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Note on the Variation of Gravity with Depth

By **A. E. Benfield,** Dept. Geodesy and Geophysics, Cambridge. — (with 1 figure)

A table and curve showing the value of g at different distances from the centre of the earth have been computed from the latest density distribution data. Gravity is shown to be remarkably uniform over a large distance.

In a recent paper Bullen *) gives the variation of density within the earth. Since then it has been shown by Jeffreys**) that the values require a small alteration, a depth of about 480 km. having been found for the 20^0 discontinuity instead of the somewhat lesser depth used by Bullen. In none of these papers is the variation of g with depth given explicitly.

Since these densities give a remarkable uniformity of g over half the distance to the centre of the earth it is perhaps of interest to give a table of values and a curve.

In making the calculations the revised density values have been used, and the earth has been regarded as a non-rotating sphere, an assumption which is justified by the uncertainty of the density values.

At a distance r from the centre of the earth the value of gravity,

$$g_r = \frac{G \cdot 4\pi \int_0^r \varrho_r r^2 \, dr}{r^2} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where G is the constant of gravitation and ϱ_r the density at the point considered.

From $r = 0$ to 1070 km. g_r has been evaluated by using a power series approximation for ϱ_r. Beyond this distance g_r has been obtained by numerical integration in steps of 200 km. or less. The results are given in Table 1 and Fig. 1.

Table 1. Gravity and densities at different distances from the centre of the earth

r km	ϱ g/ccm	g cm/sec²	r km	ϱ g/ccm	g cm/sec²
6370	2.67	982***)	3670	5.43	1018
6200	3.44	986	3470	5.53	1042
5900	4.23	995		9.75	
5670	4.39	990	2870	10.50	898
5270	4.64	983	2270	11.13	733
4870	4.84	978	1670	11.58	550
4470	5.04	979	1070	11.88	356
4070	5.23	990	500	12.04	170

*) M. N. R. A. S., Geophys. Suppl. Vol. 3, No. 9, p. 395 (1936)

**) Ebenda Vol. 4, No. 1, p. 50 (1937); Vol. 4, No. 1, p. 62 (1937).

***) Values in this column have been adjusted by $^1/_2\%$ to bring g at the surface to 982.

Inside the core gravity falls off rapidly, but between the core and the surface gravity is nearly constant. To obtain the condition for g_r to be constant one may differentiate equation (1) setting $dg_r/dr = 0$, whence,

$$\varrho_r = \frac{2}{3}\bar{\varrho} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

where $\bar{\varrho}$ is the average density of that part of the earth between r and the centre. This condition is satisfied at 3470, near 4720, and at 5897 km. from the centre.

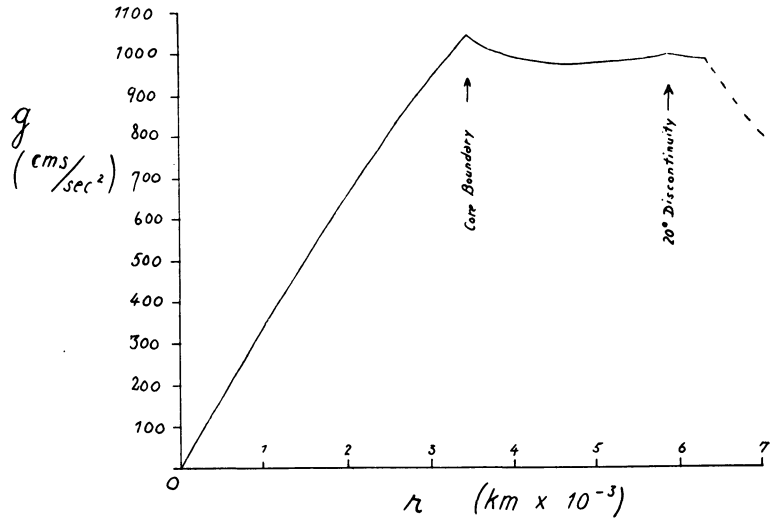

Fig. 1.
Showing the value of gravity plotted against distance from the centre of the earth