Note on the Density and Pressure Inside the Earth

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THE writer recently (1936) carried out an investigation of the variation of density and pressure within the earth. Since the publication of results, however, there have been certain significant improvements to the data used, and it has become desirable to recalculate the figures previously obtained. As was anticipated in the previous paper, the corrections lead to no general disturbance of the former results, but merely to improved numerical values. In particular, the evidence for an appreciable density increase at the new discontinuity remains.

The most important of the improvements to the data is concerned with Jeffreys's more exact determination (1936) of the depth of the new discontinuity within the earth as 481 ± 21 km., instead of 350 km. as previously taken by the writer. The second improvement is the use of more recent values of the velocities of P and S seismic waves in the earth's interior. These include the results of Jeffreys down to a depth of 800 km. and the latest results of Gutenberg and Richter (1935) at greater depths. The latter differ from those previously used chiefly in involving a greater range of variation of velocity within the earth's central core. In addition, the depth of the boundary of the central core has been taken as 2920 km. in conformity with the results of Gutenberg and Richter, while the thickness of the granitic and "intermediate" layers have been taken as 14 and 28 km., in order to be consistent with Jeffreys's investigation.

The recalculation of the density and pressure has been carried out exactly after the manner described in the previous paper. In the absence of precise knowledge of the temperature variation at considerable depths below the earth's surface, no allowance has been made for the possible influence of this factor. Its effect would be to reduce slightly the rate of increase of density with depth in any particular layer, but the consequent alterations to the following figures would be very small.

The new figures for the density ρ (in grm./cm.^{3}) and the pressure p (in dynes/cm.^{2}) at various depths d km. below the earth's surface are as follows:—

d	ρ	$p \times 10^{-12}$	d	ρ	$p \times 10^{-12}$
42	3.32	0.011	2920	5.56 / 9.69	1.359
100	3.37	0.030	3000	9.82	1.44
200	3.46	0.064	3200	10.13	1.64
300	3.55	0.099	3400	10.41	1.84
400	3.63	0.134	3600	10.66	2.03
481	3.69 / 4.23	0.164	3800	10.89	2.22
500	4.25	0.172	4000	11.10	2.39
600	4.32	0.215	4200	11.30	2.56
800	4.45	0.302	4400	11.47	2.73
1000	4.57	0.391	4600	11.62	2.87
1200	4.69	0.481	4800	11.75	3.00
1400	4.80	0.575	5000	11.86	3.12
1600	4.91	0.669	5200	11.95	3.22
1800	5.01	0.767	5400	12.02	3.31
2000	5.12	0.866	5600	12.08	3.38
2200	5.21	0.968	5800	12.13	3.44
2400	5.31	1.072	6000	12.15	3.48
2600	5.40	1.179	6200	12.17	3.50
2800	5.50	1.290	6371	12.17	3.51

The values of the ellipticities of internal strata of equal density as calculated in the earlier paper are not affected by the changes by more than 0·00001 down to depth of 2600 km. Inside the central core the values are slightly lower than those found previously, varying from 0·00258 at the boundary to 0·00250 at the centre.

The mean density, mass, and moment of inertia of the earth's central core are now 10·76, $185{\cdot}3 \times 10^{25}$ grm., and $8{\cdot}58 \times 10^{43}$ grm. cm.^{2}, respectively. The mean density of the shell is 4·49.

It is of interest to refer to the relation between density and pressure of the material of the earth's central core. This is indicated in the accompanying diagram, in which the dotted part of the curve corresponds to an extrapolation for pressures less than that at the core's boundary. Although the extrapolation is liable to some uncertainty, it appears that at zero pressure the density would probably be fairly near 7·0. Recent investigations give the density of molten iron at its melting point at $6{\cdot}92 \pm 0{\cdot}07$. Although temperature effects have of course been ignored, the diagram appears to support reasonably well the suggestion made in the earlier paper that the earth's core consists very largely of iron without appreciable quantities of heavier metal.

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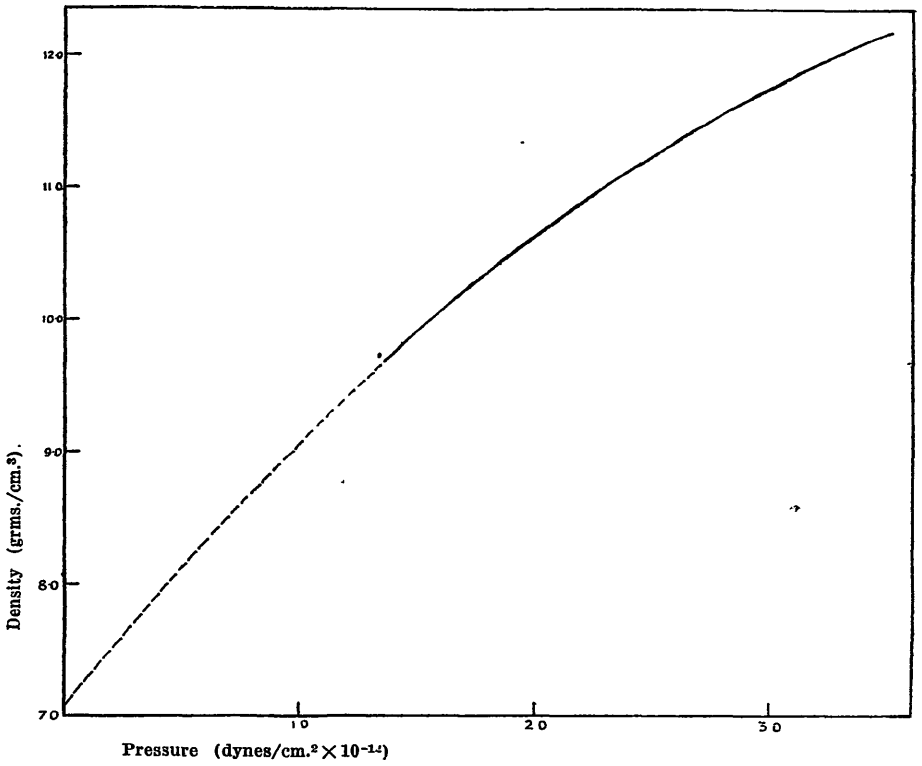

Graph of the relation between the density and pressure of the material of the Earth's central core.