IONIAN VOLCANOES REVEAL THEIR TEMPERATURES. D. Allen[1] and J. Radebaugh[2]. [1]Department of Physics and Astronomy, Brigham Young University, Provo, UT 84602, [2]Department of Geological Sciences, Brigham Young University, Provo, UT 84602.

Introduction: Cassini ISS imaged the surface of Io in eclipse by Jupiter in late 2000 and early 2001 and obtained multiple-filter images over timescales of hours. Images like these have been used to study the temperature and variability of the numerous hotspots on the surface [1, 2, 3]. For example, Pele was found to be an active lava lake with most likely basaltic lava composition [2]. New Horizons data suggests temperatures of 1150 K to 1335 K for the brightest hotspots [4]. We undertook similar color temperature analyses to determine the lava composition and eruption style of three hotspots (Figure 1): Pillan, Wayland, and Loki.

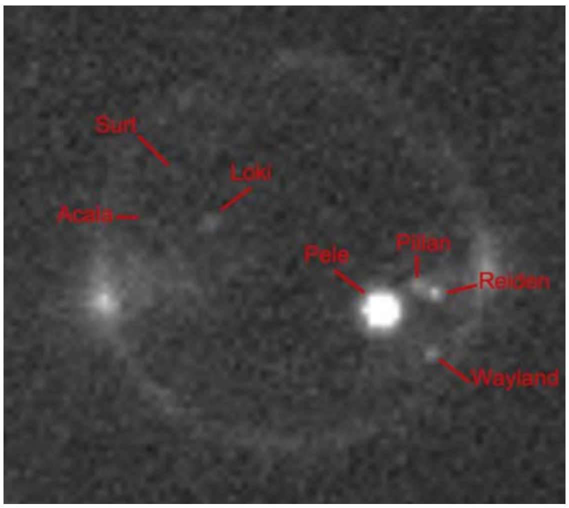

Figure 1. Image of Io in eclipse by Jupiter showing the most prominent hotspots. The image was taken January 1, 2001 by Cassini ISS at a resolution of ~61 km/pixel. The emission near Io's limb are auroral glows due to excitation of plume gases [2].

Procedure: During three eclipses of Io by Jupiter, Cassini imaged the surface as it flew by at a distance of 9.72 million miles resulting in nearly 500 images at a resolution of ~61 km/pixel. Each sequence of images ranges in time from 2-3 hours giving unprecedented temporal resolution at wavelengths ranging from 250-1050 nm. We used the filter combinations of clear 1 (CL1) and clear 2 (CL2) and infrared 4 (IR4) and CL2 with wavelength ranges of 250-1050 nm and 875-1050 nm, respectively, to determine color temperatures for the hotspots.

Color temperatures are found using variations of blackbody radiation as a function of wavelength. The relative intensities of the radiation at different wavelengths are related to the temperatures of the radiating lava eruptions. We determined the temperatures of the hotspots using the ratio of the clear signal to the IR signal and compared it to the known blackbody response curve for the Cassini ISS camera (see Figure 1) [2]. The lava composition is then inferred by comparison to temperatures of terrestrial lavas of known composition.

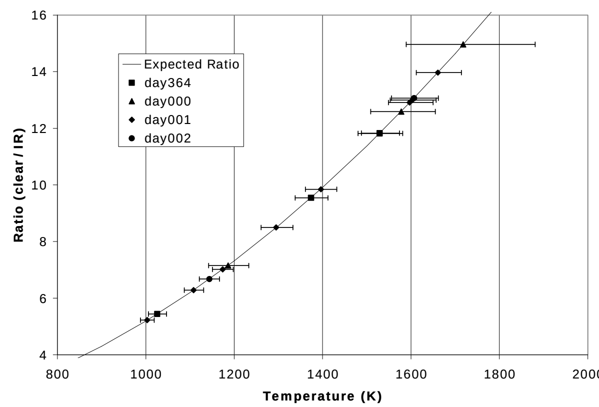

Figure 2. Plot of ratios of emission from Pillan for the clear and IR filters with the expected curve of ratios of expected blackbody emission. Error bars are >1σ, and the average color temperature is 1384±238 K. (Note: Day001 and day002 comprise the third eclipse.)

We found the hotspots thermal flux by averaging the pixel values in a 5x5 box surrounding each hotspot and subtracting an average background pixel count from four 5x5 boxes off the disk of Io. This was done on the images for both the CL1-CL2 and IR4-CL2 filter combinations. We used the resulting hotspot flux values to find a ratio of clear/IR which was then plotted on the blackbody ratio response curve for the Cassini ISS camera to find hotspot temperatures (Figure 2).

We also used the sequence of images to track the variation of intensity and temperature over time for each hotspot. This variation allows us to determine the type of eruption occurring since different types of eruptions exhibit characteristic temporal behaviors [1].

The determination of the variation and thus eruption style is twofold. First, the positions of the spacecraft and hotspots are used to find the angle of emission as seen by Cassini. This angle changes throughout the eclipse as Io rotates resulting in a decrease in emission from the hotspot. The way it decreases in relation to what we expect for a flat radiator is used to determine the geometry of the hotspot and the surrounding area. Second, the temperature variations per time and per emission angle are found. Plots of emission and time versus emission angle (Figure 3) are used together to determine the eruption style.

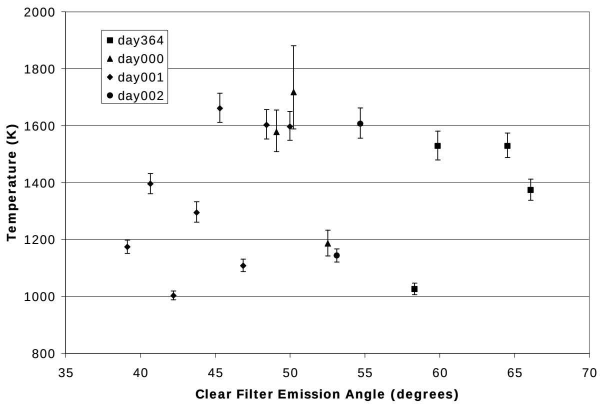

Figure 3. Shows the temperature change for Pillan as the emission angle increases. Time goes from left to right for each day.

Results: We found very similar color temperatures for all three hotspots. Pillan was found to have an average temperature over the full data set of eclipses of 1384 ± 238 K. Wayland and Loki had color temperatures of 1249 ± 148 K and 1409 ± 225 K, respectively. All three showed significant variations in temperature and emission during each eclipse, but the extent of the variations may be misleading. The hotspots were particularly faint in the infrared leading to difficulty in distinguishing the hotspots and getting a significant number of counts above background. The plots of temperature and emission versus emission angle are therefore interpreted to show overall trends in the variation per eclipse.

Conclusions and Future Work: The temperatures found for the three hotspots all lie within the range for basaltic lava [1]. The color temperature value for Loki is significantly higher than previous determinations, confirming this large body is in fact silicate with episodic exposures of actively erupting lava [3]. In addition, these observations may have occurred during a period of increased eruption. The next step is to determine the eruption styles for the hotspots and compare them to previous values. Once this is done we will see how these three hotspots contribute to the overall picture of Io's volcanism.

References: [1] Davis, A. G. et al. (2001) JGR, 106, 33079-33103. [2] Radebaugh J. et al. (2004) *Icarus*, 169, 65-79. [3] Howell R. R. and Lopes R. M. C. (2007) *Icarus*, 186, 448-461. [4] Spencer J. R. et al. (2007) *Science*, 318, 240-243.