infinite dilution. This is certainly reasonable for the aqueous phase, in which the values of the activity coefficients depend on the ionic strength, and in which the ionic strength will barely be affected by changes in the low concentrations of Gd^{3+}. If the same standard state for Gd^{3+} is chosen for all phases, then relative to its value in the aqueous phase, the free ion activity coefficient for Gd^{3+} in the silicate liquids is only about 0.006. On that basis, the assumption which is sometimes made that cations present in trace quantities in a silicate liquid behave as they do in aqueous solution would appear to be a very poor one, at least for the rare earths.

The reaction between a complexing agent (L^{-x}) and Gd^{3+} in a silicate liquid might be represented by the following equation:

$$Gd^{3+} + nL^{-x} \rightleftharpoons GdL_n^{3-nx} \qquad (4)$$

From the equilibrium constant for this reaction, it is seen that the free ion activity of Gd^{3+} would be proportional to the total concentration of Gd in the solution and would vary as the reciprocal of the concentration of the complexing agent to the nth power. Since the effect in nature and in our experiments of the composition of the silicate liquids on the distribution coefficients appears to be small, it is inferred that the entity responsible for lowering the free ion activity of Gd^{3+} is present in copious and approximately constant concentrations in common silicate liquids. If so, as long as the assumptions leading to Eq. 1 are valid, knowledge of distribution coefficients for rare earths is of as much practical use as knowledge of the appropriate activity coefficients for predicting equilibrium concentrations.

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6. Starting mixes were prepared from oxides supplied by Spex Industries Metuchen, N.J. Upper limits of < 1 ppb Gd in these oxides and < 1 ppb Gd in the deionized water were set by neutron activation analysis. Capsules were not buffered with respect to oxygen fugacity because of the stability of the Gd ion in the +3 state.
7. No measurements of the solubility of $GdCl_3$ in water above its critical temperature (647°K) have been made, but water at the pressure and temperature of these experiments is known to be an excellent solvent for NaCl [S. Sourirajan and G. C. Kennedy, *Univ. Calif. Radiat. Lab. Rep. No. 6175* (1960); *Amer. J. Sci.* **260**, 115 (1962)].
8. These obsidians are from Hawaii and Lipari, Italy, and their respective compositions in percentage (by weight), as obtained by electron microprobe measurements, are: SiO_2, 77.1, 75.0; Al_2O_3, 12.1; 12.9; Fe as FeO, 1.08, 1.60; MgO, 0.00, 0.05; CaO, 0.37, 0.71; Na_2O, 3.67, 4.03; K_2O, 5.23, 5.32; TiO_2, 0.09, 0.09; MnO, 0.02, 0.07; H_2O, 0.45, 0.36 (by difference). Their Gd concentrations are < 10 ppm.
9. We thank Drs. P. R. Bender and C. D. Cornwell for helpful suggestions. Supported in part through funds administered by the Research Committee of the Graduate School of the University of Wisconsin and by NSF grants GA-1655 and GA-14070.

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Microwave Noise from Rainstorms

Abstract. *Observations of microwave noise due to rainstorms have been made at 1415 Mhz. The observed effect may well be due to electrical discharge between water droplets.*

It has been suggested that electric discharges occur between charged water droplets during rainstorms, and further that these discharges will produce broadband noise extending into the microwave region (*1*). The intensity of this noise is predicted to be between 20°K and 100°K equivalent noise temperature. Since such an effect would be easily detectable with standard techniques of radio astronomy, we looked for it during the spring and summer of 1969 (*2*).

The observations were made at 1415 Mhz with a 20-foot horn-reflector antenna (2° beam width). This frequency is appropriate, because it is sufficiently low that rain attenuation and associated thermal radiation are very small. Yet this frequency is high enough to insure that galactic radiation is negligible, except near the galactic disk.

The radiometer used a transistor preamplifier and had a bandwidth of 1.5 Mhz centered at 1415 Mhz. The rectified output was recorded on a chart recorder, with the response time of the system determined by the settling time of the pen, ~ 0.5 second. The antenna was pointed at an elevation of 32° and an azimuth of 226°, because a continuously operated 16-Ghz radiometer system oriented in this direction is located approximately 200 m north of our antenna. The 16-Ghz device is part of a system that monitors antenna temperature to obtain atmospheric attenuation statistics at that wavelength.

Observations were made on ten occasions for periods ranging from 24 to 100 hours, during rainy weather. The data included some two dozen heavy rainstorms as well as a number of extended periods of light rain. In no case did the antenna temperature increase during a rainstorm exceed 5°K (*3*), a value an order of magnitude below the predictions mentioned above. Small increases, typically 1°K to 2°K, were observed, however. When these features were compared with the attenuation at 16 Ghz derived from the noise data, good correspondence of features was obtained. The ratio of the equivalent attenuation at 1415 Mhz (that is, the observed increase in antenna temperature divided by 280°K) to the attenuation at 16 Ghz, was typically 2×10^{-3} for heavy rainstorms (Fig. 1).

The sharp spikes on the 1415-Mhz

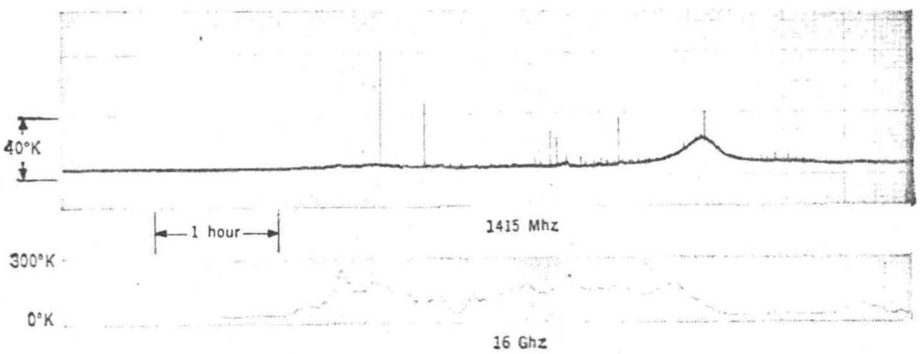

Fig. 1. Radiometer records at 1415 Mhz and 16 Ghz. Small but definite increases in the upper trace coincide with peaks in the lower record.