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THERMAL ANOMALIES ON THE TOTALLY ECLIPSED MOON OF DECEMBER 19, 1964

bу

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ABSTRACT

The lunar disk was scanned in the infrared nine times during the total eclipse of December 19, 1964 using the 74-inch

Kottamia telescope in Egypt. As expected from previous work,
the major ray craters cooled less rapidly than their environs.

However, hundreds of localized hot spots were discovered on the disk, some of which have been identified with small ray craters.

Mare Humorum and certain portions of other seas were found to be thermally enhanced compared to their surroundings.

THERMAL ANOMALIES ON THE TOTALLY ECLIPSED MOON OF DECEMBER 19, 1964

Recent infrared measurements on small portions of the lunar disk made during eclipses^{1,2} and during the lunar night^{3,4} have revealed prominent thermal anomalies on ray craters, and lesser anomalies in other areas. A survey of the entire lunar disk is needed to determine the thermal homogeneity of the surface. While such a survey is possible for the dark side of the Moon, the low temperatures there require a slow scanning rate and observations over many nights. During a total lunar eclipse, however, the surface cools for only a short period, and its substantially higher temperature allows rapid scanning during totality.

In 1962 we developed a rapid scan system for mapping the Moon thermally and photometrically under illumination, using the 60-inch telescope at Mount Wilson 4. The scan system was modified for use on the 74-inch Kottamia telescope of the Helwan Observatory in Egypt for observations during the total lunar eclipse of December 19, 1964. Using a mercury-doped germanium detector cooled to liquid mean temperature, we were able to scan the entire disk in 16 minutes at 10" arc resolution with approximately 200 successive traverses. Four scans were made on the full Moon before the eclipse began, four during the first penumbral phase, three during totality, and one during the second penumbral phase.

These data were recorded on magnetic tape and are now being reduced on a 7094 computer.

A great amount of detail was revealed by chart recordings made during the experiment and is the basis for this preliminary report. As expected, prominent anomalies were found on the major ray craters Tycho, Copernicus, Aristarchus, Aristoteles, Proclus, Theophilus, Langrenus and Stevinus. For example, Fig. 1 is a tracing of the infrared signal obtained on a traverse through Tycho, an outstanding thermal anomaly on the eclipsed Moon. Preliminary calculations indicate the maximum temperature on Tycho is 226°K and the environ temperature 178°K, a difference of 48°K. On this traverse three peaks in the signal over Tycho may correspond to the rims and the central peak.

Perhaps the most surprising result of the experiment was the discovery of hundreds of localized thermal anomalies or "hot spots" on the surface of the Moon besides those associated with the major ray craters. An example in Fig. 1 is the "spike" in the signal near Tycho, tentatively identified with Heinsius A. Other examples of hot spots are seen in Fig. 2 where seven spikes in the signal correspond to locations in Mare Tranquillitatis and Mare Foecunditatis and on the edges of Mare Imbrium and Mare Serenitatic. The largest spike on the chart recordings, comparable to the signal from Tycho, was observed from the crater Dawes.

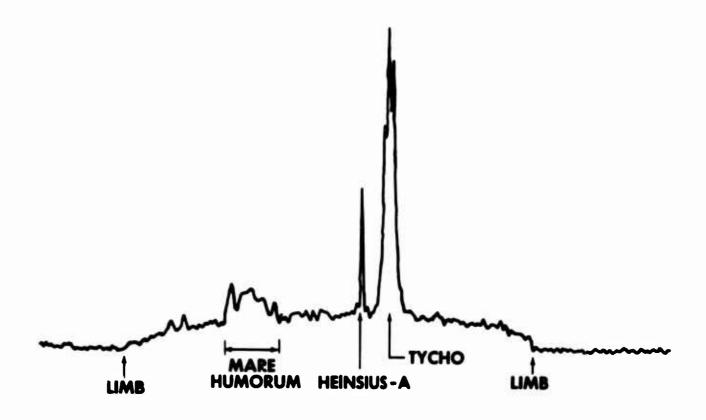


Fig. 1. Tracing of the infrared signal obtained on traverse number 31 during the third scan in totality of the December 19, 1964 total lunar eclipse. The scan began at 2^h55.^mO UT and ended at 3^h10.^m4 UT.

