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THE GEOMAGNETIC EQUATOR

RECENT literature on the subject of terrestrial magnetism reveals that there is some confusion in the understanding of the term "Magnetic Equator", as it can be considered from two points of view—first from a knowledge of the dip angles (this being zero on the magnetic equator); and second from calculations based on the assumption that the earth's magnetic field is best represented by a small but powerful magnetic dipole at the geometrical centre of the earth. The latitudes determined by measurements of dip angles are designated "Magnetic Latitudes" and those calculated on the basis of the dipole theory are called "Geomagnetic Latitudes". Many workers seem to think that the two are identical while some make this distinction.

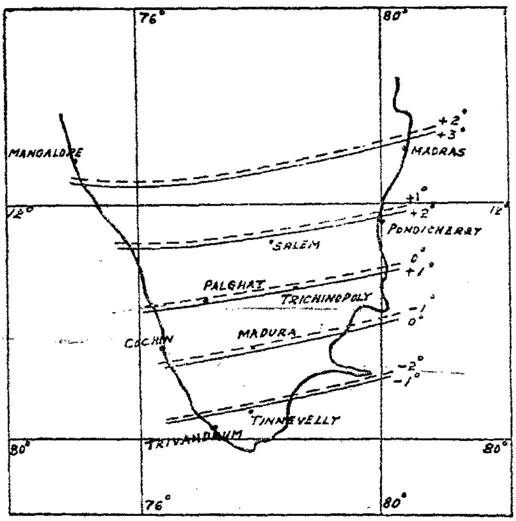
The measurements of polarisation of radio waves carried out at Huancayo where dip is 2° 10′ S, by Wells and Berkner[1] show that the ordinary and extraordinary rays are plane polarised as demanded by theory. This result leads to the view that it is the geomagnetic equator which counts and not the magnetic equator, so far as ionospheric work is concerned.

Appleton[2] first showed that for noon equinox conditions F_2 critical frequencies plotted against dip angles give symmetrical curves about the magnetic equator with maxima at 28° N. and S. Appleton[3] and later, Liang[4] have replotted the F_2 ionisation densities against geomagnetic latitudes in place of magnetic latitudes. From these curves it can be safely concluded that it is more reasonable to use geomagnetic latitudes rather than the magnetic latitudes for the determination of the geomagnetic control over the ionosphere.

The apparent divergence between the magnetic and geomagnetic latitudes may be explained as follows. The geomagnetic potential V is made up of two parts V_e and V_i

$$V = V_e + V_i,$$

where V_e and V_i are parts of external and internal origin respectively. Bauer[5] in his spherical harmonic analysis of the earth's field has shown that the field of internal origin forms 94% of the total field; the field of external origin being 3% and a non-potential part N due to earth air currents being 3%. The measurement of inclination is governed by local conditions and it represents the entire field while the dipole theory takes into account only the 94% of the total field. Although the divergence between the magnetic and geomagnetic latitudes is not much, it is there in principle and has to be considered.



A precise knowledge of the geomagnetic equator is hence necessary for those engaged in work on ionosphere, cosmic radiation and geophysical problems. To suit their needs McNish[6] has published nomographs from which the geomagnetic co-ordinates can be read off for any terrestrial point. The geomagnetic co-ordinates of any place can be calculted from the following equations:—

$$\tan x = \cos (\lambda - \lambda_0) \cot \phi$$
$$\tan \wedge = - \tan (\lambda - \lambda_0) \sin x \sec (x + \phi_0)$$
$$\tan \Phi = - \cos \wedge \operatorname{Tan} (n + \phi_0)$$

where λ_0, ϕ_0 are the co-ordinates of the geomagnetic pole; λ, ϕ are the geographical co-ordinates of the place and are Λ, Φ the geomagnetic co-ordinates of the place. x is the auxiliary angle. These calculations have been performed on the assumption that the earth's magnetic field is represented by a dipole at the geometric centre of the earth.

Later, it[7] has been shown that a still closer approximation to the earth's magnetic field is given by assuming it to be due to a dipole displaced 342 km. from the earth's centre towards a point in longitude 162° E. and latitude 6°·5 N., with its axis parallel to the line through the centre of the earth and the geomagnetic pole. Bartels has shown that the eccentric dipole gives a truer picture of the observed field than the centred dipole, especially in the equatorial region.

According to Vallarta[8] this asymmetry in the magnetic field is fully competent to account for the observations of clay, Alfven, Milikan and Neher on cosmic radiation. Also Heisenberg[9] has clearly stated that the magnetic centre does not coincide with the earth's centre.

The author has calculated the geomagnetic latitudes for about 50 places in South India, both for the centred and the eccentric dipole, using the equations given above. It was found from the analysis of the 1945 data that the co-ordinates of the geomagnetic North Pole are 78°·7 N. and 289°·9 E. in place of the earlier values of 78°·5 N. and 291°·0 E. The latest figures have been used in the present calculations; for the eccentric dipole the co-ordinates of the geomagnetic North Pole are 80°·1 N. and 277°·3 E.

The geomagnetic latitudes have been drawn at intervals of 1° (unbroken lines refer to centred dipole and the broken lines refer to eccentric dipole) in the map given in the preceding column.

The geomagnetic equator for the eccentric dipole agrees with Vallarta's results, and it is suggested that the eccentric dipole field is to be taken into account when geomagnetic latitudes are required for work in the Indian Reigion.

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