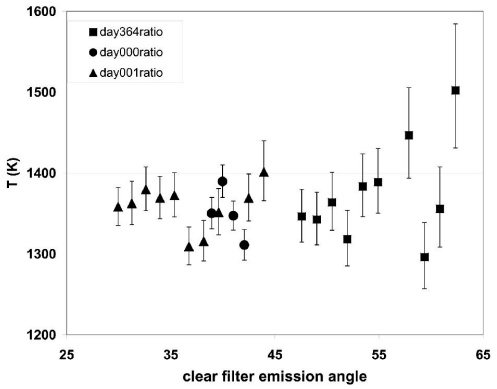
A Mafic-to-Ultramafic Silicate Lava Lake in Io's Pele Patera: Evidence from *Galileo* and *Cassini* Images

Jani Radebaugh, Alfred McEwen, Moses Milazzo, Laszlo Keszthelyi, Ashley Davies, Elizabeth Turtle, Doug Dawson

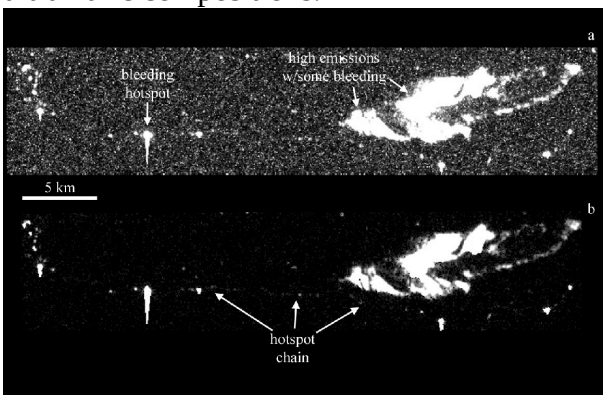
Pele has been the most intense high-temperature hotspot on Io to be continuously active during the *Galileo* monitoring from 1996-2001. A suite of characteristics suggests that Pele is an active lava lake inside a volcanic depression. In 2000-2001, Pele was observed by two spacecraft, *Cassini* and *Galileo*.

The *Cassini* Imaging Science Subsystems (ISS) observations reveal that Pele is variable in activity over timescales of minutes, typical of active lava lakes in Hawaii and Ethiopia. The graph below shows temperature differences of over 100 K in just tens of minutes.



These observations also reveal that the short-wavelength thermal emission from Pele decreases with rotation of Io by a factor significantly greater than the cosine of the emission angle [cos(emission angle)$^{1.6}$], and that the color temperature becomes more variable and hotter at high emission angles. This behavior suggests that a significant portion of the visible thermal emission from Pele comes from lava erupting in high fountains within a topographically confined lava body.

High spatial resolution, nightside Solid State Imaging (SSI) images from a *Galileo* flyby in October 2001 reveal a large, relatively cool (<800 K) region, ringed by bright hotspots, and a central region of high emission, which is hypothesized to be due to overturn and convection of a giant lava lake. The figure below shows the Pele region as seen by *Galileo* before and after noise removal. Images taken through different filters reveal color temperatures of on average 1375 K ±25 K, with a high of 1500 K ±80 K, from the *Cassini* data, and 1605 K ±220 K and 1420 K ±100 K from small portions of the *Galileo* data, values that are toward the upper end of the basaltic range. Given the limitations of deriving lava eruption temperature in the absence of *in situ* measurement, we also consider the possibility of ultramafic compositions.



Areas of hot material in the problematic, largely saturated regions were calculated to be 6,200 m^2 at 1375 K (the average Pele temperature from Cassini data) at only one hotspot, and 24,443 m^2 at 1375 K at a portion of the large, central region, and 0.124 km^2 at 1375 K for the entire Pele region. These areas are necessarily smaller for higher temperatures. Exposed lavas at these high temperatures and large areas are likely unique in the present solar system to Io.

The long-lived, vigorous activity of what is most likely an actively overturning lava lake in Pele Patera indicates that there is a strong connection to a large, well-fed magma source region.