one-tenth of this value at two low-latitude stations (Lwiro, lat. 2° S., and Nha-Trang, lat. 12° N.). The much larger variation at the middle-latitude stations is at least qualitatively in accordance with equation (3).

A more stringent quantitative test of the validity of equation (3) can, however, be applied. The values of log f_d, based on Eyfrig's data for quiet Sun conditions, were plotted against the corresponding values of log cos χ_{12} for Lindau and Freiburg. As expected, the values of f_d for the two stations differed by an amount corresponding approximately to the latitude variations in the E-layer as described by Harnischmacher[5], but each set of points lay near a straight line that was consistent with equation (3) provided that $1{,}000(m - n) = 70 \pm 5$ at Freiburg, and 60 ± 5 at Lindau.

Independent evidence concerning the individual values of m and n is also available and can be used to show that the figures just quoted are close to those expected. Eyfrig has investigated values of m during quiet Sun conditions, and has found annual mean values of 0·319 at Lindau and 0·313 at Freiburg. The differences between the annual mean and the individual monthly values have a range of about $\pm$ 0·02 if one doubtful value is omitted. Although the E-layer index of Minnis and Bazzard, and hence f_a, contains a small semi-annual variation (equation 4), it contains no detectable annual variation; this implies that n, as defined by equation (1), must be close to 0·25 and confirmation of this has been given by Beynon and Brown[6]. Nevertheless it is possible that a departure of 0·005 from this value would not have been detected and a value 0·25 $\pm$ 0·005 seems a reasonable one to adopt.

Table 1 shows the differences (column 3) between these separately determined values of m and n at Freiburg and Lindau, together with the values (column 4) of $(m - n)$ obtained from the plots of Eyfrig's data for f_d. The two sets of values are in good agreement and it is concluded that the annual variations in f_d can be accounted for mainly in terms of the relation between f_d and f_a expressed by equation (3).

Table 1. VALUES OF THE COEFFICIENTS m AND n AT TWO MIDDLE-LATITUDE STATIONS

Station	1,000 m	1,000 n	1,000 $(m-n)$ 1–2	1,000 $(m-n)$ From f_d plots
	1	2	3	4
Freiburg	313 ± 20	250 ± 5	63 ± 20	70 ± 5
Lindau	319 ± 20	250 ± 5	69 ± 20	60 ± 5

If this interpretation of the data is correct, the summer minimum in f_d at middle-latitude stations, and its absence at equatorial stations, can be explained without considering hypotheses such as the additional winter ionizing agency postulated by Shimazaki[7] or the magnetic distortion suggested by Eyfrig[8].

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[1] Nicolet, M., and Bossy, L., *Ann. Geophys.*, **5**, 275 (1949).
[2] Minnis, C. M., and Bazzard, G. H., *J. Atmos. Terr. Phys.*, **18**, 306 (1960).
[3] Eyfrig, R., *Geofis Pura e Appl.*, **45**, 179 (1960).
[4] Minnis, C. M., *Proc. Thirteenth Gen. Assem. U.R.S.I.*, **12**, Pt. 3, 10 (1960).
[5] Harnischmacher, E., *C.R. Acad. Sci. Paris*, **230**, 1301 (1950); **240**, 553 (1955).
[6] Beynon, W. J. G., and Brown, G. M., *J. Atmos. Terr. Phys.*, **14**, 138 (1959).
[7] Shimazaki, T., *J. Rad. Res. Lab. Japan*, **7**, 95 (1960).
[8] Eyfrig, R., *Nature*, **196**, 758 (1962).

Luminescence of Meteorites

IN a recent communication[1] Derham and Geake have reported on the proton excited luminescence of some stony meteorites. The emission shows a prominent red emission with a maximum at 6700 Å together with a smaller emission peak at 4000 Å. Such meteorites of the enstatite achrondite group have a significant content of magnesium metasilicate $MgSiO_3$, which suggests that the red luminescence is associated with manganese impurity centres in this silicate. The material is well known as a synthetic cathodoluminescent phosphor, and in Fig. 1 the spectrum of a typical synthesized specimen excited by 5-kV cathode rays[2] is compared with that of the emission due to proton excitation for the Khor Temiki meteorite as measured by Derham and Geake[1]. The synthetic phosphor contains 0·15 mol. per cent of manganese. Higher concentrations promote an additional emission peak of comparable intensity at about 7400 Å which is not present in the meteorite specimen.

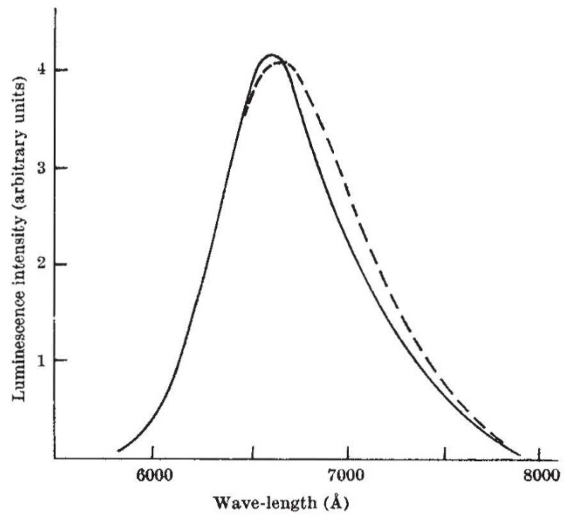

Fig. 1. Luminescence emission spectra of: (*a*) material from Khor Temiki meteorite excited by 40-keV protons (ref. 1, (– – –); (*b*) magnesium silicate phosphor activated by 0·15 mol per cent manganese excited by 5-keV cathode rays (ref. 2) (——)

The estimated efficiency of the meteorite emission seems very high, and is many times that of synthesized materials excited by cathode rays. In view of the fact that there are many other trace impurities present in the meteorite than in the synthetic phosphor the higher efficiency of the former may be associated with a fluorescence sensitization of the manganese emission by another kind of impurity present.

Investigations are in progress to explore the sensitization effect of various impurities on the red emission of magnesium silicate phosphors.

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[1] Derham, C. J., and Geake, J. E., *Nature*, **201**, 62 (1964).
[2] Fonda, G. R., and Froehlich, H. C., *Solid Luminescent Materials*, 385 (Wiley, New York, 1948).

Dating Geomagnetic Polarity Zones

INDEPENDENTLY McDougall and Tarling[1] and Cox, Doell and Dalrymple[2] recently published results from Hawaii and the Sierra Nevada, respectively, on magnetic polarities and the age of volcanic rocks. The polarities determined on rocks from these two regions were made using standard palæomagnetic techniques including magnetic cleaning. There was some disagreement among the results published in these two papers; but in view of errors in geological correlation made by Cox *et al.*[2] and later corrected[3], it is desirable to clarify the present position, for the two sets of data are now found to be in good agreement. The aim of this comparison is to attempt to establish whether or not rocks with normal and reversed polarities in these two regions occur in the same time sequence. If rocks of the same age have the same polarity