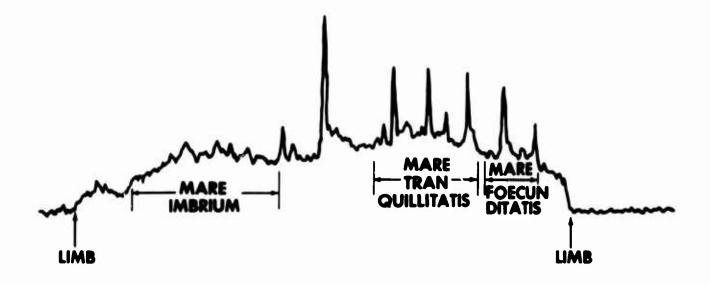


Fig. 2. Tracing of the infrared signal on traverse 134 during the third scan in totality.

The positions of 300 of the more conspicuous hot spots are plotted in Fig. 3, where the boundaries between the seas and continental areas are indicated. The distribution of these anomalies is not uniform on the disk; for instance a great number are found in Mare Tranquillitatis and relatively few in the continental area between Tycho and Theophilus. Many hot spots can be identified with the small ray craters which appear as white spots on the full Moon; these youthful features probably are thermally anomalous, as are the major ray craters, by reason of their denser and/or rougher surfaces. Some hot spots, however, are not associated with small ray craters; accurate positioning will be the first step in seeking an interpretation for these anomalies.

Another important result is the discovery of thermal enhancements over extended regions of the seas as shown in Fig. 1. Some of these extended enhancements are plotted in Fig. 3 as lines along the traverse direction. All of Mare Humorum appears higher in temperature than its environs while only parts of Oceanus Procellarum, Mare Imbrium, and Mare Frigoris are elevated. Extended enhancements are also found in Mare Tranquillitatis and Mare Foecunditatis as shown in Fig. 2.

The significance of these results will become clearer after contour maps are plotted and cooling curves for specific areas of interest are constructed. The observed thermal

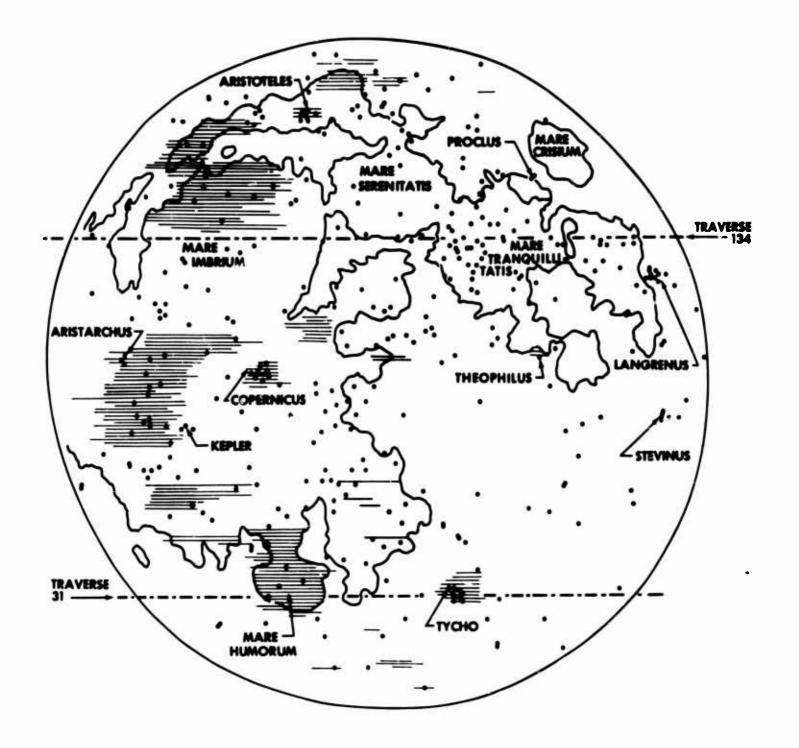


Fig. 3. Positions of "spikes" in the infrared signal (indicated by dots) obtained during the third scan in totality.

Some of the extended thermal enhancements are indicated by lines in the traverse direction (see text). Traverses 31 and 134 are indicated by dot-dash lines.

anomalies will be plotted on maps of the lunar disk and compared with surface features. The interpretation of the results can then be made with respect to theoretical cooling curves and experimental data such as albedo, color contrasts, stratigraphy, radar, and infrared measurements through a lunation.

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