

PATERAE ON IO: GALILEO IMAGES, SIZES, DISTRIBUTION, AND AGES. Jani Radebaugh¹, Laszlo Keszthelyi¹, Alfred McEwen¹, and the *Galileo* SSI Team, ¹Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721 (jani@LPL.arizona.edu).

Introduction:

Some of the most prominent volcanic features on Io are the paterae, defined by the IAU as “an irregular crater, or a complex one with scalloped edges.” Paterae on Io are unique, yet in some aspects they resemble calderas known and studied on Earth, Mars, and Venus. They have steep walls, flat floors, arcuate margins, and sometimes exhibit nesting, all typical of terrestrial and martian basaltic shield calderas, but they are much larger, many are irregular in shape, and they typically lack shields.

Their great sizes (some >200 km diameter) and lack of associated volcanic edifices beg comparison with terrestrial ash-flow calderas; however, there is no convincing evidence on Io for the silica-rich erupted products or dome resurgence associated with this type of caldera. Ionian paterae seem to be associated with the eruption of large amounts of mafic to ultramafic lavas and sulfur-rich materials that subsequently cover the floors. They are often irregular in shape or are found adjacent to mountains or plateaus, indicating tectonic influences on their formation [1].

Images from *Galileo*:

Galileo images of Io from 1999 and 2000 reveal new information about the nature of its paterae. The February 2000 *Galileo* flyby of Io produced high resolution (200 m/pixel) images of the Camaxtli region of Io (130 to 160 degrees W lon., 10 degrees N lat.), an area about 850 km x 300 km with 12 identified paterae [2]. Many of the paterae lie along a bent line, and some have straight sides, indicating that tectonic processes have been active in the region. Higher resolution (8 m/pixel) images of Chaac Patera, in the west end of the region, show a patera floor covered in pahoehoe-type lava flows, and steep walls that rise 2.8 km above the floor. Camaxtli Patera, in

the east end of the region, has a dark floor with a colorful, mottled texture. This patera, along with another small dark patera to its west, are the sources of high heat output observed by NIMS [3]. Both of these paterae are rimmed by dark and light diffuse material, possibly silicate and sulfur dioxide pyroclastic material. A more in-depth discussion with a geologic map of this region is presented as a poster by Williams et al., this meeting [4].

Another large mosaic of high resolution (200 m/pixel) images of the Amirani flow region of Io (115 to 120 degrees W lon., 18 to 32 degrees N lat.) has several paterae in it. The patera at the bottom of the long flows is dark, has one straight side, and has red diffuse material emerging from its margins. This patera is also the source of high heat flow observed by NIMS, and may be one source of the extensive lava flows [2]. A long, dark, straight feature, that could be a fracture turned to a lava channel, may connect the patera and the lava flows.

Sizes and Distribution:

A database of paterae on Io records their sizes, distributions with latitude and longitude, morphological characteristics, proximity to mountains, straightness or irregularity of margins, and presence atop shields. Information was obtained from both *Galileo* and *Voyager* spacecraft missions, and image resolution was restricted to 2 km/pixel or better (79% of the surface). The mean diameter for 417 paterae measured is 41.0 km, with minimum and maximum diameters of 2.5 km and 202.6 km, and the mode, or peak in distribution, is 15-20 km, when they are grouped in 5 km bins [1]. The mean diameter of 41.0 km is nearly identical to those for calderas of Mars and Venus, but dwarfs those for terrestrial basalt shield calderas (6.6 km) and ash-flow calderas (18.7 km).

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Most paterae on Io exist between -25 and +25 degrees latitude; a histogram shows that data is almost 50% higher than the predicted distribution in the equatorial band. Paterae within this band are also slightly smaller than those at the poles. The mean diameter for paterae from -25 to +25 degrees latitude is 38.0 km, compared with a mean diameter poleward of these latitudes of 44.6 km [1].

There is also an uneven distribution of paterae with longitude, with peaks in patera number occurring near 330 and 150 degrees W longitude, and lows around 60 and 250 degrees (Interpretation must be done cautiously due to the gap in high resolution global coverage between 0 and 70 degrees W longitude). This distribution could be related to tidal heating, the greatest concentration of which should be along the sub- and anti-Jovian axis, at 0 and 180 degrees W longitude, if heat is generated and translated primarily in the asthenosphere [8]. Patera distribution is offset from this axis, however, indicating that Io could have undergone or be undergoing an epoch of non-synchronous rotation [5, 6, 7], so that the most active hemispheres lead the current 0 and 180 degree points by 30 degrees.

Other data reveal that 13% of all paterae are found adjacent to mountains, 43% have straight or irregular margins, and only 8% are found atop low shields, while the remainder appear to have no associated edifice [1].

Ages of Paterae:

Currently, the most intriguing unknowns about paterae on Io concern the mechanism of formation of these features, and the timescale of their creation and evolution. Constraints can be made on the ages of paterae based on the fact that dark lavas are present only if the volcano has been relatively recently active. It is possible to determine an age pro-

gression in the areas in which we have high resolution images. For example, Camaxtli Patera, the small dark patera to its west, Culann, and Prometheus Paterae appear to be very young, since they have very low albedo lava flows, are prominent NIMS hotspots [9, 3], and are associated with dark, light, and sometimes red pyroclastic material. Chaac Patera and the small patera to its east are likely slightly older, since they have some low albedo materials, yet they also have solid white sulfur dioxide frost that has condensed on their cooler floors. An even older feature is the small roundish patera in the center of the Camaxtli region, since it has some colorful lava flows on its floor and a significant amount of white sulfur dioxide frost, yet there are no extremely low albedo lavas present. This age sequence continues down to paterae barely discernible due to being covered by light materials, possibly sulfur dioxide pyroclastics.

Using an estimate of resurfacing rates on Io, a rough age can be assigned to these features. With this information we can begin to understand the recycling of materials in Io's crust and mantle and the structure of its lithosphere.

References:

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