DISTRIBUTION AND COMPARISON OF IO'S PATERAE: AREAS, EFFECTIVE DIAMETERS, AND ACTIVE VOLCANISM. B. Barth, J. Radebaugh, and A. McKean, Department of Geological Sciences, Brigham Young University, Provo, UT 84602. brandovan@gmail.com, jani.radebaugh@byu.edu.

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 by 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 SO_2 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. Previously, we reported a global classification of paterae on Io, subdivided by color as indicators of volcanic activity [7]. This work enabled us to easily discern where the volcanically active regions of the moon were in order to make inferences about the geologic history and internal mechanics of this planetary body. We have since calculated the areas and effective diameters of 426 paterae on the satellite (we are missing measurements of ~30 paterae found poleward of 57˚, which will be reported on in the presentation). These features cover a total of 2.5% of the entire surface [8] making these morphological features significant in terms of denoting the locations of active volcanism. We continue to analyze the distributions of these features to make distinctions between the Sub and Anti-Jovian faces compared with the leading and trailing faces of this tidally locked body. Furthermore, we have traced out and calculated the areas of the black material found within the paterae to determine total distribution of active silicate lava within these features.

Methods: After analyzing the surface of Io using the USGS combined color image at 1-2 km/pixel resolution from the Voyager and Galileo spacecraft [9] to trace out Io's 426 paterae (minus the poles), area calculations were done in ArcGIS using the Io Sinusoidal center longitude 0˚ projection to obtain accurate values in km^2. Perimeters (m) and X and Y centroids of each patera were also calculated in this program. Using the area (km^2) calculations done in ArcGIS, we calculated effective diameter, or diameter of a circle having the same area as the object, of each patera classified. Black material within each patera was also traced out and the areas were calculated in ArcGIS.

To study the distribution of these features on Io, we divided Io into 4 quadrants in association with its position facing Jupiter. We classified the Sub-Jovian face as located between 315˚ and 45˚ longitude, the leading face from 45˚ to 135˚, the Anti-Jovian face from 135˚ to 225˚, and the trailing face from 225˚ to 315˚. This allows us to compare the paterae located in the different sections on the moon to determine the effects of tidal flexing on Io's interior and volcanism.

Some of the difficulties encountered were delineating paterae with little contrast to the background or low illumination angle. Also, it was difficult to distinguish between dark green and black in some regions. Distinctly green areas were not classified as being active lava. For this study, we did not measure black material outside of paterae.

Results: We have classified 426 total paterae across the surface of Io (minus the poles) encompassing a total area of 1.41×10^6 km^2 (compared with 1.05×10^6 km^2 found by Williams [8]) A total of 13.9% of all paterae measured are covered with black material; active lava comprises a total area of 1.96×10^5 km^2 within paterae (compared with 1.26×10^5 km^2 by [10]). The greatest numbers of paterae cover surface areas from 0-3000 km^2; however, the mean surface area for all the paterae is 3.3×10^3 km^2. The effective diameter for all the paterae, which is related to area, is 56.8 km (Fig. 1).

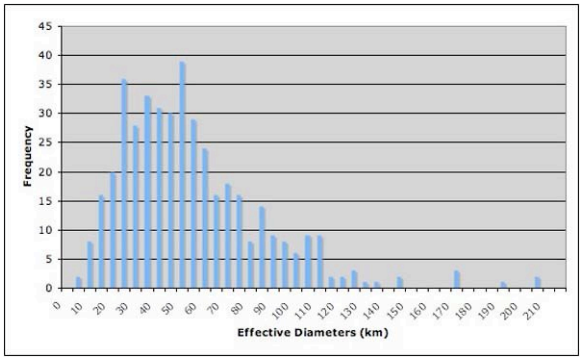

Figure 1: *Effective diameters (km) of all paterae*

When comparing the total paterae found in the Sub plus Anti-Jovian faces with the total paterae found in the leading plus trailing faces of Io we found that numbers of paterae were greater in the Sub plus Anti-Jovian faces, but that sizes of paterae were greater in the leading plus trailing faces. Mean total effective diameters and numbers for the Sub plus Anti-Jovian faces was found to be 52.04 km (248 paterae) whereas the leading plus trailing faces were 63.5 km (178 paterae).

