THE ORIGIN AND EVOLUTION OF "ISLANDS" IN IONIAN PATERAE. S. R. Black[1] and T. K. P. Gregg[1], [1]University at Buffalo Department of Geology, 876 Natural Sciences Complex, Buffalo, New York 14260, srblack@buffalo.edu

Introduction: Tidal forces acting on Io from Jupiter and Europa make it one of the most volcanically active bodies in the solar system. Io has been the target of several missions including Voyager and Galileo. These fly-bys gathered visible images with the Voyager cameras and Galileo Solid-State Imager (SSI) and infrared images with the Voyager Infrared Spectrometer and Galileo Near Infrared Mapping Spectrometer (NIMS). These images of the paterae are used in this study [1].

Ionian paterae are morphologically similar to volcanic calderas: they have flat floors and steep, but shallow, walls. Some paterae are associated with eruptive plumes hundreds of kilometers tall and some of the longest lava flows in the solar system [1, 2]. The floors of the paterae may be bright (cool material) or dark (warm, presumably fresh, lava) [1, 2]. Of the 428 paterae catalogued [3], 35 contain bright "islands" on their floors, surrounded by dark lava flows (*Fig. 1*). A NIMS image of Loki Patera taken in October 1999 shows clear temperature differences between the dark material and the bright "island." Surrounding Loki's "island" is dark floor material that is 340K. The highest measured temperature for Loki's bright "island" is 240K [9]. These "islands" may be crustal rafts on lava lakes, an uplifted area within the patera, a resurgent dome, or part of the patera floor that simply has not been covered by fresh lava flows [1, 4-8]. Hereafter, we refer to these bright patches on paterae floors as "islands." We present the preliminary results of our research to constrain the formation and evolution of islands in Ionian paterae.

Methods: We used a database containing paterae locations (latitude and longitude) of known paterae [3] and images of each patera from www.mapaplanet.com, photojournal.jpl.nasa.gov/target/Io, and galileo.jpl.nasa.gov. We constructed geologic sketch maps for 64 paterae and recorded pertinent morphological characteristics of each patera (including those that were not mapped) in a new database. We analyzed outlines of paterae containing islands, and outlines of the islands as well, to look for tectonic relationships (straight edges, touching edges, or similar shapes) between the patera walls and island edges. We interpret lobate island margins to be formed by lava flow margins, and islands with fractures cutting across them to be resurgent domes. We then search for trends and relations among the paterae and the islands they contain.

Interpretations and Discussion: It is important to differentiate between islands that are not yet covered floor material, and islands that are the crust on top of cooling lava. We used the following characteristics to classify the islands. Islands that are not yet covered patera floor may be located anywhere within the patera and should have irregular, lobate edges (from the lobate form of the overlying lava flows). If the islands form by solidification of a lava lake or pond, it is expected that they would form from the outer edges of the patera where there are the highest cooling rates and grow inward toward the patera interior. This distribution is not seen in the paterae. Instead, the islands are located away from the patera walls and tend to have irregular edges. The example shown in figure 2a is attached to the patera wall; however, the lobate margins at the north end are indicative of a lava flow rather than a cooling lava pond or lake. Using these characteristics, it can be concluded that the islands are patera floor that has not been covered by fresh lava.

We interpreted one island as a resurgent dome (containing fracture-like features across the island), and most of the islands as not yet covered patera floor. While there are a few islands that exhibit tectonic characteristics (a straight side of the island and a straight side of the patera are a few tens of kilometers apart or less, or island and patera edges that match in shape), the majority of the islands do not (*Fig. 2*). Instead, the islands appear to be patera floor that has not been covered by recent lava flows. Therefore, paterae with islands are generally less active, or at least not as recently active, as paterae that are entirely black.

The distribution of paterae with islands is not random. Paterae with islands are concentrated on the Anti-Jovian hemisphere (90º to 180º). However, paterae with no islands (completely black, interpreted as fresh lava) are evenly distributed over the moon. This uneven distribution may be due to tidal forces acting on the moon by Jupiter. The gravitational pull of Jupiter keeps the Sub-Jovian hemisphere more constantly active, while the Anti-Jovian hemisphere relies on the gravitational pull from the other three Galilean satellites. Although there are more paterae that were observed to be active (hot spot or a plume) on the Anti-Jovian hemisphere, these active paterae were detected by Galileo (beginning in 1997), and only a handful were detected at another time (*Fig. 3*). This activity correlates with the alignment of Europa, Ganymede, and Callisto, which may have produced

enough gravitational pull to begin a period of activity on the Anti-Jovian hemisphere.

