COMPARISON OF THE THERMAL EMISSION SPECTRA FROM THE SURFACES OF MERCURY AND THE MOON

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Thermal infrared emission spectra of the Moon and Mercury have been obtained using a Si:As photoconductor and circular variable filter at the NASA Infrared Telescope Facility. Spectra from 7.2 - 12.2 μm show the Christiansen frequency peak, known to be diagnostic of rock type. Other emission maxima and minima may be useful if interpreted correctly. Comparison to laboratory or synthetic spectra is possible if from the same grain size and if spectra are integrated spatially to give hemispherical reflectance or emittance. We report results from one locations on the Moon and three locations on Mercury obtained in July, 1988. Results from two locations on the Moon and two locations on Mercury obtained in March, 1988 were reported in (1). Use of the SCFM index from Salisbury (2) shows Christiansen frequency as a function of $SiO_2/CaO + FeO + MgO + SiO_2$. Using directional and hemispherical reflectance spectra obtained by Salisbury (2) and the SCFM index described above we obtain the following rock types at the locations observed. A Christiansen frequency peak of 7.8 μm indicates mafic to intermediate rock type at 5 °N latitude on the west limb of the Moon (see figure 2). Emission spectra from Mercury are not as spatially localized. The longitudes of maximum contribution to the thermal emission spectra were calculated from thermal models of the earth-facing disk. Christian frequency peaks at 7.7 μm in emission emanating from 317 °, 335 °and 341 °on Mercury indicate slightly less mafic (more intermediate) composition (see figures 2 and 3). Particle size, thermal gradients, lattice structure, composition and scattering direction all are known to affect the shape of thermal emission spectra. In particular shock from impacts and particle size are important to properly interpreting spectra from the Moon and Mercury. Figures 1 and 2 demonstrate these important physical considerations. Figure 1 shows hemispherical reflectance from shocked plagioclase in two grain sizes. The reflectance is much greater on both side of the reflectance minimum in the case of 74 - 250 μm grain size than it is in the 0 - 74 μm grain size case. Because emissivity is roughly the inverse of reflectance, we can compare the emission spectra from Mercury and the Moon in figure 2 to the laboratory hemispherical reflectance spectra in figure 1. We believe that grain size differences may explain the puzzling difference in emissivity longward of 8.5 μm between Mercury and the Moon, Mercury's thermal radiation emanating from smaller grains than those responsible for the spectra from the Moon.

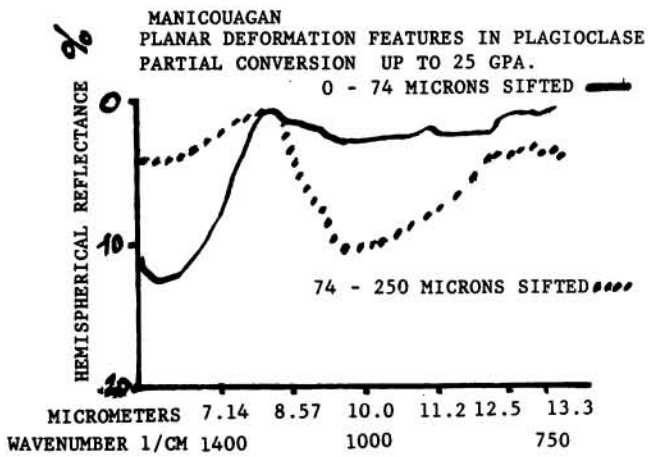

Figure 1. Hemispherical reflectance spectra of moderately shocked plagioclase. Difference in spectral structure is due to difference in grain size. Laboratory facilities and hemispherical integrating spectrometer were provided by Jack Salisbury, USGS, Reston, VA. Samples were provided by Richard A. Grieve, Geological Survey of Canada

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The emission maximum at 9.6 μm in the mercurian spectrum at 341 °longitude (see figure 3) may be an indication of composition. It may be an ultramafic silicate emission or some unknown effect. Another possible explanation is poor removal of telluric ozone features from the spectrum. Previous observations at locations very near the crater Homer on Mercury had peaks of 7.9, and 7.8 μm (1). These indicate mafic rock type in the first case and a region borderline between mafic and intermediate composition in the second. These data show that substantial portions of Mercury's surface are of intermediate or mixed intermediate and mafic rock type. Syenite, granodiorite, diorite, norite, and andesite are intermediate rock types found on Earth. Anorthosite, diabase, basalt, and gabbro are among the Earth rock types considered mafic. All those types mentioned above have Christiansen frequency peaks in the same wavelength region we observed on the Moon and Mercury.

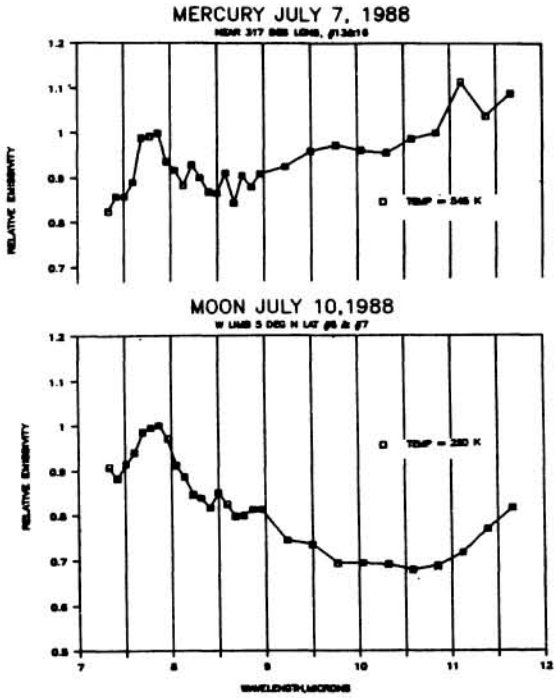

Figure 2. Thermal emission spectra from the Moon and Mercury showing Christiansen frequency . Difference in emissivity longward of 8.5 μm may be due to difference in grain size of the emitting surface.

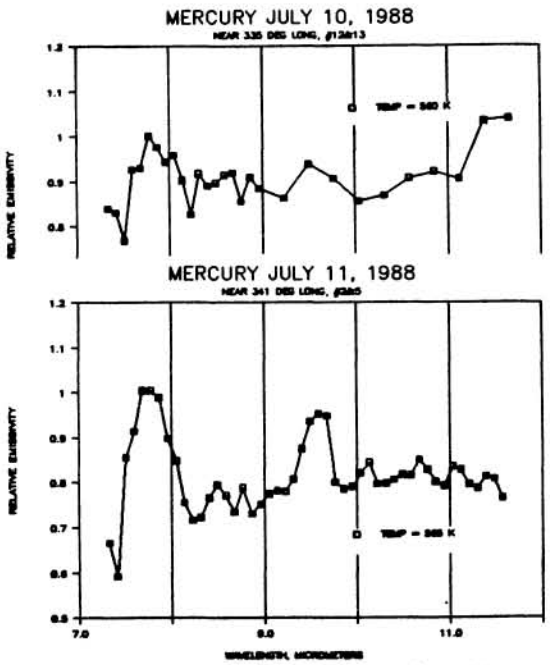

Figure 3. Thermal emission spectra from Mercury at two different locations. The unusual emission maxima at 9.6 μm may be real and due to an unknow ultramafic mineral assemblage or it may be poor removal of telluric ozone.

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REFERENCES: (1) Tyler, A.L., Kozlowski, R.W., and Lebofsky, L.A. (1988); (2) Salisbury, J. (1988)

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