1973, Lunar Science IV,
J. W. Chamberlain + C. Watkins, eds.
Lunar Science Institute, Houston

ELECTRICAL PROPERTIES OF LUNAR SOLID SAMPLES, G. R. Olhoeft, Lockheed Electronics Co., Houston, TX, A. L. Frisillo, N.R.C. Fellow, NASA/MSC, D. W. Strangway, Physics Branch, NASA/MSC, Houston, TX and H. Sharpe, Lunar Science Institute, Houston, TX 77058.

Lunar solid samples 12002,85-0 and 65015,6 have been measured over the frequency range from 50 Hz to 1 MHz and at DC from 25°C - 800°C in vacuum less than 10^{-7} Torr using equipment and procedures as described by Olhoeft et al (1972). 12002,85-0 is a solid, fine to medium-grained holocrystalline basalt which had been previously measured in dry nitrogen at room temperature by Katsube and Collett (1971) and which had been exposed to air. The room temperature, vacuum results found in our measurements duplicate theirs to within the accuracy of measurement (±9% due to geometry). Figures 1 through 3 display the DC conductivity, dielectric constant, and total loss tangent as a function of frequency and temperature. The DC term dominates the dielectric losses above 500°C and exhibits an exponential temperature distribution. The DC conductivity measured at a temperature which was higher than any previously reached followed a curve which may be described by: $\sigma = 1.7 \times 10^{-18} \exp(0.037\ T)$ mho/m, T in °K. The dielectric constant exhibits a bulk low frequency limit greater than 1000 (extrapolated), a high frequency limiting value of 8.0, and two dielectric loss relaxation peaks. Only one of the relaxation peaks was resolvable, yielding a time constant of about 10^{-6} seconds with an activation energy of about 1.0 eV; the Cole-Cole frequency distribution parameter, $1-\alpha$, was found to be temperature dependent with a value near 0.7 at 25°C.

65015,6 is a solid monomict breccia which was transferred under dry nitrogen into our vacuum system. Figures 4 - 7 display the electrical properties data. The DC conductivity behaved similarly to 12002,85 with: $\sigma = 3. \times 10^{-14} \exp(0.023\ T)$. However, a new phenomenon in lunar electrical properties was observed below 200°C and 50 volts and at all voltages below 400°C (1-1000 volts). Figure 7 displays the constant-current (CC) behavior as a function of applied voltage versus observed sample resistance (divide resistance into 36.6 to yield conductivity in mho/m). This behavior is similar to a region of the space-charge limited operation common in vacuum tubes. The bulk low frequency limiting dielectric constant is near 50, the high frequency limit is 8.0, and two relaxation peaks were observed again. In this case both were resolvable with the first characterised by a time constant of $2. \times 10^{-13}$ seconds, an activation energy of 1.2 eV, and a distribution parameter, $1-\alpha$, of 0.39-1.0 as the temperature varied from 300-500°C; the second was characterised by 5×10^{-7} seconds, 0.19 eV, and 0.56-1.0 over 25-400°C.

Olhoeft, G. R., A. L. Frisillo, and D. W. Strangway, "Lunar Soil Sample 15301,38: Correlation of Electrical Parameters with Physical Properties," AGU Annual Fall Convention, San Francisco, 1972 (submitted to JGR)

Katsube, T. J. and L. S. Collett, "Electrical Properties of Apollo 11 and Apollo 12 Lunar Samples," Proc. Second Lunar Sci. Conf., Vol. 3, 2367-2379, M.I.T. Press, 1971.

