

GALILEO SSI AND CASSINI ISS OBSERVATIONS OF IO'S PELE HOTSPOT: TEMPERATURES, AREAS, AND VARIATION WITH TIME. J. Radebaugh¹, A. S. McEwen¹, M. Milazzo¹, A. G. Davies², L. P. Keszthelyi¹, P. Geissler¹. (¹Planetary Image Research Laboratory, Univ. of Arizona, Tucson, AZ 95721-0092 (email: jani@LPL.arizona.edu); ²Jet Propulsion Laboratory-California Institute of Technology.

Introduction: Galileo, during its 4.5 year tour of the Jupiter system, has used eclipse, night, and day images to monitor the thermal output of Io's ever erupting volcanoes. The most recent Io observation occurred in October 2001, during which Galileo obtained nighttime images at 60-65 m/pixel of the Pele hotspot in the clear and infrared filters. This observation finally revealed the large area of actively erupting material that was missed in earlier observations of Pele [1]. The active hotspot Pele is the source of a 1200 km diameter red ring (a color typically associated with active volcanism on Io) and was a hotspot in 1979, when Voyager flew past the body [2,3], and it continues to be active today, as seen by Galileo, ground-based observations, and Cassini.

Cassini, on its way to Saturn, flew past the Jupiter system in December 2000-January 2001, viewing Io in eclipse by Jupiter four times from a distance of approximately 10 million kilometers. The ISS camera obtained images of Io at about 60 km/pixel resolution, and recorded both auroral glows and emissions from hotspots, the most prominent of which was Pele. These Cassini ISS and Galileo SSI images of Io were used to determine thermal output of the persistent hotspot Pele.

Temperature measurements: The Galileo SSI camera obtained night side images of Pele through the clear and 1 μ m filters. The ratio of the radiance measured through these two filters is a function of temperature. To find temperature, expected radiances through the filters were calculated using blackbody flux calibrated by instrument performance (see figure 2 [4]). A ratio of the expected radiances was compared with ratios of measured radiances from Galileo images to obtain temperatures for Pele. The Galileo SSI camera saturates at the high emissions from high-output volcanoes such as Pele, so some estimates had to be made to account for the saturation and bleeding in many pixels. Preliminary results place pixel-averaged temperatures at 1400 K, consistent with basaltic lava.

The Cassini ISS camera observed Io in eclipse through several filters; those used for initial temperature calculations are the clear (~200-1050 nm) and IR4 (~850-1050 nm). The same method discussed above for Galileo SSI dual-filter temperature measurements was used for Cassini ISS temperature calculations. Measured temperatures over the three eclipses (total elapsed time of 84 hours) averaged 1375 K, which is consistent with long-term measurements of this hotspot, and correlates well with the above-mentioned

Galileo temperatures. Eruption temperatures are likely several hundred degrees K hotter, since lavas cool so quickly on Io [5]. The Galileo SSI camera observed Pele at 1275 K in 1997 and 1390 K in 1999 [4]. In addition, Galileo NIMS has obtained temperatures for Pele of 1300 K to 1400 K [6] (possibly up to 1670 K +/-232 K in small areas [7]).

Temperature variation over time: Despite the relative constancy of Pele's temperatures over medium time intervals (84 hours to several months), during the Cassini eclipses we observed variations over time scales of tens of minutes. Due to Cassini's high data return rate, there were 10 pairs of images (clear and IR4) taken during each eclipse, separated by about 11 minutes. This is the first time we have had spacecraft observations of Io at this time resolution. During the first eclipse, temperatures were constant within error for the first half of the eclipse, and then they oscillated from a low of 1255 K to a high of 1585 K, within only 20 minutes. The first half of the third eclipse showed similarly constant temperatures, and then there was slight variation, just outside of error, during the second half of the third eclipse. Thus, although Pele is consistently active, there is some variation in vigor or manner of eruption over short time scales. The new Galileo I32 observations will be used to find variation over time scales of seconds, since 7 images were taken over a total of several seconds.

Temperature-Area measurements: Knowledge of the observed temperatures of the Pele hotspot from both Galileo and Cassini also permits a calculation of the area of the erupting material. We will use the high resolution I32 data (60-65 m/pixel) to constrain the total area at high temperature when modeling the emissions seen in the low resolution data from SSI and ISS. In this way, we can provide an upper limit on the hot area, since not all hot pixels in the I32 images are necessarily full of incandescent lava.

Is Pele a lava lake? Several lines of evidence support the existence of a lava lake at Pele hotspot:

(1) Its high temperatures over long periods of time, as seen by Galileo, groundbased, and NIMS observations, are indicative of a confined source of high temperature lava. In addition, despite Pele's long-lived, consistently high temperatures, there are no massive surrounding lava flows. Morphology is more consistent with lava being confined to the 10 km patera.

(2) Night time images taken by Galileo during I24 (November 1999) and I32 (October 2001) reveal curv-

ing lines of extremely hot material, which is similar to what is observed at Pu'u O'o, Hawaii and other lava lakes, where hot lava is exposed as a cooled lava lake crust breaks up against surrounding walls. The images taken during I32 that reveal a region of extremely hot exposed lava are likely the location of the fountaining and rapid overturn of a lava lake, and possibly the source of the large plume.

(3) With Cassini we observed rapid variation in temperature over tens of minutes, followed by a return to high average temperatures 42 hours later. Flynn et al. [8] analyzed satellite data of Kupaianaha lava lake, Hawaii, and found that temporal variability of the thermal output of lava lakes is on a time scale of seconds to minutes.

(4) Analysis of thermal emission from Galileo-NIMS data concluded that Pele was a lava lake [6].

(5) The variation of Pele's output with rotation by $[\cos(\text{emission angle})^{1.6}]$ could be achieved by the fountaining and overturning of an active lava lake.

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