THERMAL INFRARED OBSERVATIONS OF THE MOON DURING LUNAR ECLIPSE.
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Introduction: During lunar eclipses solar illumination is rapidly removed from the Moon's surface. The thermal infrared brightness of lunar locations during eclipse is a strong function of the local average thermal inertia. IR observations of the eclipsed Moon during the late 1960's at low angular resolution (10" or 20km on the lunar surface at the center of disk) showed large spatial variations in eclipse temperatures across the Moon[1,2,3]. Large rayed craters showed prominent positive anomalies, as did certain mare surfaces which have been interpreted as being relatively young via stratigraphic arguments.

We have initiated a program to reobserve the Moon during eclipse at thermal wavelengths at much higher resolution. The principal goal is to use the thermal properties of craters and Apollo landing sites with known ages to absolutely date the apparently young mare surfaces.

Eclipse Data: During the partial lunar eclipse of July 28, 1999 the Maui Space Surveillance Site AEOS and 1.6 m telescopes were used to image the moon in the 3-5 and 8-11 micron regions. The narrow field of view MSSS telescopes were scanned across the Moon during eclipse for later assembly into mosaics. Simultaneous visible light observations were made from the University of Hawaii, Institute for Astronomy Mees Observatory also located on the summit of Haleakala. These data will be used to measure the response of spatially resolved locations to the rapidly varying solar illumination in order to map the bulk thermal inertia of the Moon. These measurements will enable a number of lunar science applications ranging from understanding of local physical properties of the surface, to an improved understanding of the thermal history of the Moon over the last 4 billion years. One of the more challenging projects is to use these data to remotely determine the ages of lunar volcanic deposits. The bulk thermal inertia of the Moon is dominated by the ratio of rock to soil, which is governed by the amount of time a surface has been exposed to meteorite bombardment. Young, rock-rich surfaces should have high thermal inertias, while old, rock poor surfaces should have low thermal inertia. By comparing the thermal inertias of volcanic features to impact craters of known ages, we may be able to confirm the existence of very recent volcanic activity on the Moon[4].

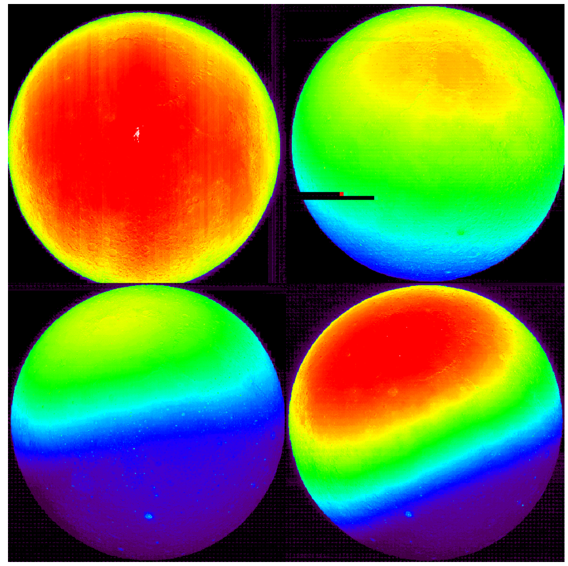

Figure 1 Figure 1. Infrared images of the Moon obtained during partial lunar eclipse. Color scale runs from 0 to 375K (blue to red). Each image is a mosaic of 70x70 framelets.

Figure 1 shows 4 mosaics of 72x73 individual 9 micron images, each 200x200 pixels, from the AEOS lunar eclipse data set showing the passage of the Moon through the partial eclipse. Red is warm and blue is cool. The portions of the Moon experiencing total eclipse show clear variations in thermal inertia. Bright spots are fresh impact craters which have strewn large blocks on the lunar surface. Subtle variations in the background are due to age differences between lunar surface units.

Tycho: Figures 2 and 3 are of the large lunar crater Tycho, 85km in diameter. Figure 2 is a mosaic of AEOS frames of Tycho obtained prior to lunar eclipse. This thermal image is dominated by variations in solar illumination and clearly shows the prominent central peak of Tycho and its terraced walls. Figure 3 was obtained during local total eclipse and shows variations in thermal inertia. Bright regions are poor in fine particulates and are emitting heat stored during the lunar day. The central peak of Tycho is prominent as are structures in the walls. A polygonal pattern can be discerned on the floor of the crater. These may correspond to cooling cracks associated with the pool of impact-generated molten rock which accumulated on the floor of Tycho when it was formed.

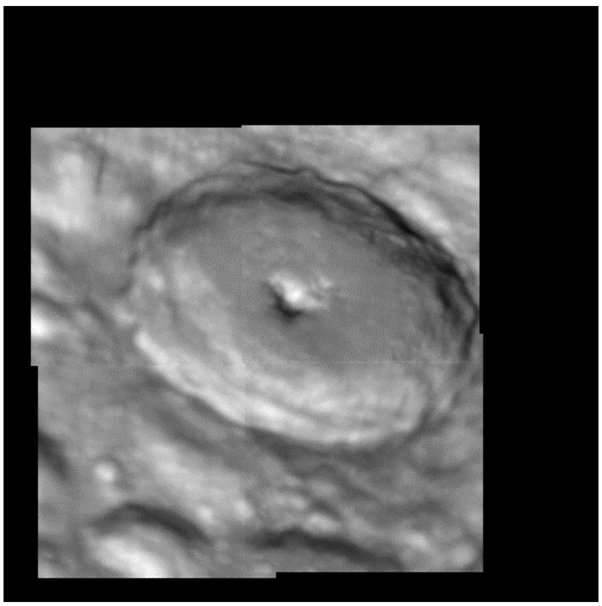

Figure 2. Full resolution image of Tycho obtained prior to the eclipse. Thermal radiance is dominated by insolation so the image mimics a visible light image.

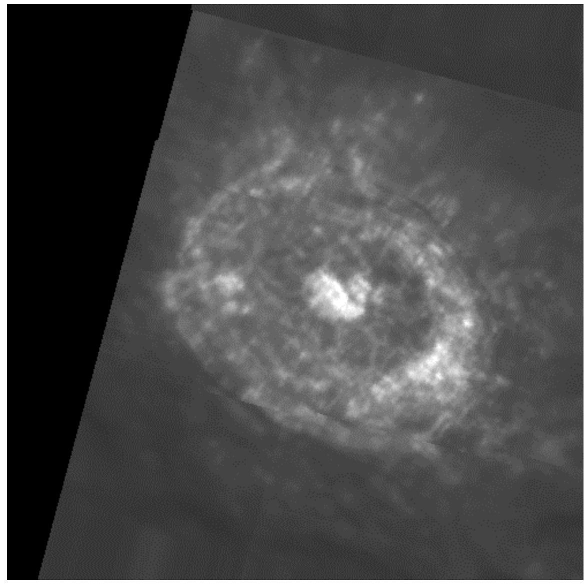

Figure 3. Full resolution image of Tycho obtained during local totality. Bright regions have high average thermal inertia.

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