A look at the activity of the paterae in association with the faces of Io also shows the same trend. There is greater size of paterae, both with and without activity, in the leading and trailing faces of Io. The non-active

paterae in the Sub plus Anti-Jovian faces have a mean effective diameter of 54.8 km (142 paterae) whereas the non-active leading plus trailing paterae were measured at 59.7 km (93 paterae). The active Sub plus Anti-Jovian faces were measured at 48.3 km (106 paterae) and the leading plus trailing active paterae were found to be 67.7 km (85 paterae).

Discussion/Implications: It is interesting to note that our mean effective diameter results of 56.8 km differ with that of 41 km found in a previous study [6]. This is largely due in part to the method used in obtaining these measurements. Whereas before, diameters were obtained by measuring length and width across each patera, essentially reporting areas as smooth ellipses, now patera perimeters have been completely traced, allowing for an accurate calculation of patera area and resulting effective diameter. The comparison between the old and new measurements reveals the high degree of angularity and irregularity of Io's patera margins. Much of the patera area was lost in the original measurements, but the new method does not cut out any of the patera area, allowing for a more precise measurement.

It is interesting to note that even though Io is tidally locked with Jupiter, the largest paterae, both active and non active, are found on the leading and trailing faces of the moon. However, there are more total active paterae found within the Sub and Anti-Jovian faces as opposed to the leading and trailing faces. This could be a significant indication of the internal heat distribution and venting within the upper mantle of Io, as paterae are associated with heat realease.

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]* Barth *et al.* (2009), *LPS XL* Abstract #2397 [8] Williams *et al.* (2008), *LPS XXXIX,* Abstract #1003. [9] Becker *et al.* (2005), *LPS XXXVI,* Abstract #1862. [10] Veeder et al. (2010), *LPS XXXXI.*

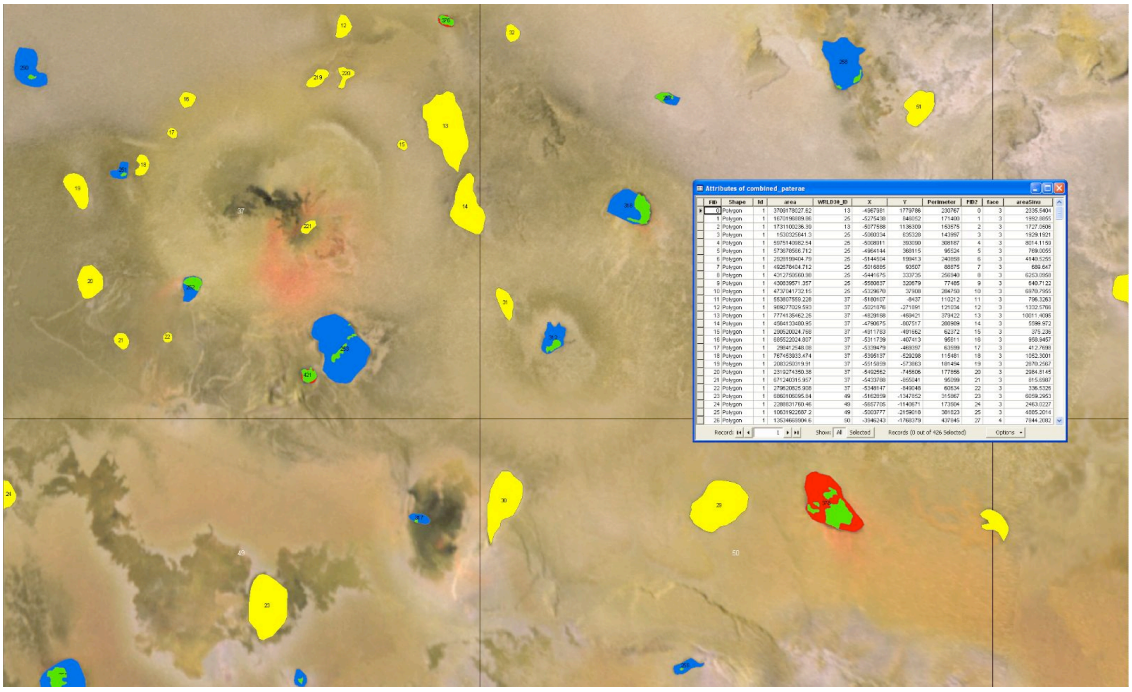

Figure 2: *Mapping project in ArcGIS showing classified paterae and corresponding black material. Red paterae have >50% black floor material, blue have <50% black material, and yellow paterae are void of any place material. Green represents black deposits within the paterae.*