *Icarus*, 140, 265-282. [5] Williams *et al.* (2001) *JGR*, 106, 33,161-33,174. [6] Radebaugh *et al.* (2001) *JGR*, 106. [7] Williams *et al.* (2008), *LPS XXXIX*, Abstract #1003. [8] Becker *et al.* (2005), *LPS XXXVI*, Abstract #1862.

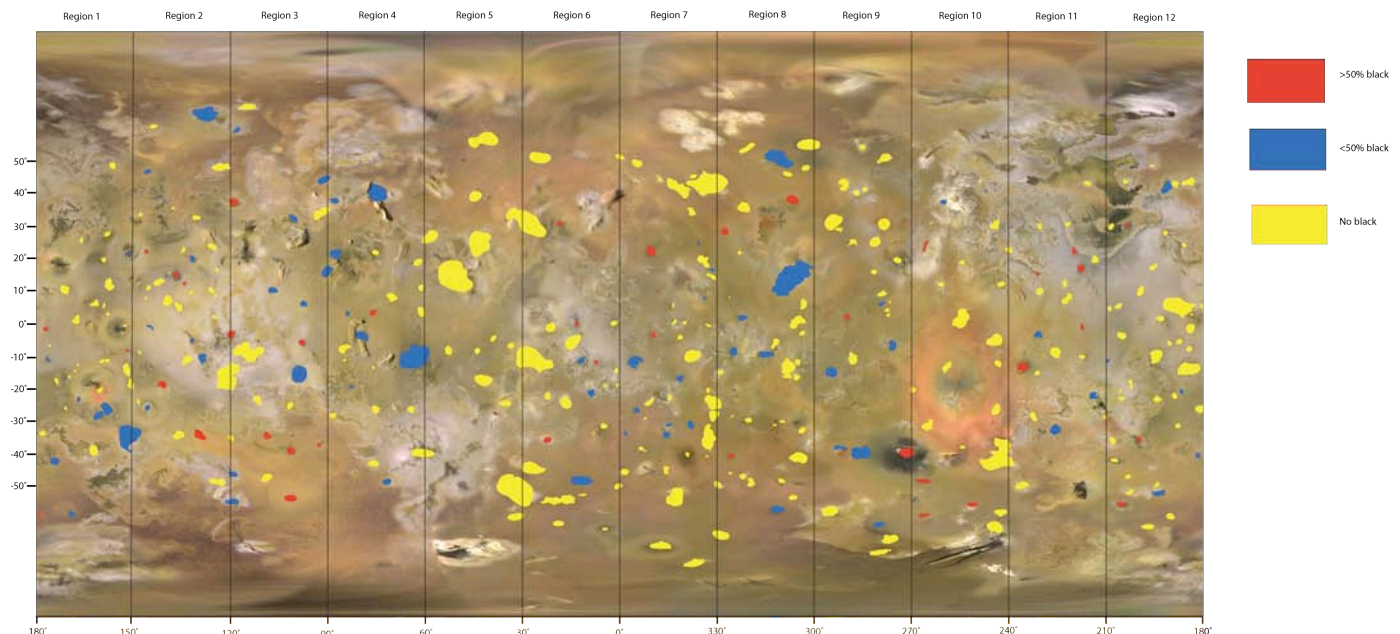


Figure 1: Map of Io showing classified paterae. Red paterae have > 50% black floor material, blue have < 50% black material, and yellow paterae are void of any black material.

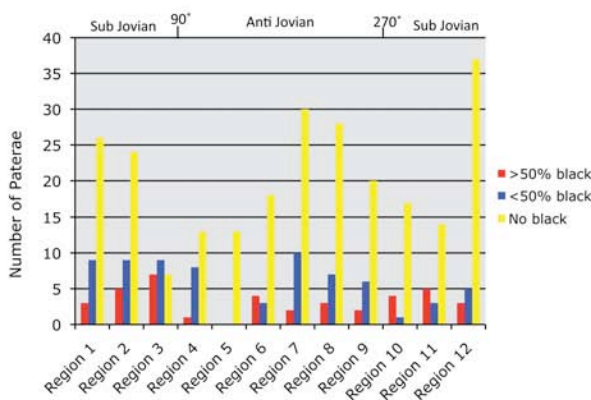


Figure 2a: Graph representing number of classified paterae per region based on amount of black floor material.

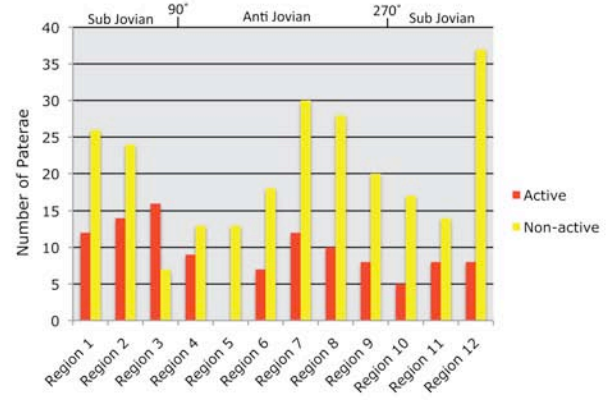


Figure 2b: Graph representing number of active vs non-active paterae per region; active paterae were those showing signs of black material within their margins.