Dielectric Constant of Powders

MEASUREMENTS have been made at 9,200 Mc/s to determine the dependence of dielectric constant of powder samples' packing densities. The net polarization P produced in a substance in an electric field consists of the contributions of electronic, atomic and dipolar polarizations. It is related to the dielectric constant by Clausius–Masotti relation:

$$KM/d = P_\varepsilon + P_a + P_\mu = P \qquad (1)$$

where $K = (\varepsilon - 1)/(\varepsilon + 2)$, M the molecular weight, ε the dielectric constant and d the density. In a mixture of two dielectrics the net value of K can be determined by summing up the K/d ratio of the individual substances in proportion to the masses. A powder sample is a dielectric–air mixture. If the contribution of air is neglected, it is expected that K/d ratio for the powder at any packing density will be constant. The relation between dielectric constant of solid ε_0 of density d_0 to the dielectric constant of powder sample ε' of density d is hence given by:

$$\frac{\varepsilon' - 1}{\varepsilon' + 2} = \frac{d}{d_0}\frac{\varepsilon_0 - 1}{\varepsilon_0 + 2} \qquad (2)$$

Cumming[1] had made measurements of the dielectric constant of snow of various densities. Snow is an ice–air mixture and hence it should follow relation (2). He has shown that his results from a density of 0·22 to 0·92 g/c.c. follow:

$$\frac{\varepsilon' - 1}{3\varepsilon'} = \frac{d}{d_0}\frac{\varepsilon_0 - 1}{\varepsilon_0 + 2\varepsilon'} \qquad (3)$$

Sulphur was chosen for this work, and powdered sulphur was packed to different densities in sample boxes of varying length. A standing wave technique[2] was used in the determination of the dielectric constant. The results showing the variation of K with density have been plotted in Fig. 1. It is observed that K/d is constant and has a value of 0·25. The value of the permittivity of solid sulphur is 4 at 9,200 Mc/s as compared with square of refractive index of 3·84. The observations of Cumming[1] have also been plotted in Fig. 1 and it is observed that K/d ratio for snow has a constant value of 0·48. Measurements made with the other substances, such as barium chloride (also plotted in Fig. 1), give the K/d ratio constant. It is concluded that the K/d ratio is constant for dielectric–air or powder samples. Detailed measurements on other samples will be reported later.

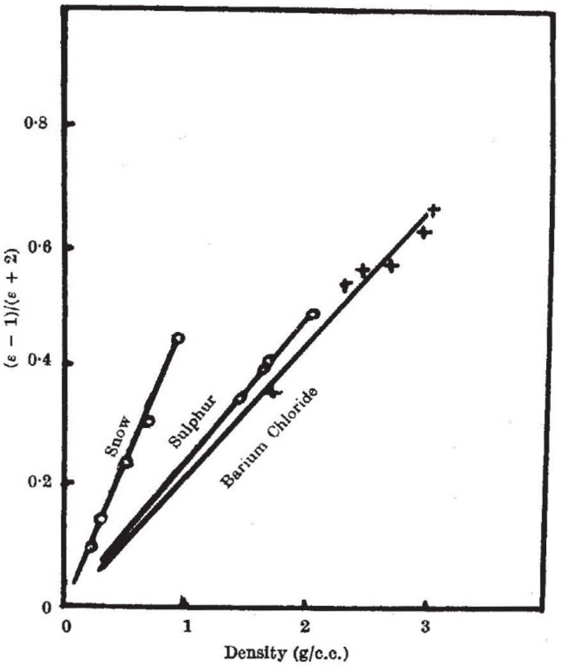

Fig. 1. Variation of $(\varepsilon - 1)/(\varepsilon + 2)$ of snow, sulphur powder and barium chloride powder with packing densities

PREM SWARUP
R. P. ARORA

Institute of Armament Studies,
Poona.

[1] Cumming, W. A., *J. App. Phys.*, 23, 768 (1962).
[2] Von Hippel, A., *Dielectric Materials and Applications* (John Wiley and Sons, 1954).

GEOLOGY

Some Markings associated with Ripple-marks from the Proterozoic of North America

IN a recent communication[1], Frarey and McLaren described vermiform markings on ripple-marked bedding surfaces of Huronian quartzites near Sault Ste. Marie, Ontario, and interpreted these markings as possible metazoan relics, while discounting the alternative hypotheses of desiccation cracks 'worm casts' (or gut casts of any kind) and feeding burrows. During the past several years very similar markings have been described from Proterozoic rocks in other regions.

Faul[2,3] described gently curving sinuous markings from ripple-marked Middle Huronian quartzites near Ishpeming, Michigan, and interpreted them as burrows. These markings average several cm long and are 3–5 mm wide, and ". . . appear to be uniform, sinuous ropes of sand, closely following the uneven bedding surfaces, but separated from them by a thin film of ferruginous material much the same as the coating of the bedding planes themselves"[2]. Faul does not indicate a relationship between the burrows and the ripple-marks, but his Fig. 1, p. 104, seems to illustrate that the burrows cross the ripples obliquely, with a possible relationship existing between the wave-length of the sinusoidal burrows and the wave-length of the ripple-marks.

Wheeler and Quinlan[4] described sinusoidal markings which they considered to be mud-cracks, lying in the troughs of ripple-marks in Proterozoic quartzites from Montana and northern Idaho. The mud-cracks are essentially restricted to the troughs of the ripple-marks where thin layers of fine silts had collected which permitted the formation of the desiccation cracks. Their paper includes a photograph showing sinusoidal mud-cracks in ripple troughs grading into normal polygonal mud-cracks where the ripples are not so well developed.

We became interested in aberrant forms of 'desiccation cracks' while engaged in regional correlation of the Proterozoic Belt series in north-west Montana. Sinusoidal markings were found in the troughs of ripple-marks in quartzite beds of the Striped Peak Formation about 26 km south-south-east of the town of Libby, Montana. We also found curved, circular, and 8-shaped marks (Fig. 1) in the 'nests' formed by the intersecting troughs of two sets of ripple-marks in quartzites of the Kintla Formation in the valley of Moran Creek 5·5 km west-north-west of its confluence with the North Fork Flathead River and about 44 km north of the town of Columbia Falls, Montana. The Kintla Formation is a partial stratigraphic equivalent of the Striped Peak.

We interpret the formation of the markings in the following manner: After the development of the rhomboid ripple-marks in the sand bed, finer detritus settled in the lower 'nests' between the ripple crests. Withdrawal of the water in which the deposit was formed and evaporation initiated desiccation. The more permeable and incoherent coarser sand of the ripple crests dried first without cracking, then the less permeable and more coherent muds between the crests dried and began to