NASA TECH BRIEF
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Microwave Emission from Granular Silicates

The microwave mass absorption coefficient of loose granular silicates is an important parameter in microwave measurements of planetary surfaces (distant planets as well as earth). For distant planets, measurements are made from space probes, and the passive microwave observations are usually described in terms of a theory in which the emitting homogeneous medium is radiating in the microwave region and is in local thermodynamic equilibrium; the temperature distribution with depth is estimated from the theory of heat conduction (at a known temperature of the surface), and the effective microwave brightness temperature is obtained from an expression for the emergent intensity resulting from an integration of the equation of radiative transfer.

At present, the most that can be learned about planetary surfaces from passive microwave measurements is the average absorption and scattering properties of materials near the surface; only gross estimates of thermal and electrical properties, together with the near-surface temperature distribution can be obtained for nonscattering media. From these data can be drawn inference about the physical state of aggregation and the atmospheric pressure at the surface; in principle, it may be possible to detect nonhomogeneities in surface properties in an isothermal medium provided the surface structure is of simple geometry (plane-parallel stratification), and the absorption and scattering coefficients increase essentially discontinuously with depth. Of particular interest is that rough determinations of surface rock type may be made if the dependence of microwave properties on rock composition and state of aggregation is known.

An effort has been made to obtain information on electrical properties of typical rocks in the microwave region by measuring the intensity of microwave energy emergent from the upper surface of a plane layer of homogeneous material on top of an aluminum plate (assumed to be a perfect reflector). Effective microwave absorption coefficients of the materials overlaying the metal were obtained from a series of measurements (the plate defines the reflective depth of the layers) at wavelengths of 0.8, 2.2, 3.2, and 21 cm. Aluminum plates were buried at various depths in sand, gravel, or cinders of roughly uniform particle size at Mono Craters, California, Reno, Nevada, and Poison Lake, near Mt. Lassen, California; layer thickness was measured in several places over the observed area, and special effort was made to keep the layer boundaries plane-parallel (±2-to-3 cm). The microwave brightness temperature measurements obtained at 1.4 to 37 GHz were used to determine the mass absorption coefficient, attenuation length, and effective values of electrical conductivity and loss tangent.

The important experimental finding is that the mass absorption coefficient is independent of frequency but highly dependent on moisture content; the effective conductivity increases with frequency, and the loss tangent is independent of frequency. Computed values of the electrical properties are in rough numerical agreement with extrapolated laboratory values on other silicate materials.

(continued overleaf)

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $6.00
(or microfiche $0.95)

Reference: JPL Technical Memorandum 33-458 (N71-10458), Microwave Emission from Granular Silicates: Determination of the Absorption Coefficient from Plate Measurements and the Effects of Scattering.

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