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METRIC CONVERSION AND GEOPHYSICS

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Following the Metric Conversion Act of July, 1970, the Metric Conversion Board has circulated Universities and will be encouraging industry to commence the conversion to the new International System (SI) units. In addition, there is the still valid reason that the new units are inherently simpler (Koefoed, 1967; Green, 1968) than the old units which they replace. The approved system is based on the following seven fundamental units:-

kilogram	kg
metric	m
second	sec
ampere	A
kelvin	°K
candela	ca
mole	n

With these units and with all derived units, only approved submultiples are to be used, e.g:-

milli	10^{-3}	m
micro	10^{-6}	μ
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f

It is the sub-multiples which are usually of significance in Geophysics. Some inconvenience arises in the change from the traditional c.g.s. units to the SI units, but some inconvenience in passing is preferable to continuing confusion in the future.

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Gravity: Density, in future, will be given in terms of k gram/cubic metre, in which case the density of water is 1000 kg m^{-3}, and the normal continental crust will be given as 2670 kg m^{-3}.

The expression for the International Formula (1924) is recast as:-

$$\Gamma_o = 9.780490\ (1+0.0052884 \sin^2 \phi - 0.0000059 \sin^2 2\phi)\ \text{m-sec}^{-2}.$$

The old c.g.s. unit of cm sec^{-2} or gal (named in honour of Galileo, Jung, 1961; Jeffreys, 1962) is to be replaced, and along with it will be the geophysical unit of the milligal. This is because the "gal" and the "milligal" are not approved sub-multiples in the SI and are to be replaced for this reason. However, the once popular "gravity unit" or 1/10 mgal turns out to be 10^{-6} m-sec^{-2} and is thus an approved sub-multiple. Because of the need in geophysics for the unit of acceleration, it is advocated that the proposal (Reilly, 1971; Parasnis, 1971) for the unit of m sec^{-2} be called the Galileo, be adopted. In this case the "gravity unit" becomes the micro-Galileo. Hence,

1 milli gal ≡ 10 μ Galileo

In other words, the gravimeter will be reading in steps of "μ Galileo" instead of the "gravity-unit" of 1/10 milli gal. Contour maps will be given in terms of the convenient unit of "Galileo" or

0.1 milli gal.

Contour maps of the vertical gradient or of first derivative will be unchanged with the new SI units. This is because it has been tradition to give vertical gradients in terms of Eotvos units (= 10^{-9} sec^{-2}) which depends only on the dimension sec^{-2} and consequently does not require any change.

In the case of the second derivative contour maps, the unit is strictly m^{-1} sec^{-2} but usage has it to quote it in terms of milli gal/km^2, and it would seem more meaningful to continue to use milli gal/km^2 which is $10^{-15}m^{-1}sec^{-2}$. This quantity is an SI-approved sub-multiple of the basic unit of m^{-1} sec^{-2} and the prefix to denote 10^{-15} is femto (symbol f).

Consequently it would appear logical to continue to use milli gal/km; contour maps of which would be unchanged but expressed as femto m^{-1} sec^{-2}.

The Universal Gravitational Constant, G, is numerically equal to 66.7 10^{-12} m^3 kg^{-1} sec^{-2} in the SI.

Magnetics: It is in geomagnetism that there could well be the greatest reluctance to change. Fortunately the SI unit of magnetic flux, B, is the Tesla (or Weber/m^2) and the geophysical unit that has been in common use is the gamma, and

$$1 \text{ gamma} \equiv 1 \text{ nano-Tesla} \equiv 1 \text{ n Tesla}$$

In other words, the magnetic anomaly map remains unchanged except that the contours in gamma are renamed as contours in n Tesla.

Susceptibilities of rocks, x, being a dimensionless ratio between the magnetization M and magnetic intensity, H. remains unchanged. However, let us hope that the old silliness of quoting susceptibilities (which are dimensionless) as x c.g.s.e.m. units - it is a pure number, unchanged in value in the change to the SI units - will be discontinued.

The magnetization, M, for rocks presents a distinct difficulty because the SI unit of amp m^{-1} is $1000/4\pi$ of the old unit of intensity of magnetization. Where maps of surface magnetization, M, are presented there seems little alternative but to present the data in terms of milli amp/m. These are convenient in magnitude being $1/4\pi$ numerically, of the contour values of the the old units which have been used. Also where the dimension of the new SI unit is clearly stated, there is little room for confusion with c.g.s. values.

In other fields of geophysics, seismic velocities in m/sec are well established, likewise resistivity values in ohm-m are widely used and there is no difficulty in the change to SI units.

Conclusion: It would appear that it is advisable for geophysicists to make the change recommended initially by the E.A.E.G. in 1967 (Koefoed, 1967) as soon as possible so as to conform with the SI units, especially as, in the future, science and later the general public will use the SI units exclusively. By making the change now, continuing confusion may be avoided in the future. Besides asking for conformity with the SI unit, there is the proposal that the SI unit of acceleration be called the Galileo (m sec^{-2}) in which case the geophysical gravity unit of 0.1 mgal would be 1 μ Galileo.

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