ELECTRICAL PROPERTIES OF LUNAR SOLID SAMPLES

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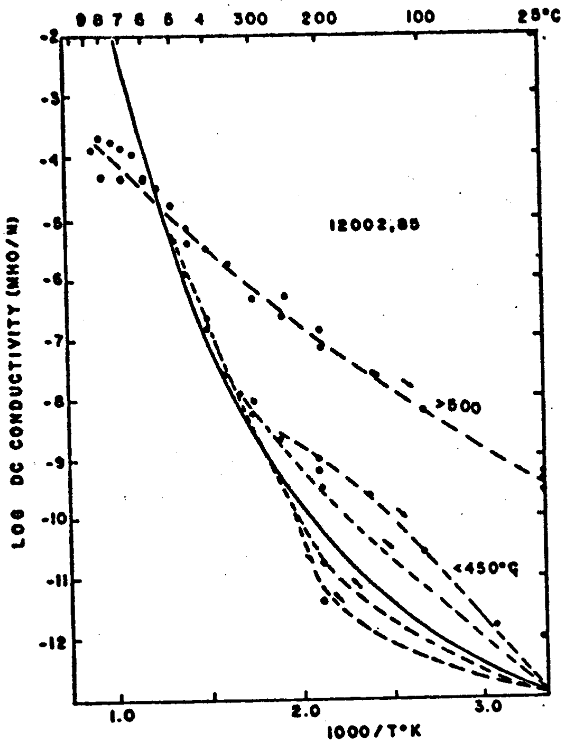

FIGURE 1

Figure Notes:

Figure 1: at all temperatures below 450°C the curves followed the lower set upon heating and the upper set on cooling; the two curves in each case represent the range of data scatter.

Figure 6: the dotted curves below 200°C are th CC region estimated conductivity. The small"c" data points show the recovery of the conductivity hysteresis in air suggesting the original cause to be vacuum reduction.

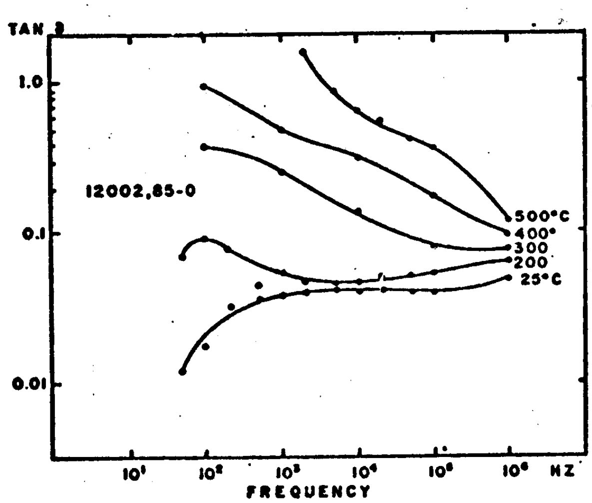

FIGURE 2

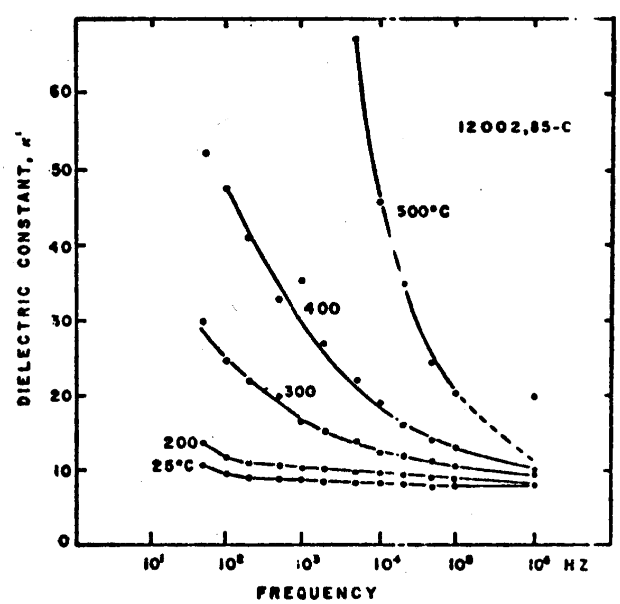

FIGURE 3

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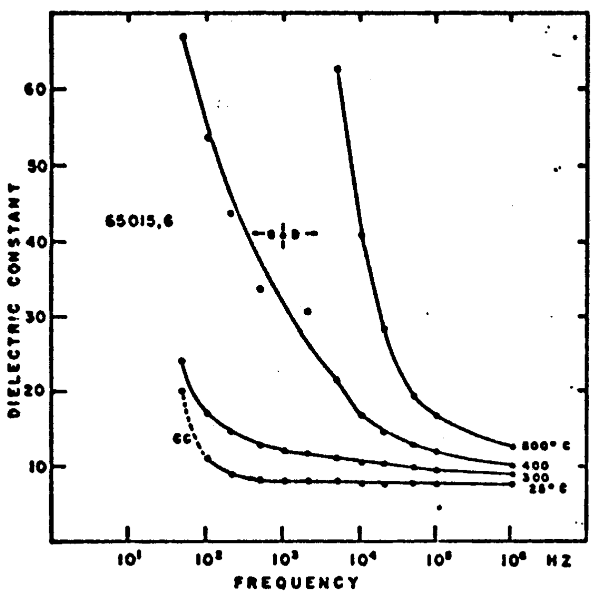