Future Work: A quantitative investigation of the planform shapes of paterae and the islands they contain will be conducted in an effort to further understand the morphology of these features.

References: [1] Lopes et al., (2004) *Icarus* 169, 140-174. [2] Johnson, T.V., (1999) *The New Solar System*, 241-253. [3] Radebaugh J. (2004) personal comm. [4] Davaille, A. and Jaupart, C. (1993) *Geophys. Res. Letters* 20, 1827-1830. [5] Davies, A.G. (2003) *Geophys. Res. Letters* 30, 1-4. [6] Harris et al., (1999) *JGR* 104, 7117-7136. [7] Radebaugh et al., (2001) *JGR* 106, 33005-33020. [8] Rathbun et al., (2002) *Geophys. Res. Letters* 29, 4. [9] galileo.jpl.nasa.gov

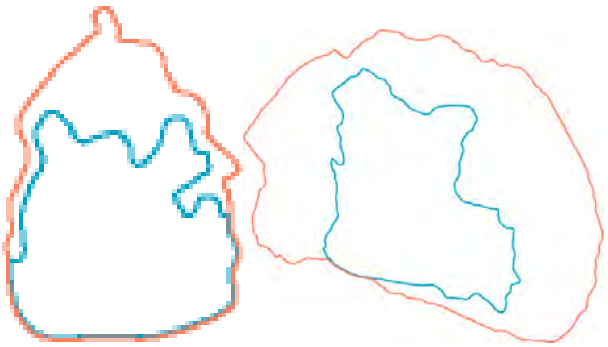

Fig. 2. The patera on the left (2a) appears to be a lava flow covering the floor from the north end. However, the patera on the right (2b) has a straight "island" edge touching a straight patera edge and may be tectonic in origin. Paterae are outlined in pink; "islands" are outlined in blue.

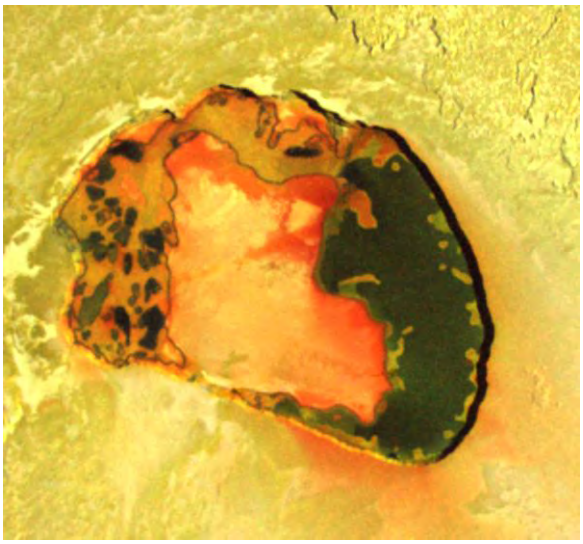

Fig. 1. An image of Tupan Patera (75 km diameter) taken by Galileo's Solid-State Imager in October 2001. The black is fresh lava. The southern edge is very straight and may be tectonically controlled. The cliffs are almost 900 m tall. Image resolution is 135 m/pixel.

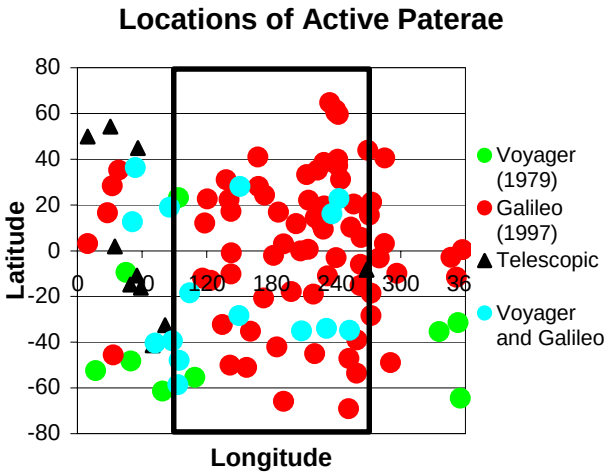

Fig. 3. A graph showing active paterae and when they were observed. The Anti-Jovian hemisphere is located within the black box. The majority of the active paterae within the Anti-Jovian hemisphere were observed by Galileo