FIGURE 4

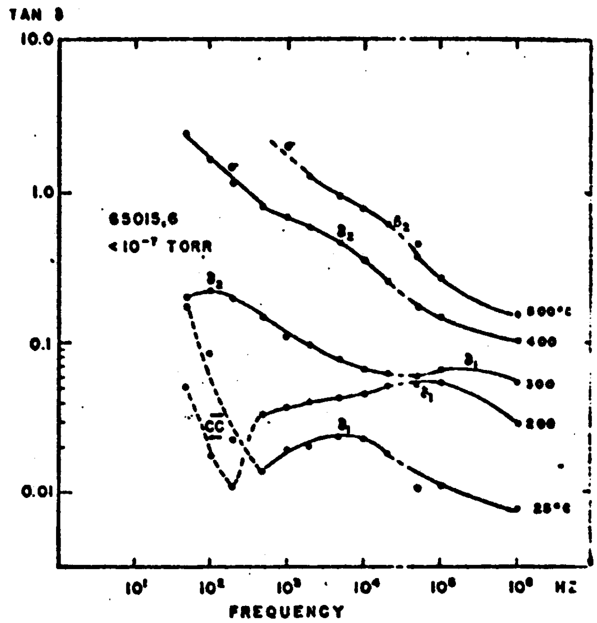

FIGURE 5

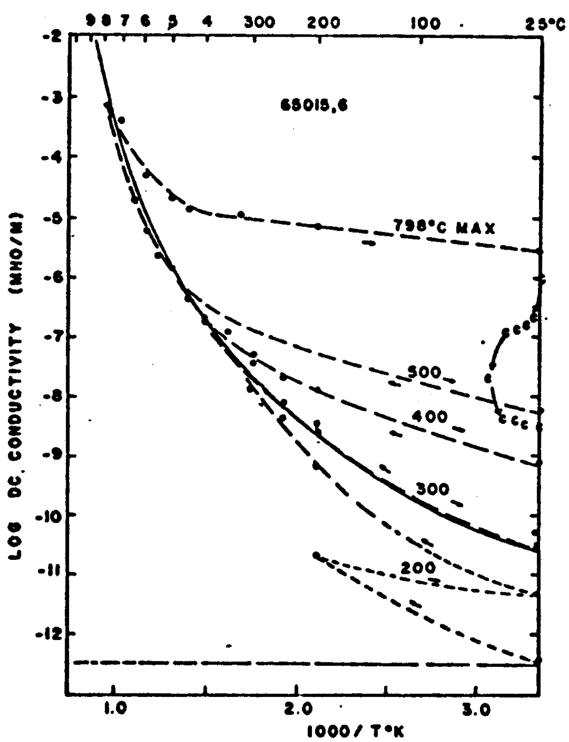

FIGURE 6

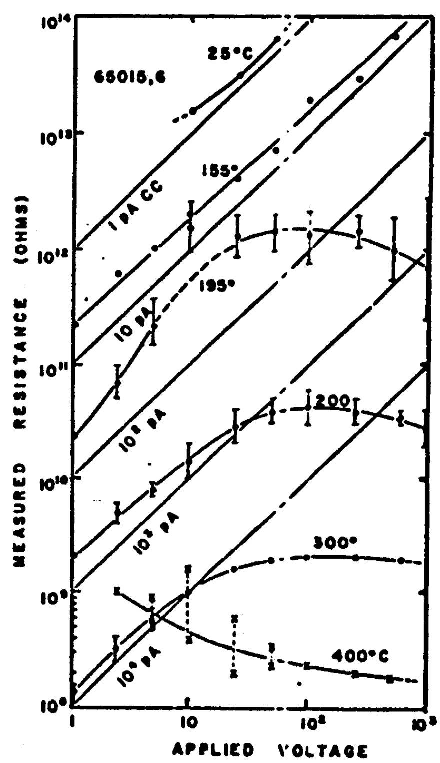

FIGURE 7